Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the

MISCELLANEOUS FOODS AND BEVERAGES

Point Source Category

Prepared by
ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
GAINESVILLE, FLORIDA

FEBRUARY, 1975

For

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DRAFT

DEVELOPMENT DOCUMENT FOR
EFFLUENT LIMITATIONS GUIDELINES
AND NEW SOURCE PERFORMANCE STANDARDS

MISCELLANEOUS FOODS AND BEVERAGES
POINT SOURCE CATEGORY

PREPARED BY
ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
P. O. BOX 13454
GAINESVILLE, FLORIDA 32604
FEBRUARY 1975

FOR:
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NOTICE

The attached document is a DRAFT CONTRACTOR'S REPORT. It includes technical information and recommendations submitted by the Contractor to the United States Environmental Protection Agency ("EPA") regarding the subject industry. It is being distributed for review and comment only. The report is not an official EPA publication and it has not been reviewed by the Agency.

The report, including the recommendations, will be undergoing extensive review by EPA, Federal and State agencies, public interest organizations and other interested groups and persons during the coming weeks. The report and in particular the contractor's recommended effluent guidelines and standards of performance is subject to change in any and all respects.

The regulations to be published by EPA under Sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended, will be based to a large extent on the report and the comments received on it. However, pursuant to Sections 304(b) and 306 of the Act, EPA will also consider additional pertinent technical and economic information which is developed in the course of review of this report by the public and within EPA. EPA is currently performing an economic impact analysis regarding the subject industry, which will be taken into account as part of the review of the report. Upon completion of the review process, and prior to final promulgation of regulations, an EPA report will be issued setting forth EPA's conclusions regarding the subject industry, effluent limitations guidelines and standards of performance applicable to such industry. Judgements necessary to promulgation of regulations under Sections 304(b) and 306 of the Act, of course, remain the responsibility of EPA. Subject to these limitations, EPA is making this draft contractor's report available in order to encourage the widest possible participation of interested persons in the decision making process at the earliest possible time.

The report shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the Contractor who studied the subject industry and prepared the information and recommendations. It cannot be cited, referenced, or represented in any respect in any such proceedings as a statement of EPA's views regarding the subject industry.

U. S. Environmental Protection Agency
Office of Water and Hazardous Materials
Effluent Guidelines Division
Washington, D. C. 20460

DRAFT

ABSTRACT

This document presents the findings of an extensive study of the Miscellaneous Foods and Beverages Point Source Category by Environmental Science and Engineering, Inc., SCS Engineers, Inc., and Environmental Associates, Inc., for the purpose of presenting recommendations to the United States Environmental Protection Agency for Effluent Limitations Guidelines, Standards of Performance, and Pretreatment Standards for the industry for the purpose of implementing Sections 304, 306, and 307 of the Federal Water Pollution Control Act, as ammended.

Effluent Limitation Guidelines recommended herein set forth the degree of effluent reduction attainable through the application of the Best Practicable Control Technology Currently Available (BPCTCA) and the degree of effluent reduction attainable through the application of the Best Available Technology Economically Achievable (BATEA) which must be achieved by existing point sources by July 1, 1977, and July 1, 1983, respectively. The Standards of Performance for New Sources (NSPS) recommended herein set forth the degree of effluent reduction which is achievable through the application of the Best Available Demonstrated Control Technology, Processes, Operating Methods, or other alternatives.

Supportive data and rationale for subcategorization of the Miscellaneous Foods and Beverages Industry and for development of recommended Effluent Limitations Guidelines and Standards of Performance are contained in this document.

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

DRAFT

TABLE OF CONTENTS

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

SECTION | PAGE

DRAFT

TABLE OF CONTENTS
(CONTINUED)

L.JA. I

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

TABLE OF CONTENTS
(CONTINUED)

SECTION | PAGE

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONT'D)

DRAFT

TABLE OF CONTENTS
(CONT'D)

DRAFT

FIGURES

DRAFT

FIGURES
(CONTINUED)

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

FIGURES
(CONTINUED)

DRAFT

FIGURES
(CONTINUED)

DRAFT

LIST OF TABLES

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLES
(CONTINUED)

DRAFT

TABLE OF CONTENTS
(CONTINUED)

DRAFT

SECTION I

CONCLUSIONS

For the purpose of developing recommended Effluent Limitations Guidelines, this study subcategorizes the industry as follows:

VEGETABLE OIL PROCESSING AND REFINING

A1 Establishments primarily engaged in the production of unrefined vegetable oils and by-product cake and meal from soybeans, cottonseed, flaxseed, peanuts, safflower seed, sesame seed, sunflower seed by mechanical screw press operations.

A2 Establishments primarily engaged in the production of unrefined vegetable oils and by-product cake and meal from soybeans, cottonseed, flaxseed, peanuts, safflower seed, sesame seed, sunflower seed by direct solvent extraction or prepress solvent extraction techniques.

A3 Establishments primarily engaged in the production of olive oil and by-product cake or meal from raw olives by hydraulic press and solvent extraction methods.

A4 Establishments primarily engaged in the production of olive oil and by-product cake or meal from raw olives by mechanical screw press methods.

A5 Establishments primarily engaged in the processing of edible oils by the use of caustic refining methods only.

A6 Establishments primarily engaged in the processing of edible oils by the use of caustic refining and acidulation refining methods.

A7 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, acidulation, bleaching, deodorization, winterizing, and hydrogenation.

A8 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, bleaching, deodorization, winterizing, and hydrogenation.

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

DRAFT

A9 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, acidulation, bleaching, deodorization, and the production of shortening and table oils.

A10 Establishments primarily engaged in the processing of edible oils utilizing the following refinery methods: caustic refining, bleaching, deodorization, winterizing, hydrogenation, and the plasticizing and packaging of shortening and table oils.

A11 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, acidulation, bleaching, deodorization, winterizing, hydrogenation, and the plasticizing and packaging of shortening, table oils, and margarine.

A12 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, bleaching, deodorization, winterizing, hydrogenation, and the plasticizing and packaging of shortening, table oils, and margarine.

A13 Establishments primarily engaged in the processing of edible oils into margarine.

A14 Establishments primarily engaged in the processing of edible oils into shortening and table oils.

A15 Establishments primarily engaged in the refining of olive oil.

BEVERAGES

A16 Production of malt beverages by breweries constructed since January 1, 1950, and with a production capacity in excess of 800 cubic meters per day. In addition, this subcategory includes plant 82A16.

A17 Production of malt beverages by breweries constructed before January 1, 1900, and with a production capacity in excess of 2000 cubic meters per day.

A18 Production of malt beverages by breweries not included in subcategories A16 and A17.

A19 Installations primarily engaged in the production of malt and malt by-products.

A20 Wineries primarily engaged in the production of wine, brandy, or brandy spirits, and not operating stills.

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

A21 Wineries primarily engaged in the production of wine, brandy, or brandy spirits, and operating stills.

A22 Distilleries primarily engaged in the production of beverage alcohol from grains and operating stillage recovery systems.

A23 Distilleries primarily engaged in the production of beverage alcohol from grains and not operating stillage recovery systems.

A24 Distilleries primarily engaged in the production of beverage alcohol by distillation of molasses.

A25 Installations primarily engaged in the blending and bottling of purchased wines of spirits.

A26 Installations primarily engaged in the production of soft drinks; and which package exclusively in cans.

A27 Installations primarily engaged in the production of soft drinks; and which are not included in Subcategory A26.

A28 Installations primarily engaged in the production of beverage base syrups, all types

A30 Installations primarily engaged in the production of instant tea.

C8 Installations primarily engaged in the production of roasted coffee.

C9 Installations primarily engaged in the decaffeination of coffee.

C10 Installations primarily engaged in the production of soluble coffee.

F1 Installations primarily engaged in the blending of tea.

BAKERY AND CONFECTIONERY PRODUCTS

C1 Production of cakes, pies, doughnuts, or sweet yeast goods, separately or in any combination, by facilities using pan washing.

C2 Production of cakes, pies, doughnuts, or sweet yeast goods separately or in any combination by facilities not using pan washing.

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

DRAFT

C3 Installations primarily engaged in the production of bread related products

C7 Installations primarily engaged in the production of cookies or crackers separately or in any combination.

C13 Installations primarily engaged in the production of bread and buns in any combination.

C14 Installations primarily engaged in the production of bread and snack items, in any combination.

D1 Installations primarily engaged in the production of candy or confectionery products separately or in any combination, except glazed fruits.

D2 Installations primarily engaged in the production of chewing gum.

D3 Installations primarily engaged in the production of chewing gum base.

D5 Installations primarily engaged in the production of milk chocolate with condensory processing.

D6 Installations primarily engaged in the production of milk chocolate without condensory processing.

PET FOODS

B5 Installations primarily engaged in the production of canned pet food, low meat.

B6 Installations primarily engaged in the production of canned pet food, high meat.

B7 Installations primarily engaged in the production of pet food, dry.

B8 Installations primarily engaged in the production of pet food, soft moist.

MISCELLANEOUS AND SPECIALTY PRODUCTS

A29 Installations primarily engaged in the production of flavorings, or extracts, separately or in any combination.

A31 Installations primarily engaged in the production of bouillon products.

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

DRAFT

A32 Installations primarily engaged in the production of non-dairy creamer.

A33 Installations primarily engaged in the production of yeast and by-product molasses, if recovered.

A34 The production of peanut butter by facilities using jar washing.

A35 The production of peanut butter by facilities not using jar washing.

A36 Installations primarily engaged in the production of pectin and peel by-products, if recovered.

A37 Installations primarily engaged in the production of almond paste.

B1 Installations primarily engaged in the production of frozen prepared dinners.

B2 Installations primarily engaged in the production of frozen breaded or battered specialty items, separately or in any combination.

B3 Installations primarily engaged in the production of frozen bakery products.

B4 Installations primarily engaged in the production of tomato-cheese-starch products.

B9 Installations primarily engaged in the production of chili pepper and paparika, in combination.

C4 Installations primarily engaged in the processing of eggs.

C5 Installations primarily engaged in the production of shell eggs.

C6 Installations primarily engaged in the production of manufactured ice.

C12 Installations primarily engaged in the production of prepared sandwiches.

D4 Installations primarily engaged in the production of vinegar.

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

DRAFT

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

TABLE 1A

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY		BOD Max. 30-Day Ave.	BOD Max. Day	SS Max. 30-Day Ave.	SS Max. Day	O & G Max. 30-Day Ave.	O & G Max. Day
(VEGETABLE OIL PROCESSING AND REFINING)							
A1	BPCTCA	0.0072	0.018	0.0090	0.023	0.0054	0.014
	BATEA	0.0036	0.090	0.0045	0.011	0.0027	0.0070
	NSPS	0.0072	0.018	0.0090	0.023	0.0054	0.014
A2	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
A3	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
A4	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
A5	BPCTCA	0.035	0.087	0.035	0.087	0.014	0.035
	BATEA	0.021	0.052	0.017	0.043	0.0070	0.017
	NSPS	0.035	0.087	0.035	0.087	0.014	0.035
A6	BPCTCA	0.067	0.17	0.061	0.15	0.023	0.057
	BATEA	0.035	0.087	0.030	0.075	0.012	0.030
	NSPS	0.067	0.17	0.061	0.15	0.023	0.057
A7	BPCTCA	0.13	0.32	0.13	0.32	0.051	0.13
	BATEA	0.076	0.19	0.063	0.16	0.025	0.062
	NSPS	0.13	0.32	0.13	0.32	0.051	0.13
A8	BPCTCA	0.10	0.26	0.10	0.26	0.041	0.10
	BATEA	0.051	0.137	0.051	0.137	0.020	0.050
	NSPS	0.10	0.26	0.10	0.26	0.041	0.10
A9	BPCTCA	0.13	0.33	0.13	0.33	0.058	0.14
	BATEA	0.073	0.18	0.073	0.18	0.029	0.073
	NSPS	0.13	0.33	0.13	0.33	0.058	0.14
A10	BPCTCA	0.097	0.24	0.11	0.27	0.048	0.12
	BATEA	0.048	0.12	0.056	0.14	0.024	0.060
	NSPS	0.097	0.24	0.11	0.27	0.048	0.12
A11	BPCTCA	0.16	0.39	0.17	0.44	0.069	0.17
	BATEA	0.076	0.19	0.087	0.22	0.035	0.087
	NSPS	0.16	0.39	0.17	0.44	0.059	0.17
A12	BPCTCA	0.12	0.30	0.14	0.36	0.060	0.15
	BATEA	0.060	0.15	0.072	0.18	0.030	0.075
	NSPS	0.12	0.30	0.14	0.36	0.060	0.15
A13	BPCTCA	0.060	0.15	0.075	0.19	0.075	0.19
	BATEA	0.030	0.075	0.037	0.092	0.037	0.092
	NSPS	0.060	0.15	0.075	0.19	0.075	0.19
A14	BPCTCA	0.015	0.037	0.015	0.037	0.0080	0.024
	BATEA	0.0080	0.020	0.0080	0.02	0.0040	0.012
	NSPS	0.015	0.037	0.015	0.037	0.0090	0.024
A15	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
(BEVERAGES)							
A16	BPCTCA	0.28	0.70	0.39	0.97	-	-
	BATEA	0.14	0.35	0.19	0.48	-	-
	NSPS	0.070	0.17	0.097	0.24	-	-
A17	BPCTCA	0.55	1.37	0.76	1.90	-	-
	BATEA	0.27	0.67	0.38	0.95	-	-
	NSPS	NA	NA	NA	NA	-	-
A18	BPCTCA	0.48	1.20	0.68	1.70	-	-
	BATEA	0.24	0.60	0.34	0.85	-	-
	NSPS	NA	NA	NA	NA	-	-
A19	BPCTCA	0.22	0.55	0.13	0.32	-	-
	BATEA	0.11	0.27	0.065	0.16	-	-
	NSPS	0.11	0.27	0.055	0.16	-	-

TABLE 1A (CONT'D)

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY		BOD Max. 30-Day Ave.	BOD Max. Day	SS Max. 30-Day Ave.	SS Max. Day	O & G Max. 30-Day Ave.	O & G Max. Day
*A20	BPCTCA	0.77	2.30	0.11	0.34	-	-
	BATEA	0.38	1.10	0.054	0.16	-	-
	NSPS	0.23	0.69	0.031	0.093	-	-
**A20	BPCTCA	0.28	0.83	0.41	1.20		
	BATEA	0.14	0.41	0.19	0.58	-	-
	NSPS	0.083	0.25	0.11	0.33	-	-
A21	BPCTCA	0.0	0.0	0.0	0.0	-	-
	BATEA	0.0	0.0	0.0	0.0	-	-
	NSPS	0.0	0.0	0.0	0.0	-	-
A22	BPCTCA	0.26	0.65	0.32	0.80	-	-
	BATEA	0.13	0.32	0.16	0.40	-	-
	NSPS	0.13	0.32	0.16	0.40	-	-
A23	BPCTCA	0.054	0.14	0.072	0.18	-	-
	BATEA	0.027	0.62	0.036	0.090	-	-
	NSPS	0.027	0.62	0.036	0.090	-	-
A24	BPCTCA	1.2	3.0	0.69	1.7	-	-
	BATEA	0.58	1.5	0.35	0.86	-	-
	NSPS	0.58	1.5	0.35	0.86	-	-
A25	BPCTCA	0.0	0.0	0.0	0.0	-	-
	BATEA	0.0	0.0	0.0	0.0	-	-
	NSPS	0.0	0.0	0.0	0.0	-	-
A26	BPCTCA	0.052	0.13	0.030	0.075	-	-
	BATEA	0.026	0.065	0.015	0.037	-	-
	NSPS	0.026	0.065	0.015	0.037	-	-
A27	PCTCA	0.24	0.60	0.14	0.35	-	-
	BATEA	0.12	0.30	0.070	0.17	-	-
	NSPS	0.12	0.30	0.070	0.17	-	-
A28	BPCTCA	0.0050	0.013	0.0010	0.0025	-	-
	BATEA	0.0025	0.0063	0.00050	0.0013	-	-
	NSPS	0.0025	0.0063	0.0005	0.0013	-	-

SUBCATEGORY		BOD Max. 30-Day Ave.	BOD Max. Day	SS Max. 30-Day Ave.	SS Max. Day	O & G Max. 30-Day Ave.	O & G Max. Day
A30	BPCTCA	2.00	5.0	5.5	13.0	-	-
	BATEA	1.0	2.5	1.0	2.5	-	-
	NSPS	1.0	2.5	1.0	2.5	-	-
C8	BPCTCA	0.070	0.21	0.070	0.21	0.040	0.12
	BATEA	0.030	0.09	0.030	0.09	0.020	0.06
	NSPS	0.030	0.09	0.030	0.09	0.020	0.06
C9	BPCTCA	0.19	0.48	0.19	0.48	0.10	0.25
	BATEA	0.10	0.25	0.10	0.25	0.05	0.13
	NSPS	0.10	0.25	0.10	0.25	0.05	0.13
C10	BPCTCA	0.95	2.4	0.95	2.4	0.16	0.40
	BATEA	0.25	0.60	0.25	0.60	0.16	0.40
	NSPS	0.25	0.60	0.25	0.60	0.16	0.40
F1	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
(BAKERY AND CONFECTIONERY PRODUCTS)							
C1	BPCTCA	0.50	1.3	0.50	1.3	0.11	0.28
	BATEA	0.25	0.65	0.25	0.65	0.04	0.10
	NSPS	0.25	0.65	0.25	0.65	0.04	0.10
C2	BPCTCA	0.050	0.15	0.05	0.15	0.030	0.090
	BATEA	0.030	0.090	0.03	0.09	0.020	0.060
	NSPS	0.030	0.090	0.03	0.09	0.020	0.060
C3	BPCTCA	0.060	0.18	0.060	0.18	0.040	0.12
	BATEA	0.030	0.090	0.030	0.090	0.020	0.060
	NSPS	0.030	0.090	0.030	0.090	0.020	0.060
C7	BPCTCA	0.10	0.25	0.10	0.25	0.050	0.13
	BATEA	0.050	0.13	0.050	0.13	0.030	0.080
	NSPS	0.050	0.13	0.050	0.13	0.030	0.080

* Crushing Season

** Processing Season

DRAFT

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

TABLE 1A (CONT'D)

RECOMMENDED EFFLUENT LIMITATIONS
GUIDELINES

DRAFT

SUBCATEGORY		BOD Max. 30-Day Ave.	BOD Max. Day	SS Max. 30-Day Ave.	SS Max. Day	O & G Max. 30-Day Ave.	O & G Max. Day
	BPCTCA	0.15	0.45	0.075	0.22	-	-
D1	BATEA	0.075	0.22	0.040	0.12	-	-
	NSPS	0.075	0.22	0.040	0.12	-	-
	BPCTCA	0.12	0.36	0.090	0.27	-	-
D2	BATEA	0.080	0.24	0.045	0.13	-	-
	NSPS	0.080	0.24	0.045	0.13	-	-
	BPCTCA	0.085	0.24	0.085	0.24	-	-
D3	BATEA	0.030	0.090	0.035	0.10	-	-
	NSPS	0.030	0.090	0.035	0.10	-	-
	BPCTCA	0.37	1.1	0.25	0.75	0.070	0.21
D5	BATEA	0.075	0.22	0.035	0.10	0.010	0.03
	NSPS	0.075	0.22	0.035	0.10	0.010	0.03
	BPCTCA	0.23	0.69	0.23	0.69	0.11	0.33
D6	BATEA	0.045	0.13	0.06	0.18	0.010	0.03
	NSPS	0.045	0.13	0.06	0.18	0.010	0.03
		(PET FOODS)					
	BPCTCA	0.18	0.45	0.18	0.45	0.065	0.17
B5	BATEA	0.09	0.23	0.09	0.23	0.033	0.085
	NSPS	0.09	0.23	0.09	0.23	0.033	0.085
	BPCTCA	0.51	1.28	0.51	1.28	0.51	1.28
B6	BATEA	0.26	0.64	0.26	0.64	0.26	0.64
	NSPS	0.26	0.64	0.26	0.64	0.26	0.64
	BPCTCA	0.0046	0.012	0.0046	0.012	0.0031	0.0080
B7	BATEA	0.0023	0.0060	0.0023	0.0060	0.0016	0.0040
	NSPS	0.0023	0.0060	0.0023	0.0060	0.0016	0.0040

SUBCATEGORY		BOD Max. 30-Day Ave.	BOD Max. Day	SS Max. 30-Day Ave.	SS Max. Day	O & G Max. 30-Day Ave.	O & G Max. Day
	BPCTCA	0.18	0.45	0.18	0.45	0.028	0.075
B8	BATEA	0.090	0.23	0.090	0.23	0.014	0.038
	NSPS	0.090	0.23	0.090	0.23	0.014	0.038
		(MISCELLANEOUS AND SPECIALITY PRODUCTS)					
	BPCTCA	0.041	0.10	0.012	0.030	-	-
A29	BATEA	0.02	0.05	0.0062	0.016	-	-
	NSPS	0.012	0.03	0.0040	0.010	-	-
	BPCTCA	2.34	5.85	0.63	1.58	0.63	1.26
A31	BATEA	1.09	2.73	0.31	0.78	0.31	0.62
	NSPS	1.09	2.73	0.31	0.78	0.31	0.62
	BPCTCA	0.025	0.063	0.071	0.18	0.043	0.086
A32	BATEA	0.106	0.265	0.014	0.035	0.014	0.028
	NSPS	0.106	0.265	0.014	0.035	0.014	0.028
	BPCTCA	3.23	6.46	1.62	3.24	-	-
A33	BATEA	1.62	3.24	0.81	1.62	-	-
	NSPS	1.62	3.24	0.81	1.62	-	-
	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
A34	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
	PCTCA	0.0	0.0	0.0	0.0	0.0	0.0
A35	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
	BPCTCA	208	417	175.1	350	-	-
A36	BATEA	104	209	83.4	167	-	-
	NSPS	104	209	83.4	167	-	-

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

TABLE 1A (CONT'D)

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY		BOD Max. 30-Day Ave.	BOD Max. Day	SS Max. 30-Day Ave.	SS Max. Day	O & G Max. 30-Day Ave.	O & G Max. Day
	BPCTCA	0.78	1.95	0.78	2.0	0.29	0.73
B1	BATEA	0.39	0.98	0.39	0.98	0.15	0.37
	NSPS	0.39	0.98	0.39	0.98	0.15	0.37
	BPCTCA	0.81	2.0	0.81	2.0	0.23	0.57
B2	BATEA	0.41	1.0	0.41	1.0	0.12	0.29
	NSPS	0.41	1.0	0.41	1.0	0.12	0.29
	BPCTCA	1.1	2.7	1.1	2.7	0.46	1.1
B3	BATEA	0.54	1.3	0.54	1.3	0.23	0.57
	NSPS	0.54	1.3	0.54	1.3	0.23	0.57
	BPCTCA	2.4	5.9	2.4	5.94	1.59	4.0
B4	BATEA	1.2	3.0	1.2	3.0	0.80	2.0
	NSPS	1.2	3.0	1.2	3.0	0.80	2.0
	BPCTCA	0.65	1.6	0.65	1.6	0.43	1.1
B9	BATEA	0.33	0.8	0.33	0.8	0.22	0.54
	NSPS	0.33	0.8	0.33	0.8	0.22	0.54
	BPCTCA	1.3	3.9	1.3	3.9	1.3	0.39
C4	BATEA	0.21	0.63	0.21	0.63	0.07	0.21
	NSPS	0.21	0.63	0.21	0.63	0.07	0.21
	BPCTCA	0.080	0.24	0.080	0.24	0.020	0.060
C5	BATEA	0.030	0.090	0.030	0.090	0.010	0.030
	NSPS	0.030	0.090	0.030	0.090	0.010	0.030
	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
C12	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
	BPCTCA	0.060	0.18	0.030	0.090	-	-
D4	BATEA	0.040	0.12	0.020	0.060	-	-
	NSPS	0.040	0.12	0.020	0.060	-	-

SUBCATEGORY		BOD Max. 30-Day Ave.	BOD Max. Day	SS Max. 30-Day Ave.	SS Max. Day	O & G Max. 30-Day Ave.	O & G Max. Day
	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
E1-6	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0
	BPCTCA	0.0	0.0	0.0	0.0	0.0	0.0
F2-4	BATEA	0.0	0.0	0.0	0.0	0.0	0.0
	NSPS	0.0	0.0	0.0	0.0	0.0	0.0

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

DRAFT

SECTION III

INTRODUCTION

PURPOSE AND AUTHORITY

Section 301(b) of the Act requires the achievement by not later than July 1, 1977, of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the best practicable control technology currently available as defined by the Administrator pursuant to Section 304(b) of the Act. Section 301 (b) also requires the achievement by not later than July 1, 1983, of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the best available technology economically achievable which will result in reasonable further progress towards the national goal of eliminating the discharge of all pollutants, and which reflect the greatest degree of effluent reduction which the Administrator determines to be achievable through the application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including where practicable a standard permitting no discharge of pollutants.

Section 304 (b) of the Act requires the Administrator to publish regulations providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of the best practicable control technology currently available and the degree of effluent reduction attainable through the application of the best control and procedure innovations, operation methods, and other alternatives. The regulations proposed herein set forth effluent limitations guidelines pursuant to Section 304(b) of the Act for the Miscellaneous Food and Beverages Industry. Section 306 of the Act requires the Administrator to propose regulations establishing Federal Standards of performances for new sources.

SUMMARY OF METHODS USED FOR DEVELOPMENT OF THE EFFLUENT LIMITATIONS GUIDELINES

The effluent limitations and standards of performance recommended in this document were developed in the following manner:

1. An exhaustive review of available literature was conducted. This included searches at the University of Florida, Oregon State University, University of Tennessee, University of California, University of Nebraska, and California State University libraries; the in-house libraries of Environmental Science and Engineering, Inc., SCS Engineers, Inc., and Environmental Associates, Inc.; and the libraries of the Department of the Interior and the Environmental Protection

Agency in Washington. Additional literature was obtained from the California Wine Institute, the National Association of Chewing Gum Manufacturers, The William Wrigley, Jr. Company, and from various individuals throughout the miscellaneous foods and beverages industry. Literature searches were also conducted through the following Federal systems: Compendex, Environ/Prog, SWIRS, WRSIC, MTIS/GRA, and SSIE. A list of references is contained in Section XIII of this document.

2. Telephone surveys were conducted for 839 plants, and information concerning production, wastewater characteristics, and control and treatment technology was obtained. A copy of the telephone survey form is contained in Appendix A.

3. Information was obtained from questionnaires submitted to 336 plants by various trade associations.

4. On-site inspections were conducted at 264 plants and detailed information concerning process flows, related water usage, water management practices, and control and treatment technology was obtained. A copy of the visitation questionnaire form is contained in Appendix B.

5. Sampling programs were conducted at 104 plants to verify the accumulated data. Sampling procedures were generally conducted in accordance with the methods set forth in the Handbook For Monitoring Industrial Wastewater (1).

6. The data base was handled and summarized on a computerized system. A discussion of the data handling and reduction system and a detailed explanation of the algorithms used are presented in Appendix C.

The reviews, analyses, and evaluations were coordinated and applied to the following:

1. An identification of distinguishing features that could potentially provide a basis for subcategorization of the industry. These features included the nature of raw materials utilized, plant size and age, the nature of processes, and others as discussed in Section IV.

2. A determination of the water usage and wastewater characteristics for each subcategory, as discussed in Section V, including volume of water used, sources of pollution, and the type and quantity of constituents in the wastewater.

3. An identification of those wastewater constituents, as discussed in Section VI, which are characteristic of the industry

and were determined to be pollutants subject to effluent limitations guidelines and standards of performance.

4. An identification of the control and treatment technologies presently employed or capable of being employed by the industry, as discussed in Section VII, including the effluent level attainable and associated treatment efficiency related to each technology.

5. An evaluation of the cost associated with the application of each control and treatment technology, as discussed in Section VIII.

This document is the result of intensive data collection and analysis conducted over a six month period. It is probably the most comprehensive coverage of wastewater and wastewater control and treatment technology existing for the miscellaneous foods and beverages industry. But it must be noted that the conclusions and recommendations presented herein are based on the information available to the study, and in many instances on information made available by industry. The amount of information available was found to be extensive for several of the subcategories defined in Section IV and less extensive for others. In all cases strong efforts were made to obtain the cooperation of and input by industry and other interested parties.

DEFINITION OF THE INDUSTRY

The Miscellaneous Foods and Beverages Industry includes establishments engaged in the processing of distilled, fermented beverages, nonalcoholic beverages, confectioner products, vegetable oils, and food preparations. More specifically, the industry may be defined as that listed in Table 1. It can be seen that the industry includes an extremely wide range of products from bagels to beer, from chocolate candy and popcorn balls to soybean oil. Early in the study several products were eliminated from further consideration for various reasons. These included the following:

1. Castor oil and pomace. It was established that castor oil is not manufactured as a vegetable oil or by-product cake and meal in the United States.

2. Coconut, oiticica, palm and palm kernel oil. It was established that these oils are not produced in the United States.

3. Tung oil and walnut oil. These oils are neither foods nor beverages, and no processing plants could be located in the United States.

DRAFT

TABLE 1

MISCELLANEOUS FOODS AND BEVERAGES INDUSTRY DEFINED BY SIC CODE

SIC 2017 Egg processing

Establishments primarily engaged in the drying, freezing, and breaking of eggs.

Egg albumen
Eggs: canned, dehydrated, desiccated, frozen, processed
Eggs: drying, freezing, and breaking

SIC 5144 Egg Packing

Establishments primarily engaged in the cleaning, oil treating, packing, and grading of eggs.

SIC 2034 Dehydrated Soups

SIC 2038 Frozen Specialities

Establishments primarily engaged in freezing and cold packing (freezing) food specialities, such as frozen dinners and frozen pizza.

Baked goods, frozen: except bread and bread-type rolls
Dinners, frozen: packaged
Food specialities, frozen
Frozen dinners, packaged
Meals, frozen
"Native" foods, frozen
Pies, frozen
Pizza, frozen
Soups, frozen: except seafood soups
Spaghetti and meat balls, frozen
Waffles, frozen

SIC 2047 Dog, Cat and Other Pet Food

Establishments primarily engaged in manufacturing dog, cat and other pet food from cereal, meat, and other ingredients. These preparations may be canned, frozen, or dry. This industry also includes establishments slaughtering animals for pet food. Establishments primarily engaged in manufacturing feed for animals, other than pets, are classified in Industry 2048.

Bird food, prepared
Dog and cat food
Horse meat: canned, fresh, or frozen
Pet food: canned, frozen, dry
Slaughtering of nonfood animals

DRAFT

TABLE 1 (CONT'D)

SIC 2051 Bread and Other Bakery Products, Except Cookies and Crackers

Establishments primarily engaged in manufacturing bread, cakes, and other "perishable" baker products. Establishments manufacturing bakery products for sale primarily for home service delivery, or through one or more non-baking retail outlets, are included in this industry. Establishments primarily engaged in producing "dry" baker products, such as biscuits, crackers, and cookies are classified in Industry 2052. Establishments producing bakery products primarily for direct sale on the premises to household consumers are classified in Retail Trade, Industry 5462.

Bagels
Bakeries, manufacturing for home-service delivery
Bakery products "perishable": bread, cakes doughnuts, pastries, etc.
Biscuits baked: baking powder and raised
Bread, brown: Boston and other--canned
Charlotte Russe (bakery product)
Bakeries: wholesale, wholesale and retail combined
Bakery products, partially cooked (not frozen)
Crullers
Knishes
Pastries: Danish, French, etc.
Pies, except meat pies
Rolls (baker products)
Sponge goods (bakery products)
Sweet yeast goods

SIC 2052 Cookies and Crackers

Establishments primarily engaged in manufacturing cookies, crackers, pretzels, and similar "dry" bakery products. Establishments primarily engaged in producing "perishable" bakery products are classified in Industry 2051.

Baker products, "dry": biscuits, crackers, pretzels, etc.
Biscuits, baked: dry, except baking powder and raised biscuit
Communion wafers
Cones, ice cream
Cookies
Cracker meal and crumbs
Crackers: graham, soda, etc.
Matzoths
Rusk, machine-made
Saltines
Zwieback, machine-made

SIC 2065 Candy and Other Confectionery Products

Establishments primarily engaged in manufacturing candy, including chocolate candy, salted nuts, other confections and related

TABLE 1 (CONT'D)

products. Establishments primarily engaged in manufacturing solid chocolate bars are classified in Industry 2066 and chewing gum in Industry 2067. Establishments primarily engaged in manufacturing confectionery for direct sale on the premises are classified in Industry 5441, and those primarily engaged in shelling and roasting nuts are classified in Industry 5145.

Bars, candy: including chocolate covered bars
Cake ornaments, confectionery
Candy, except solid chocolate
Chewing candy (not chewing gum)
Chocolate candy, except solid chocolate
Confectionery
Cough drops, except pharmaceutical preparations
Dates: chocolate covered, sugared, and stuffed
Fruit peel products: candied, glazed, glace, and crystallized
Fruits: candied, glazed and crystallized
Fudge (candy)
Halvah
Licorice candy
Lozenges, candy: non-medicated
Marshmallows
Marzipan
Nuts, glace
Nuts, salted or candy-covered: packaged
Popcorn balls and other treated popcorn products, packaged

SIC 2066 Chocolate and Cocoa Products

Establishments primarily engaged in shelling, roasting, and grinding cacao beans for the purpose of making chocolate liquor, from which cocoa powder and cocoa butter are derived, and in the further manufacture of solid chocolate bars and chocolate coatings. Establishments primarily engaged in manufacturing products, except candy, from purchased chocolate and cocoa are classified in Industry 2099, and chocolate candy in Industry 2065.

Baking chocolate
Bars, candy: solid chocolate
Cacao bean products: chocolate, cocoa butter, and cocoa
Cacao beans: shelling, roasting and grinding for making chocolate liquor
Candy, solid chocolate
Chocolate bars
Chocolate coatings and syrups, made in chocolate plants
Chocolate liquor
Chocolate, sweetened or unsweetened
Cocoa butter
Cocoa, powdered: mixed with other substances--made in chocolate plants

DRAFT

TABLE 1 (CONT'D)

SIC 2067 Chewing Gum

Establishments primarily engaged in manufacturing chewing gum or chewing gum base.

Chewing gum	Chewing gum base

SIC 2074 Cottonseed Oil Mills

Establishments primarily engaged in manufacturing cottonseed oil, and by-product cake, meal, and linters. Establishments primarily engaged in refining cottonseed oil into edible cooking oils are classified in Industry 2079.

Cottonseed oil, cake and meal: made in cottonseed oil mills

SIC 2075 Soybean Oil Mills

Establishments primarily engaged in manufacturing soybean oil, and by-product cake and meal. Establishments primarily engaged in refining soybean oil into edible cooking oils are classified in Industry 2079.

Lecithin	Soybean oil, cake and meal

SIC 2076 Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean

Establishments primarily engaged in manufacturing vegetable oils and by-product cake and meal, except corn, cottonseed, and soybean. Establishments primarily engaged in manufacturing corn oil and its by-products are classified in Industry 2046, those which are refining vegetable oils into edible cooking oils are classified in Industry 2079, and those refining these oils for medicinal purposes in Industry 2833.

Castor oil and pomace	Peanut oil, cake and meal: made in peanut oil mills
Coconut oil	Safflower oil
Linseed oil, cake and meal	Tallow vegetable
Oils, vegetable: except corn, cottonseed, and soybean	Tung oil
Oiticica oil	Walnut oil, except artists' materials
Palm kernel oil	

SIC 2079 Shortening, Table Oils, Margarine and Other Edible Fats and Oils, Not Elsewhere Classified

TABLE 1 (CONT'D)

Establishments primarily engaged in manufacturing shortening, table oils, margarine, and other edible fats and oils, not elsewhere classified, by further processing of purchased animal and vegetable oils. Establishments primarily engaged in producing corn oil are classified in Industry 2046.

Butterine	Olive oil
Cottonseed oil, refined: not made in cottonseed oil mills	Peanut oil, refined: not made in peanut oil mills
Margarine	Shortenings, compound and vegetable
Nut margarine	Vegetable cooking and salad oils, except corn oil: refined
Oleomargarine	

SIC 2082 Malt Beverages

Establishments primarily engaged in manufacturing all kinds of malt beverages. Establishments primarily engaged in bottling purchased malt beverages are classified in Industry 5181.

Ale	Malt extract, liquors and syrups
Beer (alcoholic beverage)	Near beer
Breweries	Porter (alcoholic beverage)
Brewers' grain	Stout (alcoholic beverage)
Liquors, malt	

SIC 2083 Malt

Establishments primarily engaged in manufacturing malt or malt by-products from barley or other grains.

Malt: barley, rye, wheat, and corn	Malthouses
Malt by-products	Sprouts, made in malthouses

SIC 2084 Wines, Brandy, and Brandy Spirits

Establishments primarily engaged in manufacturing wines, brandy, and brandy spirits. This industry also includes bonded storerooms which are engaged in blending wines. Establishments primarily bottling purchased wines, brandy, and brandy spirits, but which do not manufacture wines and brandy, are classified in Industry 5182.

DRAFT

TABLE 1 (CONT'D)

Brandy
Brandy spirits
Storerooms, bonded: engaged in blending wines
Wines: still, sparkling and artifically carbonated

SIC 2085 Distilled, Rectified, and Blended Liquors

Establishments primarily engaged in manufacturing alcoholic liquors by distillation and rectification, and in manufacturing cordials, and alcoholic cocktails by blending processes or by mixing liquors and other ingredients. Establishments primarily engaged in manufacturing industrial alcohol are classified in Industry 2869, and those only bottling purchased liquors in Industry 5182.

Applejack
Cocktails (alcoholic beverages)
Cordials, alcoholic
Distillers dried grains and solubles
Ethyl alcohol for medicinal and beverage purposes
Gin (alcoholic beverage)
Grain alcohol for medicinal and beverage purposes
Liquors: Distilled, rectified, and blended- except brandy
Rum
Spirits, neutral except fruit: for beverage purposes
Vodka
Whiskey: Bourbon, rye, scotch type, and corn

SIC 5182 Bottling Purchased Wines, Brandy, Brandy Spirits, and Liquors

SIC 2086 Bottled and Canned Soft Drinks and Carbonated Waters

Establishments primarily engaged in manufacturing soft drinks (nonalcoholic beverages) and carbonated waters. Establishments primarily engaged in manufacturing fruit and vegetable juices are classified in Group 203, fruit syrups for flavoring in Industry 2087, and cider in Industry 2099. Establishments primarily engaged in bottling natural spring waters are classified in Industry 5149.

Beer, birch and root: bottled or canned
Beverages, non-alcoholic: bottled or canned
Carbonated beverages, non-alcoholic: bottled or canned
Drinks, fresh fruit: bottled or canned
Ginger ale, bottled or canned
Mineral water, carbonated: bottled or canned
Non-alcoholic beverages, bottled or canned
Soft drinks, bottled or canned
Still beverages, non-alcoholic: bottled or canned
Water, pasteurized: bottled or canned

DRAFT

TABLE 1 (CONT'D)

SIC 2087 Flavoring Extracts and Flavoring Syrups, Not Elsewhere Classified

Establishments primarily engaged in manufacturing flavoring extracts, syrups, and fruit juices, not elsewhere classified, for soda fountain use or for the manufacture of soft drinks, and colors for bakers' and confectioners' use. Establishments primarily engaged in manufacturing chocolate syrup are classified in Industry 2066 if from cacao beans and in Industry 2099 if from purchased chocolate.

Beverage bases
Bitters (flavoring concentrates)
Burnt sugar (food color)
Coffee flavorings and syrups
Colors for bakers, and confectioners; use, except synthetic
Cordials, non-alcoholic
Drink powders and concentrates
Flavoring concentrates
Flavoring extracts, pastes, powders, and syrups
Food colorings, except synthetic
Food glace for glazing foods (cozeen)
Fruit juices, concentrated: for fountain use
Fruits, crushed: for soda fountain use

SIC 2095 Roasted Coffee

Establishments primarily engaged in roasting coffee, and in manufacturing coffee concentrates and extracts in powdered, liquid or frozen form, including freeze-dried.

Coffee extracts
Coffee roasting, except by wholesale grocers
Coffee, instant and freeze-dried

SIC 2097 Manufactured Ice

Establishments primarily engaged in manufacturing ice for sale. Ice plants operated by public utility companies are included in this industry when separate reports are available. When separate reports are not available, they should be classified in Major Group 49. Establishments primarily engaged in manufacturing dry ice are classified in Industry 2813.

SIC 2098 Macaroni, Spaghetti, Vermicelli, and Noodles

Establishments primarily engaged in manufacturing dry macaroni, spaghetti, vermicelli, and noodles. Establishments primarily engaged in manufacturing canned macaroni, spaghetti, etc., are classified in Industry 2032.

DRAFT

TABLE 1 (CONCLUDED)

Macaroni and products, dry: including alphabets, rings, seashells, etc.
Noodles: egg, plain, and water
Spaghetti, except canned
Vermicelli

SIC 2099 Food Preparations, Not Elsewhere Classified

Establishments primarily engaged in manufacturing prepared foods and miscellaneous food specialties, not elsewhere classified, such as baking powder, yeast and other leavening compounds; chocolate and cocoa products except confectionery, made from purchase materials; peanut butter; packaged tea including instant; ground spices; potato, corn and other chips; and vinegar and cider.

Almond pastes
Bakers' malt
Baking powder
Beans, baked: except canned
Bouillon cubes
Box lunches, for sale off premises
Bread crumbs, not made in bakeries
Butter, ladle
Butter, renovated and processed
Chicory root, dried
Chili pepper or powder
Chocolate, instant, mfpm
Chocolate syrup; mfpm
Cider
Cocoa, instant; mfpm
Coconut, desiccated and shredded
Cole slaw, in bulk
Desserts, ready-to-mix
Emulsifiers food
Fillings, cake or pie: except fruits, vegetables and meat
Gelatin dessert preparations
Honey, strained and bottled
Jelly corncob (gelatin)
Leavening compounds, prepared
Marshmallow creme
Meat seasonings, except sauces
Molasses, mixed or blended; mfpm
Pancake syrup, blended and mixed
Peanut butter
Pectin
Pepper, chili
Pizza, refrigerated: not frozen
Popcorn, packaged but not popped
Pork and beans, except canned
Potato chips
Sandwiches, assembled and packaged: for wholesale market
Syrups, sweetening: honey, maple syrup, sorghum
Sorghum, including custom refining
Spices, including grinding
Sugar grinding
Sugar, industrial maple: made in plants producing maple syrup
Sugar, powdered: mfpm
Tea blending
Tortillas, in bulk
Vegetables, peeled for the trade
Vinegar
Yeast

DRAFT

4. Non-synthetic food colorings. It was established that guidelines for the manufacture of food colorings had been developed in the organic chemicals guidelines, Phase II.

5. Baker's Malt. The only known producer of Baker's Malt discontinued manufacturing the product several years ago.

6. Food emulsifiers processed by organic chemical plants. Guidelines for these facilities were developed by the Organic Chemical Industry, Guideline , Phase II. Therefore, this document will develop recommended guidelines only for food emulsifiers processed by edible oil refining facilities.

7. Butter (ladle, renovated and processed). These products were determined to have been the subject of effluent guidelines previously developed for the dairy industry.

8. Baked beans, cole slaw, vegetables peeled for the trade, corn and potato chips, cider, and pork and beans. These products were established to have been the subject of effluent guidelines previously developed for the fruit and vegetable industry.

9. Jelly corncob (gelatin) and box lunches. These products could not be established as active industries in the United States.

10. Sugar grinding. Other than in sugar refineries which were subject to previously established guidelines, sugar grinding could not be defined as an industry in the United States.

To the original industry scope as defined by the Environmental Protection Agency were added several products considered closely related to the miscellaneous foods and beverages industry. These additional products were the following:

1. SIC 5144 Egg Packing. Establishments primarily engaged in the washing, inspecting, grading, and packaging of eggs purchased from laying farms or independent farmers.

2. SIC 2034 Dehydrated soups. The blending and packaging of dehydrated soups, and the combining at previously dehydrated vegetables with various flavorings and protein bases.

3. SIC 2099 Non-Dairy Coffee Creamer.

4. SIC 5182 Bottling purchased wines, brandy, brandy spirits, and liquors.

At the conclusion of the current study it is tentatively planned to develop recommended effluent limitations guidelines for the production of blended flour and hydrolyzed plant protein (hydrolysate) as an addendum to this document.

SIC 2017 - Egg Processing

General - According to the U.S. Department of Commerce (2), about 12 to 15 percent of this country's total egg output is processed into egg products, and the demand is increasing as the use of specialty and convenience foods increases. These products are whole eggs, whites, or yolks and are in liquid, dried, or frozen form. These egg products are used directly or in the production of other foods such as in bakeries. Egg breaking and subsequent processing occurs in approximately 150 plants in 41 states. Nearly one-half of the total annual production of 393,000 kkg (433,000 tons) occurs in the north central states.

Egg processing occurs in a variety of scales. Plants have from 1 to at least 13 breaker lines and produce from 5 kkg (6 tons) to 140 kkg (154 tons) of liquid egg per day. Some processing plants also produce shell eggs (graded) and some plants receive only liquid egg for further processing. In plants which break and grade eggs, the majority of the waste load from the plants is from breaking. In plants which receive liquid egg for processing, the waste load is significantly lower than in the plants where the breaking is done.

USDA inspectors are present on a full-time basis of egg breaking plants to inspect the sanitation practices of the production. It should be noted that some USDA health regulations, such as frequent cleaning requirements, add to the waste load of the plant.

Egg processing operations usually operate on an 8 or 24 hour per day work schedule, 5 or 6 days a week. Egg processing occurs year-round, but more eggs are broken during the spring and summer months when the wholesale prices are the lowest.

Table 2(3) shows the distribution among frozen, dried, and liquid product produced of the total of shell eggs broken. The large majority of the dried product is produced by a few plants in the north central region. The liquid and frozen products are produced by the majority of producers in all geographical regions.

Description of Process - Eggs for processing (breaking stock) come from several sources. Those noted at shell egg handling operations with cracked, checked, thin, stained, or rough shells are sold to egg processors, or are transferred to the breaking line if the plant does both operations. Another source of breaking stock is supermarkets. Fresh eggs can only be held for sale for a limited time; unsold eggs are often sold to egg processors as breaking stock. Some breaking stock is purchased directly from egg laying farms. The steps in egg processing are outlined below and illustrated in Figure 1 .

DRAFT

TABLE 2

Egg Products under Federal Inspection (3)

Item	Period 6/1/72-5/30/73 (1,000 kkg)	(1,000 tons)	6/1/73-5/30/74 (1,000 kkg)	(1,000 tons)
Total shell eggs broken	393	433	433	477
Edible liquid from shell eggs broken	306	337	341	376
Inedible liquid from shell eggs broken	16.6	18.3	17.7	19.5
Liquid egg used in processing*				
Whole	187	206	211	233
White	117	129	131	144
Yolk	68	75	72	79
Total	373	411	414	456
Liquid product produced	118	131	137	151
Frozen product produced	153	169	166	183
Dried product produced	30	33	33	36

* Includes frozen eggs used for processing.

DRAFT

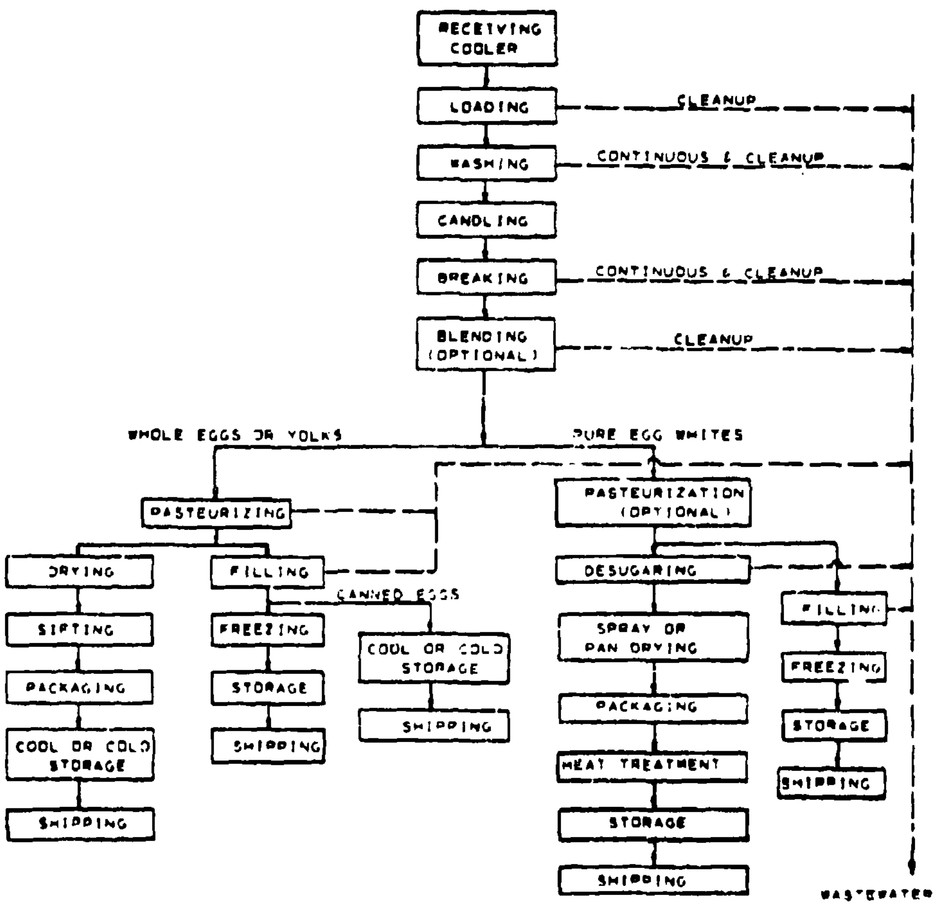


FIGURE 1

EGG PROCESSING PROCESS FLOW DIAGRAM

Delivery and Storage: Delivery of breaking stock and outgoing shipments of processed eggs are normally made by truck. Since the quality and product life of eggs is quite temperature dependent, the trucks used for incoming as well as outgoing shipments are usually refrigerated and the storage areas are always refrigerated (10° to 13°C). Relative humidity is controlled at 70 to 80 percent in some plants. In many plants, the loading areas are also refrigerated. Incoming nest run eggs are usually in cases containing 30 dozen eggs. The cases are stored on pallets, although some contract shipments utilize steel racks for shipment and storage of eggs.

Loading and Washing: Flats holding 30 eggs are unpacked from the 30 dozen cases manually. The eggs are inspected as they are unpacked and cracked or leaking eggs are put in buckets to be sold as inedibles. In most plants, the eggs are then automatically vacuum loaded onto a conveyor which passes through washing machinery. Some small plants transfer the eggs manually onto a conveyor, but this method results in increased egg breakage. In the washer, the eggs are sprayed, and sometimes scrubbed by brushes, with a recirculating disinfectant and detergent solution, the concentration of which is automatically maintained. Candling follows washing. The eggs are passed over a light source, and visually inspected. Blood spotted or other inedible eggs are manually removed. It should be noted that one plant visited did not candle their eggs before breaking. Some plants reverse these processes, contending that candling can result in the removal of cracked eggs that would break in the washer.

Sources of wastewater prior to the breaking of the eggs are:

1. Cleaning of egg handling equipment

2. Cleaning of floors

3. Overflow and dumping of the egg washwater

Since the shells of breaking stock are less sound than those at shell egg handling plants, eggs are sometimes broken during unloading, washing, and candling. Unloading and candling equipment is normally equipped to catch these broken eggs which then may be sold as inedibles. However, some eggs fall to the floor where they must be scraped or mopped up or hosed into a floor drain. A significant number of eggs are broken during washing and these go into the washwater, and subsequently into the sewer. Egg washing equipment is normally of the recirculating type. The same washwater is used over and over with a small quantity of constant overflow and make-up. This make-up comes from the water used to rinse the detergent from the washed eggs.

Breaking and Pasteurizing: Egg breaking is usually accomplished automatically by machines, normally capable of breaking 0.64 kkg (0.7 tons) per hour. The eggs are transferred mechanically from candling to the breakers where the liquid yolks and whites are collected separately or the whole egg is collected. Visual inspection of the broken eggs is also done to eliminate inedibles. The broken shells are conveyed from the breaking room to a disposal vehicle by a conveyor such as an auger.

DRAFT

The liquid egg is conveyed from the breakers into an insnection tank where odor is periodically checked. Next, the liquid is pumped through a chiller and then into refrigerated holding tanks. When a holding tank has been filled with egg yolk or whole egg, the contents are pasteurized. Conditions used in pasteurizing vary according to the product. For example, liquid whole eggs are heated for at least 3.5 minutes at not less than 60°C (140°F) and then rechilled. Due to the heat sensitive nature of egg whites, they must be pasteurized at about 56°C (134°F) or 52°C (126°F) using hydrogen peroxide injection. (4)

The sources of most of the waste load from egg processing plants is the cleaning of the liquid egg handling equipment. Egg breaking machines are continually washed with a fine spray. The pumps, piping, pasteurizer, and tanks used in conveying and processing the liquid product are completely flushed and cleaned every 4 hours. Similarly, equipment used for the canning, freezing, and drying of eggs is water cleaned and thus contributes to the waste stream. Effluent from these cleaning operations contains the liquid egg product in varying concentrations plus detergents and disinfectants.

Some egg processing plants receive liquid egg in tank trucks for blending, freezing, canning, or drying. The wastewater generation in this type of plant comes only from cleaning the blending equipment, the tank trucks, and the holding tanks.

Blending: Some industrial consumers of processed eggs prefer to purchase blended frozen or dried egg products. Blending occurs before pasteurization and rechilling. The liquid whole egg or egg yolk, or both, are transferred to blending vats where the percent solids is adjusted. Sugar, corn syrup, occasionally salt, and various other additives are combined with the liquid egg in assorted combinations and quantities. After completion of the blending, the product is transferred to a holding tank and then to the pasteurizer.

Canning and Freezing: If the final product is to be in liquid or frozen form, the pasteurized liquid yolk, whole egg, or blend is rechilled and packaged mechanically in 2.3 kg (5 lb) or 4.6 kg (10 lb) milk-type cartons or 14 kg (30 lb) cans. The packaging room is equipped with positive flow filtered ventilation to prevent contamination of the pasteurized product. After packaging, the liquid egg may be stored at 2 to 5°C for up to 1 month before use. Wastewater from the canning process is normally only generated by the cleanup of the egg dispensing equipment.

About one half of the total liquid egg production is frozen. Egg whites, yolks, whole egg, and blends are frozen, normally in 14 kg (30 lb) cans or 2.3 kg (5 lb) cartons. Freezing causes major changes in the texture of some egg products and some reduction in bacterial count. However, the functional characteristics are only slightly affected. Some egg products are adversely affected by slow rates of freezing; therefore some producers of frozen products utilize air blast freezing at temperatures as low as -40°C (-40°F). Subsequent storage of the frozen product is usually at -18° to -23°C (0° to -10°F).

Egg Drying: Dehydrated albumen (egg whites) must be prepared from desugared liquid egg to prevent loss of solubility, formation of off-color and objectionable flavor, and decreased versatility of the dried product during storage. Bacterial fermentation is the most widely employed method of glucose removal from eggs. Controlled bacterial fermentation is a process in which a tank of liquid egg white is inoculated with a culture. After 12 to 24 hours, the albumen is completely desugared and is transferred to the drier. Other methods of desugaring include the use of glucose oxidase enzyme or yeast fermentation. Since the product is to be dried, almost all of the liquid egg white can be rinsed from the tank into the drier. As a result, the waste load from this process is quite low.

Egg whites can be either pan or spray dried. Pan drying is a procedure in which 0.15 sq m (1.5 sq ft) aluminum trays are covered with a thin layer of liquid egg white, placed on racks, and run through a heated tunnel for 24 hours or longer. The resulting egg white solids are packaged as a flake or granular product or ground and packaged as a powder. Pasteurization is accomplished by storage of the dried and packaged product for at least one week at 60°C (140°F).

The majority of all dried egg products are produced by spray drying. In this process, the liquid egg is atomized into a stream of hot air. The air used for drying is filtered and heated to between 120° and 189°C (250° and 375°F). Because atomization creates a great deal of surface area, water evaporation is very rapid. The powder formed separates from the air in the drying chamber and in a separating device. The dried product is removed mechanically from the dryer, sometimes cooled, and normally sifted before packaging in 2 or 5 kg boxes, or 45, 70 or 90 kg drums. Dried egg white needs no temperature control during storage, but other dried egg products are normally refrigerated during storage. Egg drying equipment is normally cleaned semi-annually or when required by a change in product (for example, egg yolk to egg white production).

Inedible Eggs: Eggs classed as inedibles such as blood spots, cracks, leaks, and stained eggs are processed separately. Eggs which break on the floor or grading machinery are normally recovered and also classed as inedibles. Egg albumen is sometimes recovered by centrifuging from the shells and is included in the product sold as inedible egg. Inedible eggs are normally frozen in 14 kg cans or dried at plants specializing in inedible egg processing. Inedibles are normally sold to pet food processors to be used as ingredients in their products.

Egg Shells: Egg shells are a significant source of solid waste from egg breaking plants. These shells are normally spread on fields as fertilizer, if the location is such that odors do not cause a problem.

or in a landfill. Experiments have been conducted in the utilization of egg shell wastes as feed for chickens. Despite the high protein content, a satisfactory method of processing egg shells into feed has not been developed.

SIC 5144 - Shell Eggs

General - The fresh eggs available at the wholesale and retail level have been washed, inspected, graded and packaged by shell egg handling firms. Eggs from processor's laying farms or purchased from independent farmers are the raw materials for this industry.

In 1972, the total volume of shell egg production was 50 million kkg (70 billion eggs). The gross income of the industry was $1.8 billion.

According to the Bureau of the Census (2), an estimated 9,500 shell egg producers are currently operating. They range in size from family businesses to automated operations producing 20 to 30 kkg (several thousand 30-dozen cases) daily. The top ten egg producing states account for slightly over one-half of the total shell egg production. California is the largest producing state with 12 percent of the national total, and Georgia is second with 8 percent. Six of the top ten states are located in the south and two are in the midwest.

Description of the Process - Shell egg grading plants are normally not located at egg laying farms.

Since cool temperatures improve egg life, the trucks used for hauling incoming and outgoing eggs are normally refrigerated. Storage areas are always refrigerated (10° to 13°C, 50° to 55°F) and sometimes humidity controlled. In some plants, loading areas are also refrigerated.

Eggs delivered to a grading plant are usually packed in reuseable corrugated cases which hold 30 dozen eggs. In some plants which have contracted suppliers, the eggs are shipped and stored on steel racks.

The eggs in storage are transported on pallets to the loading area of the process room. The flats of eggs are unpacked manually from the corrugated cases and inspected. Broken and obviously damaged eggs are removed and the sound eggs are normally automatically vacuum loaded onto a roller conveyor (see Figure 2). On the conveyor, the eggs are moved through the washer in which they are sprayed, and sometimes scrubbed by brushes, with a warm (50°C) recirculating detergent and disinfectant solution, the concentration of which is automatically maintained. As the eggs leave the washer they are dried, given a light oil spray to strengthen and prevent drying of the shell during storage, and candled. The eggs are passed over a high intensity light source and visually inspected. Blood spots or other inedible eggs are removed manually.

Sources of wastewater prior to the grading of the eggs are as follows:

1. Cleaning of the egg handling equipment
2. Cleaning of floors

DRAFT

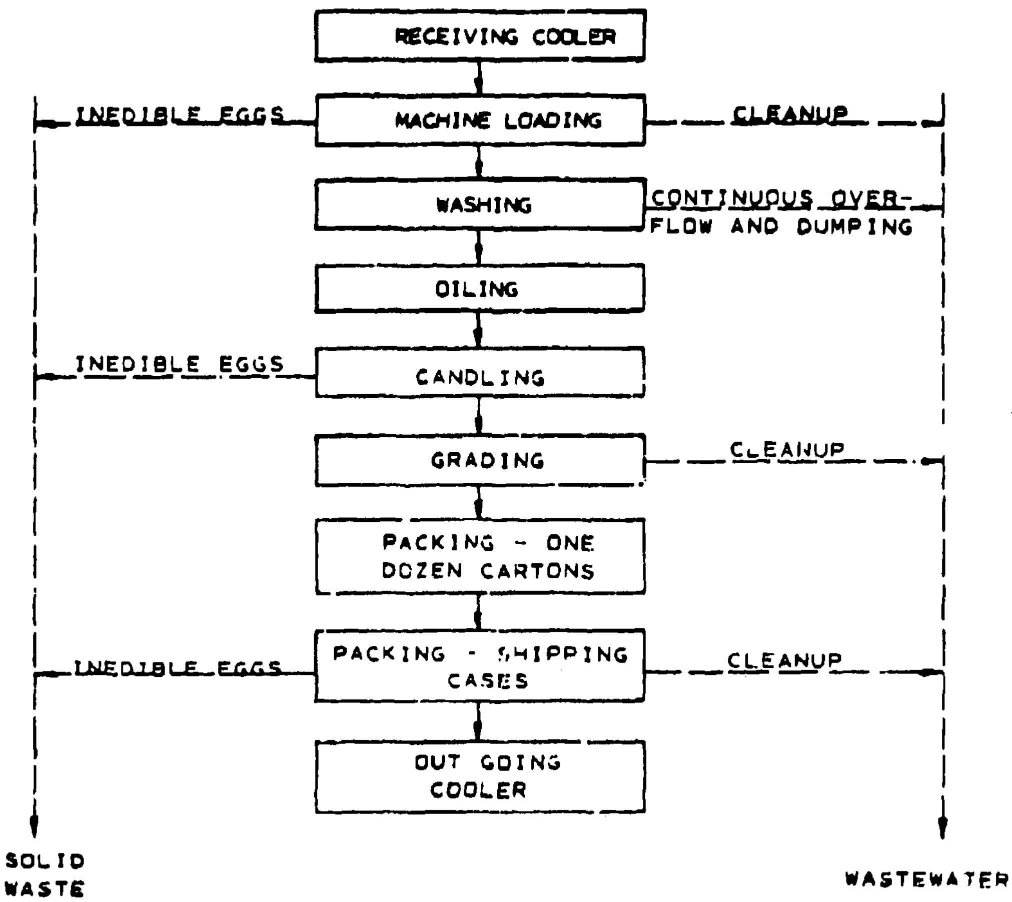


FIGURE 2

SHELL EGG PROCESS FLOW DIAGRAM

3. Overflow and dumping of the egg washwater

Eggs are sometimes broken during unloading, washing, and candling. Unloading and candling equipment is normally equipped to catch these broken eggs which then may be sold as inedibles. However, some eggs fall to the floor where they must be scraped or mopped up or hosed into a floor drain Eggs broken during washing go into the washwater, and subsequently, into the sewer. Egg washing equipment is normally of the recirculating type. The same washwater is used over and over with a small quantity of constant overflow and make-up. This make-up comes from the water used to rinse the detergent from the washed eggs.

After candling, the eggs are graded by weight and packed, usually mechanically, into cartons containing one dozen eggs. The cartons are manually closed and loaded into a shipping container (usually a 24 or 30 dozen case or a 15 dozen wire basket) and stacked on pallets. The pallets are transferred to the outgoing refrigerated storage area and from there are loaded onto trucks.

Wastewater generated during grading and packing comes from cleaning up broken eggs and equipment cleaning. Some eggs fall to the floor where they must be scraped or mopped up or washed into a floor drain. Wastewater is also generated from the cleaning of the equipment.

Solid waste at shell egg plants is primarily inedible eggs. Eggs classed as inedibles such as blood spots, cracks, leaks, and stained eggs are processed separately. Eggs which break on the floor or in grading machinery are normally recovered and also classed as inedibles. Inedible eggs are normally put in covered plastic buckets, dyed with a food color to identify them as inedible eggs, and sold to processors. Inedible eggs are also frozen in 14 kg (30 lb) cans and sold directly to pet food processors to be used as ingredients in their products, or dried at plants specializing in inedible egg processing and sold for general animal feed applications.

<u>SIC Code 2034 - Dehydrated Soups</u>

Dehydrated soups are a minor but important part of the dehydrated vegetable industry. Typically, they are a combination of previously dehydrated vegetables with various flavorings and protein "bases" added.

The industry is dominated by two large corporations which account for the bulk of all production. Additionally, there are some small operations which blend and package regional brands.

Dehydrated soup manufacturers use as principal ingredients various vegetables that have been previously dehydrated. Typically, these are potatoes, carrots, onions, garlic, bell peppers, celery, and parsley, but spinach, green onion tops, green beans, etc., may also be included. Various flavorings are used and normally incorporated in a sugar or salt carrier. Sugar and/or salt itself may be a significant ingredient.

Also incorporated into most blends are various types of soup bases; e.g., hydrolyzed vegetable protein. One processor was observed to manufacture its own soup base and also to dehydrate from fresh vegetables a small portion of its vegetable needs. All other processors contacted used only ingredients preprocessed elsewhere.

Process Description. Figure 3 shows a process flow diagram for a typical dehydrated soup operation. The manufacturing of dry soups is essentially a dry ingredients blending and packaging operation. All the various dehydrated ingredients (preprocessed elsewhere) are taken from dry storage and carefully weighed as per specific formulation. The ingredients are dumped directly into a blender (typically a ribbon type) and mixed until the dry blend is homogeneous. Alternately, some soups, such as onion soup, premix the dehydrated onions and soup base separately to prevent breakage of the onion flakes.

The premixed soup formulation or base mix is transferred to a filling hopper on a packaging machine. The soup mix (other than onion soup) is automatically filled (by weight) into pouches, sealed, cased, and sent to storage. Onion soup, however, is filled in two steps: base and onion flakes are filled separately to minimize breaking of the dried onion pieces and to assure a consistent ratio of onion to base. The packages are then sealed, cased, and stored.

Clean-up throughout an operating shift consists of dry methods--sweeping, brushing, vacuuming. At the end of daily operations, the ribbon blenders are normally rinsed clean.

The daily effluent is of a low volume, typically less than several hundred gallons. Packaging equipment may be steam-cleaned, vacuumed, or both, but never washed with water. No other water is used in any aspects of dehydrated soup manufacturing.

SIC Code 2038 Frozen Specialties

Frozen specialties include such specialties as frozen baked goods, frozen dinners, frozen pizzas, and other frozen specialties. It does not include frozen meats, fish, vegetables and fruit except as they appear as ingredients to prepared dinners or other frozen specialties. Since production value of frozen specialties has increased 214 percent since 1967 and currently constitutes 49 percent of the 1974 value of all frozen food production, these products were removed from SIC 2037 and given a new industry identification, SIC 2038. The value of production of frozen food specialties in 1974 rose to over two billion dollars. In 1975, frozen specialties are forecast to increase 16 percent over the 1974 production as illustrated in Table 3 .

The Department of Commerce Census of Manufactures, 1972, estimates there are 436 plants nationwide that process frozen specialties. The North Central states lead the nation with 140 establishments. The Northeast is next with 110 plants, followed by 94 plants in the

DRAFT

TABLE 3

PRODUCTION OF FROZEN FOOD SPECIALTIES

Year	Production in Million Dollars	% Increase
1967	947	
1970	1401	48
1971	1397	-2
1972	1612	16
1973	1779	10
1974	2028	14
1975	2352	16

DRAFT

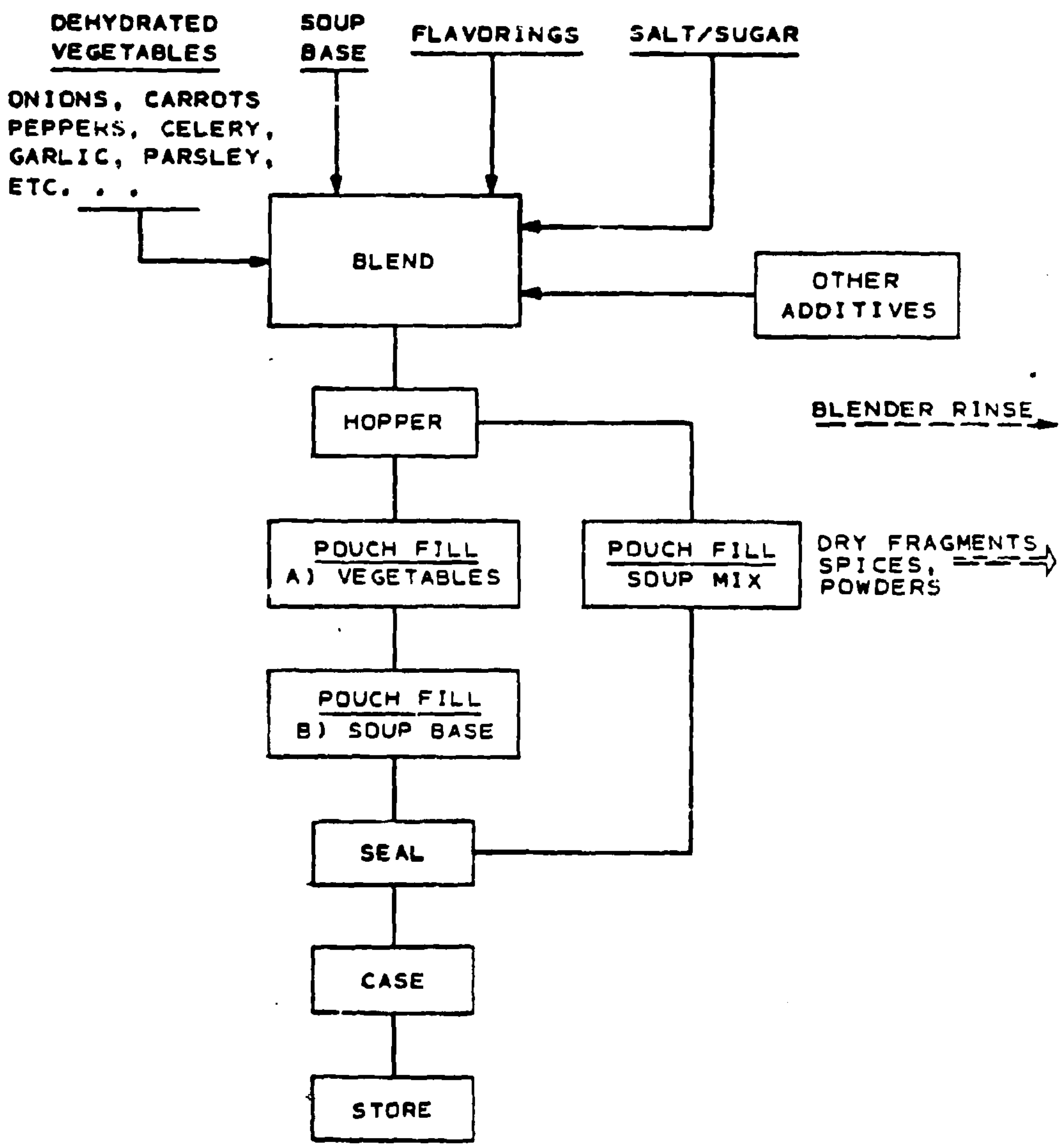


FIGURE 3
PROCESS FLOW DIAGRAM FOR DEHYDRATED SOUPS

South and 92 in the West. This location pattern is due to the fact that frozen specialty plants desire convenient distribution to major consumer populations. The major producing states are California, Illinois, Pennsylvania, New York, Arkansas, and Ohio.

For simplicity, frozen T.V. dinners, meat pies, and other frozen dinners and main courses may be designated as "Frozen Prepared Dinners." Frozen prepared dinners represent a substantial sales volume in America's supermarkets. Specific sales information is lacking, but the American Frozen Food Institute (1974) informally estimates that at least three million T.V. dinners and other frozen main course specialties are sold daily. The number of processing plants is estimated to be between 40 and 60. This number was derived through analysis of industry organization directories and the Standard and Poor index.

The industry is dominated by about six large corporations. Geographical distribution of plants is generally in accordance with population distribution; e.g., plants tend to be located in small communities because a large force of cheap labor is required to do the hand work needed in the preparation of ingredients and assembly of the prepared dinners.

Ingredients usually include meat, fowl, or fish; vegetables; gravies; and minor additives. In addition, there may be added starches (such as noodles), grains (such as rice), and a variety of small dessert dishes. These ingredients are usually pre-prepared elsewhere and are then further processed, cooked, assembled, packaged, and frozen at the prepared dinner plant. The bulk of the wastes generated originates from preparation of the ingredients.

"Frozen Bakery Desserts" is defined to include frozen cakes, pies, brownies, cookies, waffles, breakfast coffee cakes, turnovers, and other desserts. This segment does not include bread or bread-like rolls. The plants are generally large-scale kitchens and most have national distribution. The magnitude of this industry in terms of sales and number of plants is not known with exactness. It is estimated that there are between five and ten million frozen bakery desserts sold daily in the United States, and that there are approximately 50 to 70 plants manufacturing the bulk of these products. The latter figure is derived primarily from an analysis of industry organization yearbooks and Standard and Poor's index. The industry is dominated by six to eight large corporations whose brand names are household words.

Frozen "Tomato-Cheese-Starch Combinations" include frozen pizza, lasagna, ravioli, and other "Italian" specialties made with a tomato, starch, and cheese base. The magnitude of this segment of the industry is not known in terms of total production or sales. It is believed that there may be over 100 plants of various sizes manufacturing frozen pizza. All those identified discharge wastewater into municipal systems.

"Battered and Breaded Frozen Specialties" include many frozen meats, fish, chicken, and vegetables which are battered and/or breaded. Onion rings are the most common vegetable item in this segment. Shrimp and other seafood are also commonly prepared in this fashion, as is chicken. Generally, the seafood is thawed, washed, dried, dipped in batter, and frozen without pre-cooking. Vegetables and chicken follow the same procedure but are cooked before freezing.

As with the other individual segments of frozen specialty items, there are no accurate data available defining production volumes and number of plants manufacturing these items. Battered and breaded frozen specialties do, however, occupy a prominent place in the freezer section of the average supermarket, and it is likely that at least several million pounds a day are sold. All plants identified in this study that manufacture these items discharge into municipal systems. Two plants were investigated, one processing primarily shrimp, and the other processing primarily onion rings.

Process Description for Frozen Prepared Dinners. In many ways, the unit processes of a prepared dinner plant can be compared to the activities of an ordinary housewife as she prepares the evening meal for her family, the only difference being one of scale. Just as the housewife goes through different steps with each of her ingredients, of cutting, thawing, cooking, adding spices, etc., and finally assembling them on the plate to form a complete dinner, the prepared dinner plant goes through similar steps and finally assembles the dinner on an aluminum tray for packaging and freezing. The housewife generates the majority of her wastewater when she discards cooking liquids and cleans her pots and pans. Similarly, the majority of the wastes from a prepared dinner plant originates from clean-up of the vats, kettles, fryers, mixers, piping, etc., which are used during preparation of the various components of the final dinner. The major processes as they are conducted in a typical prepared dinner plant are described in the following paragraphs.

Turkeys and chickens arrive plucked, viscerated, and washed. The birds are placed on overhead meat hooks which travel down a dismantling line operation. The deskinning of the birds is accomplished by the manual hypodermic injection of air and subsequent expansion and separation of the skin away from the flesh. The skin is then peeled off, and various pieces are cut from the bird as it continues down the line. The pieces are placed in movable vats and either frozen and stored for later processing, or moved directly to the inspection, sorting, and deboning operation. The chicken is then floured and fried as whole pieces for later use in prepared chicken dinners or cooked. If cooked, the cooking operation (for both chicken and turkey) is followed by hand trimming from the bone and slicing for later addition to meat pies or dinners.

Following the hand trimming operation, the bones with adhering flesh are run through a rotating drum that scrapes and tumbles the meat from the bones. The meat is collected, stuffed into skin (sausage like), cooked, frozen, and then sliced, making a uniform section of meat.

Beef and other meat normally arrive at the plant in frozen chunks and are air thawed, sliced (for dinners) or diced (for Pies), cooked, and then moved directly to the assembly area, or they are frozen for later use. An alternate preparation involves the grinding of the beef and pressing into hamburger or salisbury steak patties. Veal patties are floured. The partial cooking of the meat is usually accomplished by passing the slices or patties through a long line of infra-red lamps installed in the roof of the cooking tunnels. Both sides are cooked by inverting the meat segment half way through the tunnel. As the pieces emerge from the broilers, they fall off the belt into trays and are carried to the assembly area.

The juices from the meat cooking operations are combined with flour and milk to produce the various types of gravies. The gravy is then pumped to the assembly area, where it is held ready to be sprayed onto the appropriate section of the T.V. dinner tray as the tray passes underneath the nozzle.

Vegetables, other than potatoes, usually arrive frozen in bulk, are thawed, run through cluster busters, and are then brought to the assembly area. The vegetables are placed in "hand pocket fillers" which rotate--keeping the individual pieces from sticking together--and held until needed for addition to the tray. Exceptions to the above are those vegetables which require longer cooking times, e.g., carrots, which may be partially precooked prior to being brought to the assembly area. Potatoes are usually prepared from dehydrated potato products. Water is added to the potato flakes which are then cooked in steam jacketed kettles, mashed, pumped to stainless steel movable carts, and wheeled to the assembly area. Other potato varieties, such as French fries, normally arrive frozen and partially precooked--ready to assemble without further processing at the frozen prepared dinner plant.

"Mexican" prepared dinners utilize tortillas, which are normally made at the plant. The rendering of corn into flat, pliable sheets involves pumping whole kernels from a storage silo to a grinder which reduces the corn to the consistency of paste. The paste is then extruded and rolled into flat sheets, mechanically cut to size and cooked in vegetable oil. The tortillas are then rolled, stuffed with meat, and transferred to the assembly area.

Assembly of the commodities that make up the finished product is performed along a moving belt assembly line. A hopper, placed at the start of the line, holds the aluminum trays and drops them one at a time onto the moving belt. Meat pieces, such as hot dogs, veal patties, chicken pieces, etc., are placed on the tray by hand counting the number of pieces necessary to make up the correct weight. Portions such as slices or smaller pieces are first hand weighed on scales placed next to the moving belt and then placed on the tray by hand. The tortilla products, e.g., tacos, are similarly added to the trays.

Vegetables are added by hand packed fillers which are mechanically cued to drop a measured portion onto the moving trays. Mashed potatoes are pumped from their movable carts and are gun injected, from overhead extruders, onto the proper section of the tray. The addition of gravies and butter to the tray is performed by overhead "guns" which spray a preset volume of the liquid onto the vegetables, meat, and potato portions.

When the complete dinner has been assembled, the trays are mechanically covered with foil, sealed, packaged, and transferred to the freezers. The dinners are then frozen, cased, and stored in refrigerated warehouses for shipment to customers.

Figure 4 schematically illustrates the processes described in manufacturing frozen prepared dinners. Of course, there are many kinds of frozen prepared dinner products on the market, and undoubtedly, some are prepared and assembled differently than the foregoing description. The reader, however, should have gained a general feel for how most prepared dinners are processed.

Process Description for Frozen Bakery Desserts. Under the process description for frozen prepared dinners, the analogy was made between the housewife cooking and baking in her kitchen and the activities of the large manufacturing plant. The analogy is equally valid for the frozen bakery dessert industry. Rich ingredients, e.g., butter, sugar, cream, etc., are purchased in bulk, received, blended under controlled conditions, further assembled in the final product form, sometimes baked, packaged, and frozen. All this is accomplished using large equipment under sanitary conditions with a high degree of quality control exercised. Just as the housewife may use and "dirty" many bowls, pans, and utensils on her baking day, so also the frozen bakery dessert plant must thoroughly clean with hot water all the many mixing vats, cooking kettles, measuring devices, pumps, piping, etc., which have come in contact with the ingredients and product. This clean-up is continuous during the shift as different products are manufactured; e.g., a section of the plant may run several different kinds of pies during a shift, and reaches a peak during the massive final clean-up at the end of each day's operations.

The process wastewaters thus consist of a mixture of water and the product ingredients. In this industry the ingredients are very "rich," e.g., high in carbohydrates, fats, etc., and the resulting waste is high in BOD, grease and oil, etc.

DRAFT

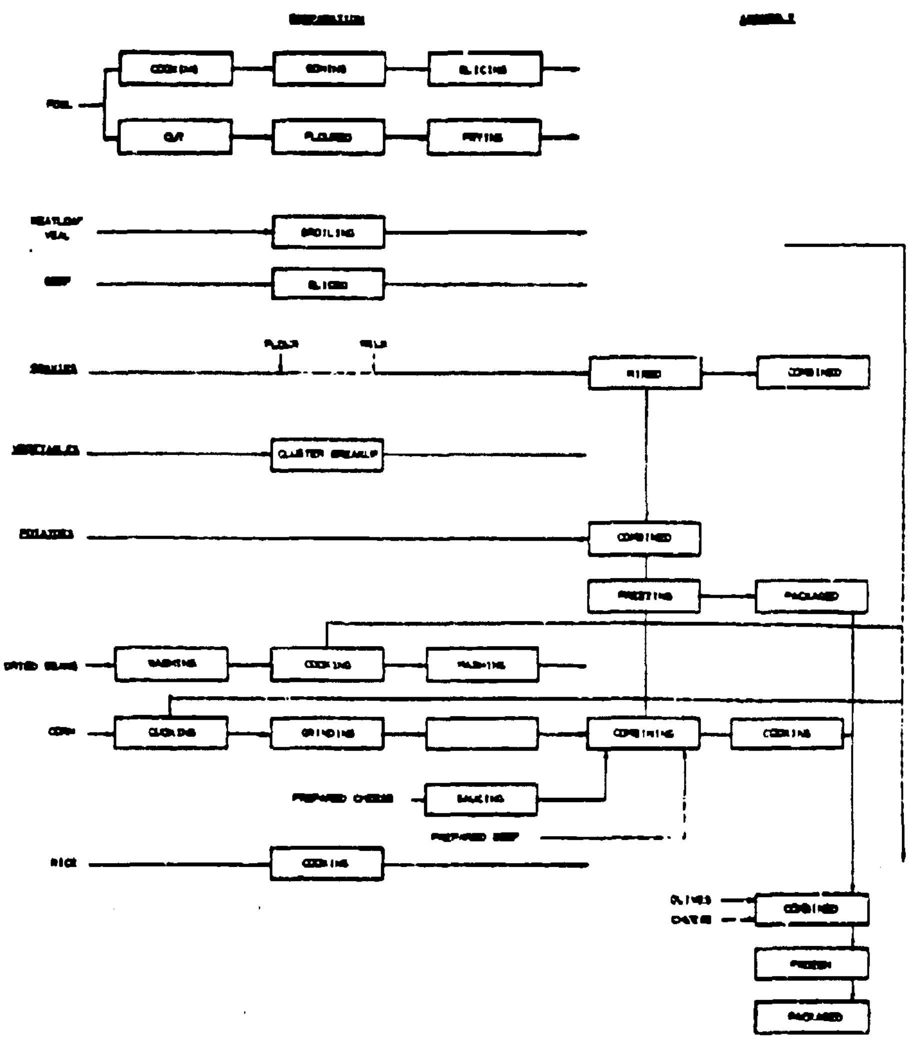


FIGURE 4

PREPARED DINNER PLANT
SIMPLIFIED PROCESS FLOW DIAGRAM

Since health standards are strictly enforced, there appears to be no alternative to the extensive clean-up requirements of these plants or the resulting strong wastes.

In-plant waste generation can be reduced, however, by separate disposal as solid waste of spilled material and sub-standard ingredients. Employees must be educated to refrain from discharging such wastes to the sewer. Figure 5 shows a simplified diagram of unit process steps in a frozen bakery dessert plant.

Process Description for Frozen Tomato-Cheese-Starch Combinations - All major ingredients are preprocessed elsewhere and arrive at the manufacturing plant in bulk containers. These ingredients include tomato paste, cheese, flour, milk, oil, noodles, seasonings, and meat. Onions and green pepper may be peeled and sliced at the plant, but the processing of these vegetables is a negligible wastewater generator.

Manufacturing processes consist basically of blending ingredients, assembling the end product, and packaging and freezing it. Occasionally, the product may be precooked or baked prior to freezing. Differences between plants are mainly a function of degree of automation used versus hand labor. As might be expected, the larger the plant production, generally the greater the degree of automation.

In pizza manufacturing, the dough is mixed separately by combining flour, baking powder, salt, and sufficient water in large mixing vats to make an elastic dough. The dough is allowed to sit for several minutes, and then repeatedly machine kneaded. Finally, the dough is extruded flat on a belt to uniform thickness, and mechanically cut into the typical round shape. Meanwhile, the tomato sauce and spices are being heated and mixed in a separate vat, and the cheese sauce heated in still another vat. The ingredients are then combined mechanically on a moving belt assembly line by use of automatic spray dispensers which place a measured quantity of tomato and cheese sauce on each circular dough segment. Topping ingredients such as meat, onions, green peppers, etc., are then added by hand or machine. The assembled pizza is wrapped, packaged, and frozen.

Wastewater is generated primarily by clean-up of equipment and spills. Refrigeration water is generally recycled, but, if not recycled, contributes a significant volume of clean water to the wastewater. Because process wastewater is primarily generated by clean-up, it follows that the wastewater contents consist of the major ingredients used.

DRAFT

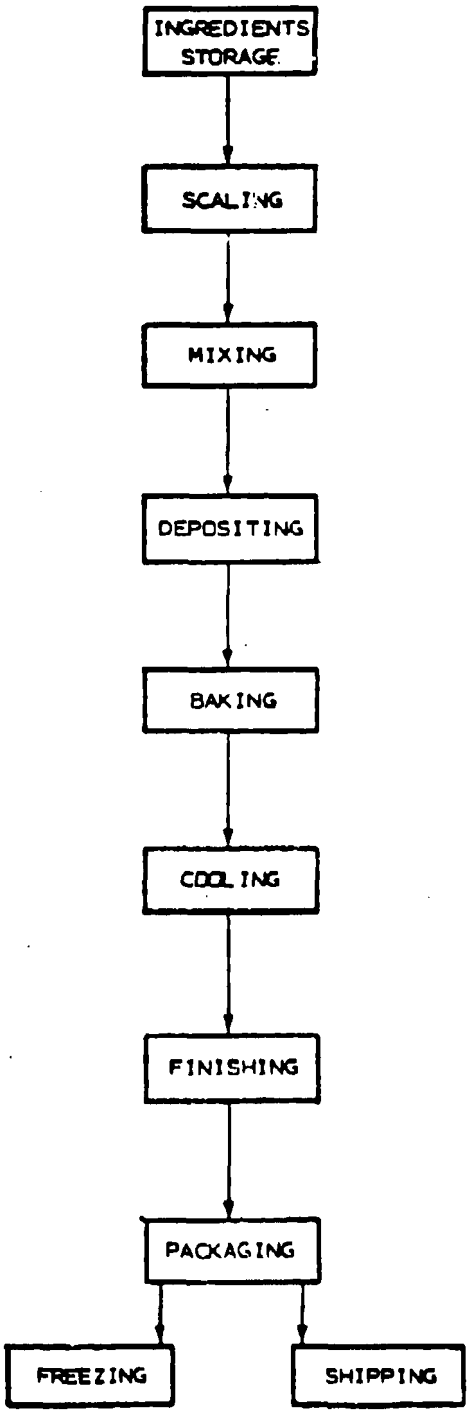


FIGURE 5

PLANT G
FROZEN BAKERY PRODUCTS PLANT
SIMPLIFIED PROCESS FLOW DIAGRAM

An efficient plant can hold its waste of ingredients to under one percent of the incoming ingredient weight, e.g., loss of less than one pound of tomato paste for every hundred pounds of tomato paste used.

Process Description for Battered and Breaded Frozen Specialties

Generally, the food item to be battered and breaded has been preprocessed to some extent prior to arrival at the plant. Typical preprocessing is as follows:

- Shrimp - washed and frozen
- Fish - eviscerated, heads and tails removed, washed and frozen
- Meat - slaughtered, dressed, and frozen
- Chicken - dressed and frozen
- Onions and Mushrooms - washed

Since shrimp is the "worst case" for non-vegetable items, processing of shrimp is described below and illustrated in Figure 6.

Frozen shrimp are bought in bulk, thawed overnight, and processed the next day. Thawing produces a substantial waste volume since it is followed by thorough washing. The shrimp is then shelled, ends removed, deveined, and washed again. There is equipment to automatically perform these steps, but in smaller plants they are done manually by skilled workers. The shrimp are then dried, "butterflyed" by machine, spread on a belt, and conveyed through egg batter. Following battering, the shrimp are tumbled through a breading machine which coats the exteriors with bread crumbs and flour. Finally the shrimp is boxed and quick frozen.

Waste generation results from the thawing water, subsequent washings, and clean-up of equipment and spills. If the shells, heads, and tails are included in the wastewater, they constitute a major organic load and should be removed as solid waste.

Frozen onion rings are by far the major item in battered and breaded vegetable specialties. A typical production has the onions arriving washed in 23-46 kg (50 or 100 lb) bags. They are then machine peeled with the peels handled dry, e.g., air conveyed from the peeler. Next, the onions are machine sliced, automatically arranged on a mesh belt, and conveyed through egg batter. Following the batter, the onion rings are machine dipped in bread crumbs and flour, packaged, and frozen. They are sometimes precooked before being frozen.

Wastewater generation results from clean-up of equipment and spills, and juices from the onion slicing operation. The batter is very high in organic strength, and the clean-up wastes are correspondingly strong.

DRAFT

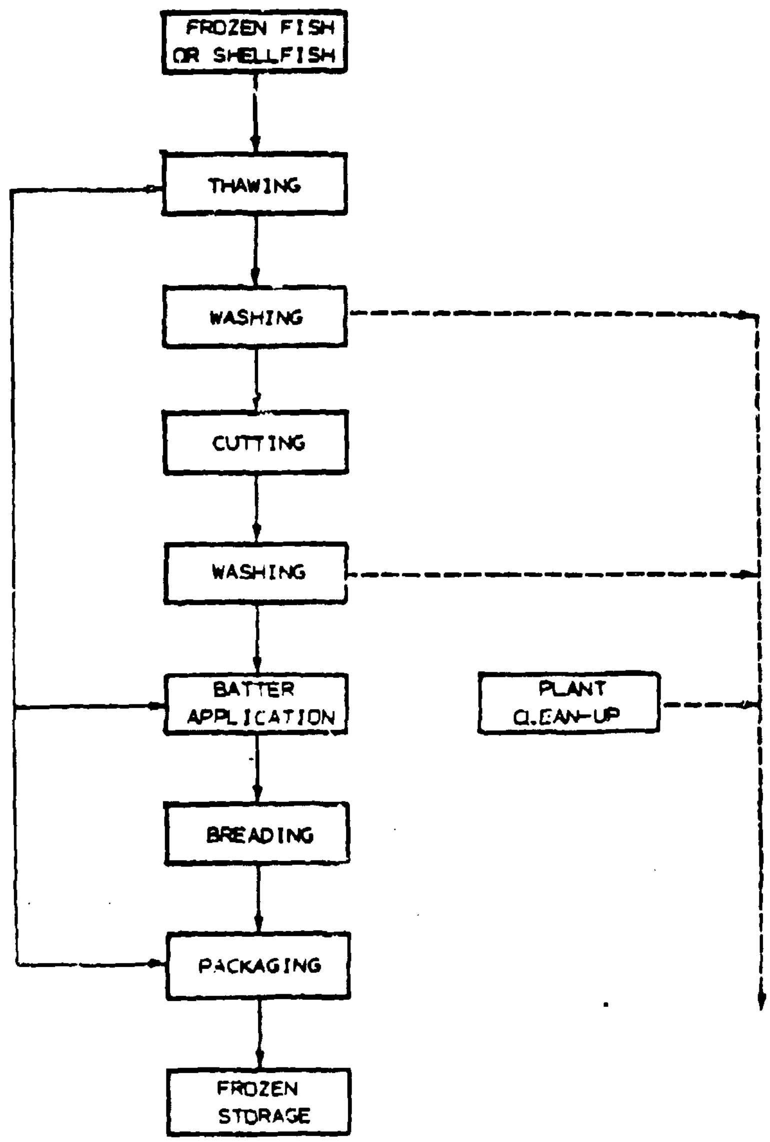


FIGURE 6

BREADED FISH AND SHELLFISH PLANT
SIMPLIFIED PROCESS FLOW DIAGRAM

SIC Code 2047 - Dog and Cat Foods

General - Food products for dogs and cats represent virtually all of what is generally referred to as the pet food industry. Of the two major pet foods, cat food represents approximately 20 percent of the industry tonnage and 30 percent of the retail dollars. Dog food contributes the remaining 80 percent of tonnage and 70 percent of retail dollars.

The 1972 Census of Manufacture (2) counts 204 pet food manufacturing establishments nationwide. California leads the nation with 26 pet food plants. The Midwest also manufactures a good portion of the nation's pet food.

At least 90 percent of the dollar sales of pet foods are produced by plants owned by a few major corporations; many small, family-owned pet food operations make up the remaining 10 percent of the industry.

Table 4 shows pet food production by sales dollars, and pounds sold from 1969 through 1974 (estimated). This table shows the trend toward greater production of dry pet food for both cats and dogs and a general trend toward increased production of all pet food.

Raw Ingredients - Pet foods are generally made up of meat and meat by-products, fish and fish by-products, cereals, and other nutritional ingredients which may be received at the plant in the form of wet, dry, or semi-dry products. Proteins and carbohydrates are principal constituents, and other diet balancing components are present in varying concentrations and ratios. The final product is marketed in three major styles: canned, dry, and semi-moist.

The variety, style, and form of raw ingredients used in pet foods are numerous.

Meats are delivered to the plants fresh in barrels or frozen, typically in 23 to 46 kg (50 to 100 lb) blocks. The meat may be whole cuts, chopped, or comminuted to a particular desired piece size. The meats commonly used are beef, pork, sheep, horse, poultry, and various types of fish. These cuts can be either striated muscle tissue or "by-products" (lungs, tripe, esophagus, gullets, etc.). Poultry products normally are either finely ground whole carcasses or by-products. Fish may be fresh whole, frozen whole, fresh by-products, or frozen by-products.

Other ingredients used by pet food processors are typically derived from soybeans, corn, wheat, barley, and oats. Storage is normally in silos for the larger processors but may also be accomplished in 23 to 46 kg (50 to 100 lb) paper or cloth bags. Size reduction is normally performed prior to delivery, but grains may also be milled or screened by the pet food plants. Particle sizes utilized include whole grains, cracked grains, grits, mids, flakes, and flour.

TABLE 4

PET FOOD VOLUME

RETAIL DOLLAR SALES (MILLIONS) THROUGH U.S. FOOD STORES

TYPE	1974*	1973	1972	1971	1970	1969
Dog food, dry	$ 675	$ 531	$ 397	$ 355	$ 297	$ 259
Dog food, wet (canned)	565	523	471	458	421	385
Dog food, semi-moist	265	214	174	152	128	108
Cat food,dry	160	129	101	90	75	61
Cat food, wet (canned)	400	343	308	296	270	237
Cat food, semi-moist	70	44	30	14	1	---
TOTALS	$2,135	$1,784	$1,481	$1,365	$1,192	$1,050

RETAIL POUND SALES (MILLIONS) THROUGH U.S. FOOD STORES

TYPE	1974*	1973	1972	1971	1970	1969
Dog food, dry	3,220	2,902	2,591	2,332	2,065	1,848
Dog food, wet (canned)	2,120	2,254	2,216	2,254	2,254	2,155
Dog food, semi-moist	500	477	407	356	310	265
Cat food, dry	420	390	347	309	265	217
Cat food, wet (canned)	960	963	907	909	873	813
Cat food, semi-moist	90	58	40	17	1	---
TOTALS (in lbs)	7,310	7,044	6,508	6,177	5,768	5,298

* estimated

Formulations dictate what style, type, and amount of raw ingredients are used. Other additives used in these formulations cover a wide and descriptive field; for example, fresh onions, frozen carrots, dried vegetables, gums and food starches, colors, flavorings, milk-base products, preservatives, humectants, emulsifiers, sugars and syrups, vitamins and minerals, and yeasts are often added. In most cases, these additives are prepared elsewhere, but in certain circumstances some degree of processing may be needed to prepare ingredients for a particular formulation.

Process Description for Soft-Moist Pet Food - There are two styles of soft-moist pet food, extruded and expanded, each one requiring a different processing approach. Figures 7 and 8 show typical soft-moist pet food process flow diagrams for both of the above styles.

The extruded chunk and patty forms can be of similar or identical formulation. Each contains from ten to thirty percent meat and meat by-products. Only the package size, shape, and individual product form are different among the different brands.

The six basic ingredients in extruded chunk and patty-formed products are soybean meal (and other grains), sugar, fresh meat by-products, animal fat, preservatives, and humectants. Additionally, minor ingredients such as vitamins, minerals, flavorings, and colorings are normally used for various reasons (nutritional balance, final product identity, etc.). All of these materials are typically handled through automatic mix cycles.

Soybean meal, sugar, fat, propylene glycol, and sorbitol are usually stored in bulk. Each of the bulk-stored ingredients is located so that conventional conveying and pumping equipment are used to convey the ingredients to a weighscale hopper located above the batch mixer.

Extruded soft-moist can be made in two ways. These are shown as A. and B. on Figure 7. The first method involves pre-cooking a meat-preservatives-additives slurry, milling and subsequent addition and mixing of grains, cooking of the mixture, extruding, further cooling, and packaging. The second method involves the mixing of all ingredients, a combination cooking-expanding-extruding step, cooling, and packaging.

In the first method, known as the meat-slurry method, a selection of meats and meat by-products (fresh or frozen) is ground through a .635 cm (¼ in) or smaller plate and conveyed to a cooking tank where a measured amount of water, sugar, and other additives are brought together in a specific formulation. The entire slurry is heated with agitation for a predetermined length of time and at a predetermined temperature. The heated meat slurry is usually run through a mill to further reduce particle size and is introduced into a continuous-type mixer. Weighed and blended grains are then added to the continuous mixer. Following thorough mixing, the mass is conveyed through a

DRAFT

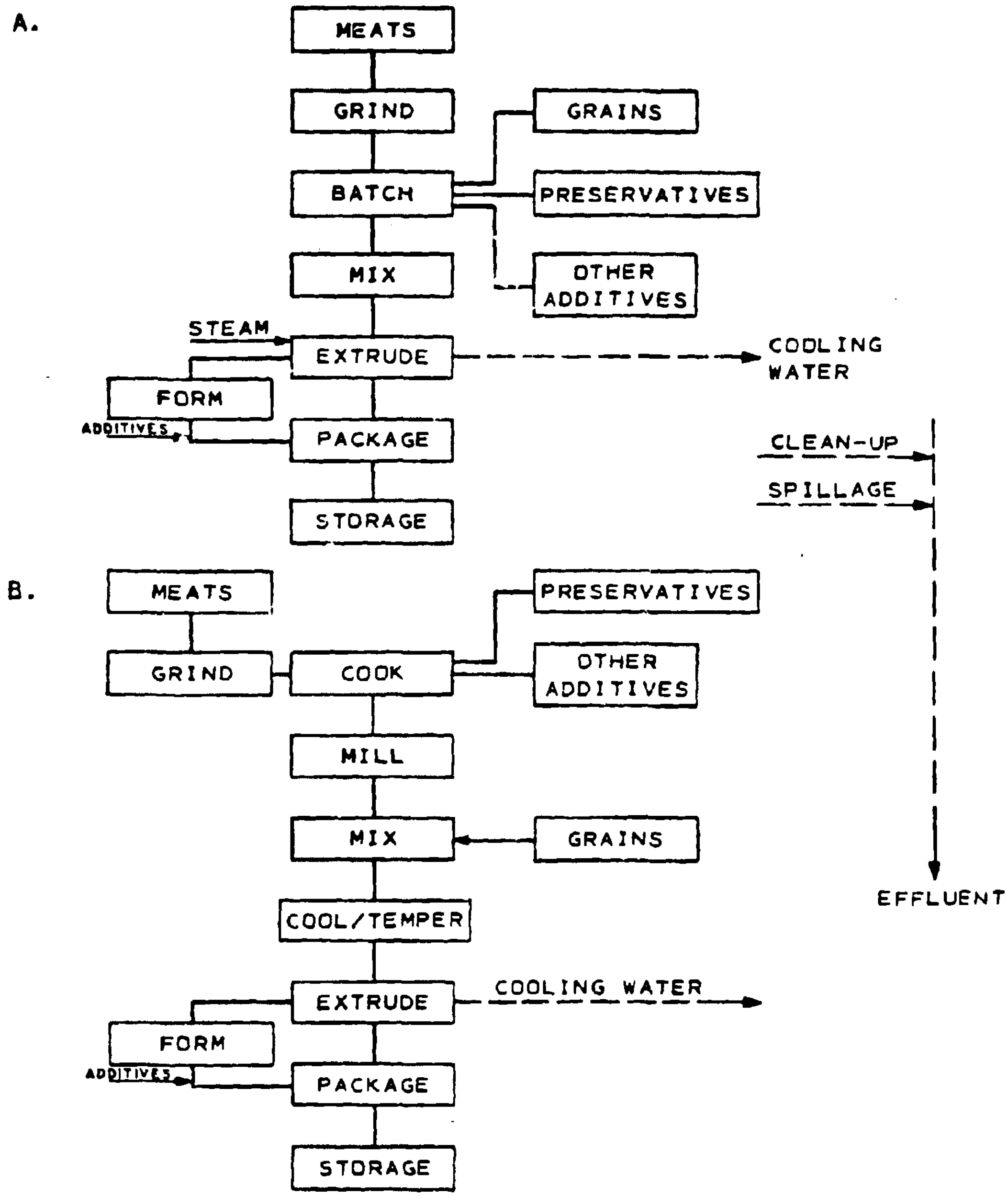


FIGURE 7
PROCESS FLOW DIAGRAM FOR
EXTRUDED SOFT-MOIST PET FOODS

DRAFT

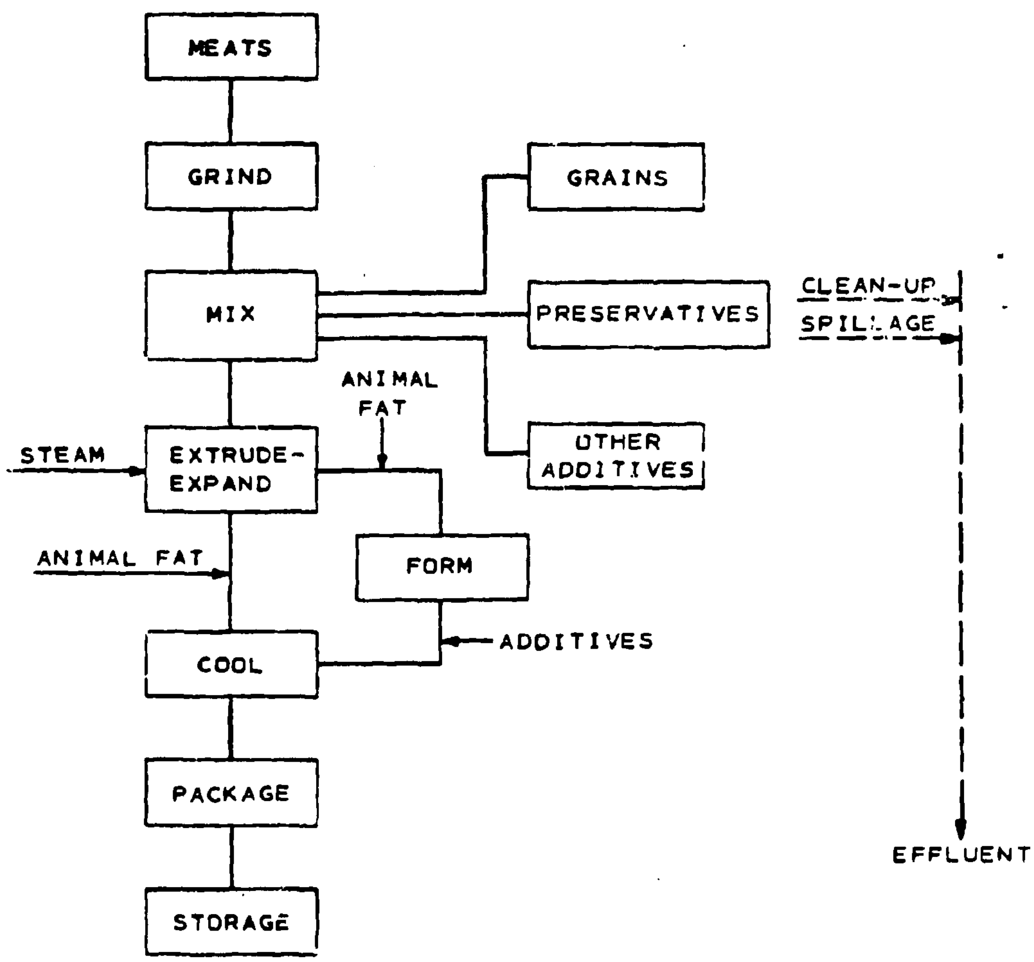


FIGURE 8
PROCESS FLOW DIAGRAM FOR
EXPANDED SOFT-MOIST PET FOOD

heat exchanger (for cooling) and extruded into the desired size, shape, and length. Additional forming (patties, burgers, etc.) is accomplished after extruding but prior to further cooling.

The extruded and formed product is cooled in a continuous cooler, wrapped, and packaged.

The second method, shown as B. on Figure 7 , uses a continuous batching system. This system is considered the most desirable for soft-moist processing because less labor is used, and the interlocking systems reduce human error. A typical .45 kkg (one-ton) batch makeup system for soft-moist consists of:

1. A hopper bin scale which is equipped with a gate for weighing and collecting all dry ingredients.

2. Hopper bin scale especially designed for weighing and discharging ground meats.

3. 0.45 kkg (one-ton) stainless steel paddle-type batch mixer designed for proper mixing of soft-moist ingredients.

4. An agitated holding bin below the batch mixer to serve as a surge bin and assure a constant and uninterrupted flow of material to the extruder feeder screw.

A typical batch cycle is as follows: soybean meal, sugar, flavorings, color, and micro-ingredients are fed into the hopper scale, each to the desired weight, and transferred into the batch mixer below. Propylene glycol, sorbitol, and fat from storage are then pumped through meters into the batch mixer. The meters are preset for the desired volume and stop the pump when the desired volumes in pounds have been reached. The meat products are then pumped or screw conveyed to the meat hopper scale above the mixer, where they are weighed and dropped slowly into the batch mixer.

The mixture becomes very doughy and somewhat sticky. The mixture is continuously fed into the extruder barrel where live steam is injected into the mix. The heated mixture is forced through the extruder head under pressure, resulting in:

1. Gelatinization of raw starch.

2. Further reduction of coarse meat fibers, improving product appearance and texture.

3. Production of a well-blended, homogeneous chunk with a meaty appearance.

4. Cooking and pasteurization of the products.

5. Final formation of desired piece size and shape. Since soft-moist becomes quite soft when heated and extruded, various techniques in die design must be used to produce smooth, uniform product shapes.

Product temperature varies from 52°C to 163°C (125°F to 325°F). The extruded product may be further shaped into patties, burgers, etc., as desired. The final product is cooled in a continuous cooler, wrapped, and packaged.

The second type is an expanded soft-moist which contains little or no meat, but instead is high in cereals (soy, wheat, corn, oats, etc.) which have been cooked during the processing cycle. After cooking, extruding, and expanding, the product is coated with fat in a revolving reel prior to the cooler. This finished product will vary in density and weight, depending upon ingredients used and formulation.

Figure 8 shows a typical expanded soft-moist manufacturing process. The ingredients are weighed and mixed in a batch mixer in a manner similar to that described previously for extruded soft-moist. Propylene glycol and sorbitol can either be injected into the mix at the batch mixer or can be pumped continuously at a prescribed percentage into a mixing cylinder which is a part of the extruder-expander. From the mixer, the product is typically fed into an extruder barrel with live steam injection. The steam under pressure moistens and pasteurizes the product which is in turn expanded while being extruded. No drying of the extruded product is necessary since the final moisture content is governed by the amount of water added in the extruder.

Since fat is not added to the mix prior to extrusion, fat and other liquids are applied to the product externally in a rotary fat application reel prior to the cooling process.

When the hot extruded product leaves the extruder/expander and is in the atmosphere a few minutes, its temperature will drop to approximately 66°C (150°F). From this temperature the product is further reduced to approximately 27°C (80°F) or lower for optimum packaging and handling qualities. This final cooling is typically accomplished in a horizontal continuous cooler. The product enters the cooler and is spread uniformly to the desired depth over the entire width of a wire mesh belt. Air drawn into the cooler flows up and around the chunks or patties, cooling them. Product retention time within the cooler is regulated by changing the speed of the wire mesh belt. After proper cooling the product is ready for packaging.

DRAFT

The preservation of both extruded and expanded semi-moist pet food is basically accomplished through a reduction of water activity. Water activity (A_w) is defined as the ratio of the vapor pressure (P) of water in the food to the vapor pressure of pure water (P_o) at the same temperature. That is, $A_w = P/P_o$. Within the range favorable to the growth of mesophilic micro-organisms A_w is practically independent of temperature. By incorporating an effective anti-micotic, heating to destroy vegetative organisms, and adjusting to an A_w level of 0.85 or lower, pet food packaged in various types of plastic wrapping has proved to have excellent stability.

Process Description for Canned Pet Food - Canned dog and cat food covers a large variety of styles. Essentially, however, there are three major styles of canned pet foods--ration, gourmet, and high meat/fish. Typically, canned ration pet food is characterized by its "meat-loaf" appearance. It is usually a blend of meats, meat by-products, and cereals. Additionally, vegetables and various vitamins and minerals are added to provide desired levels of animal nutrition.

Figure 9 shows a typical process flow diagram for canned ration pet food. Meat (fish) and meat (fish) by-products, fresh or frozen, are taken from storage and ground to a desired piece size. Fresh bones (usually beef) are run through a disintegrator. These are weighed and conveyed to large agitating cooker-blenders. Additionally, freshly ground vegetables (onions, carrots, etc.) and other minor ingredients may be added to the blender. A measured quantity of water is added, and the entire mixture is agitated while being heated by steam (indirect or "live" injection). Measured quantities of various grains including soybean meal, ground corn, wheat, barley, milo, or oats are added to the cooker-blender, and the mixture is heated. The product is pumped to fillers, and the cans are filled, seamed, washed, retorted, cooled, and packaged.

Canned gourmet pet food is characterized by the presence of "pre-formed" chunks, patties, or meatballs mixed with varying types of gravies or sauces. Additionally, in some cases, vegetables, "biscuits," or specialized "bits" may be incorporated. The mix is formulated to provide a nutritionally balanced diet for dogs or cats, or for a particular subgrouping by age or condition; e.g., puppies, adult dogs, lactating bitches, etc. Figure 10 shows a typical process flow diagram for canned gourmet pet food. Meat (fish) and meat (fish) by-products, fresh or frozen, are taken from cold storage and ground to the desired piece size. These are conveyed to a large mixer. Pre-weighed amounts of grains and minor ingredients are similarly conveyed into the mixer. The mass is mixed for a predetermined length of time resulting in a product consistency closely resembling "dough." This "dough" is dumped into an extruder storage bin and the "dough" is extruded as per specific product requirements. Alternately, steam may be injected into the extruder head, and the product may be "expanded." The resultant pieces are conveyed directly through drying ovens (drying temperature

DRAFT

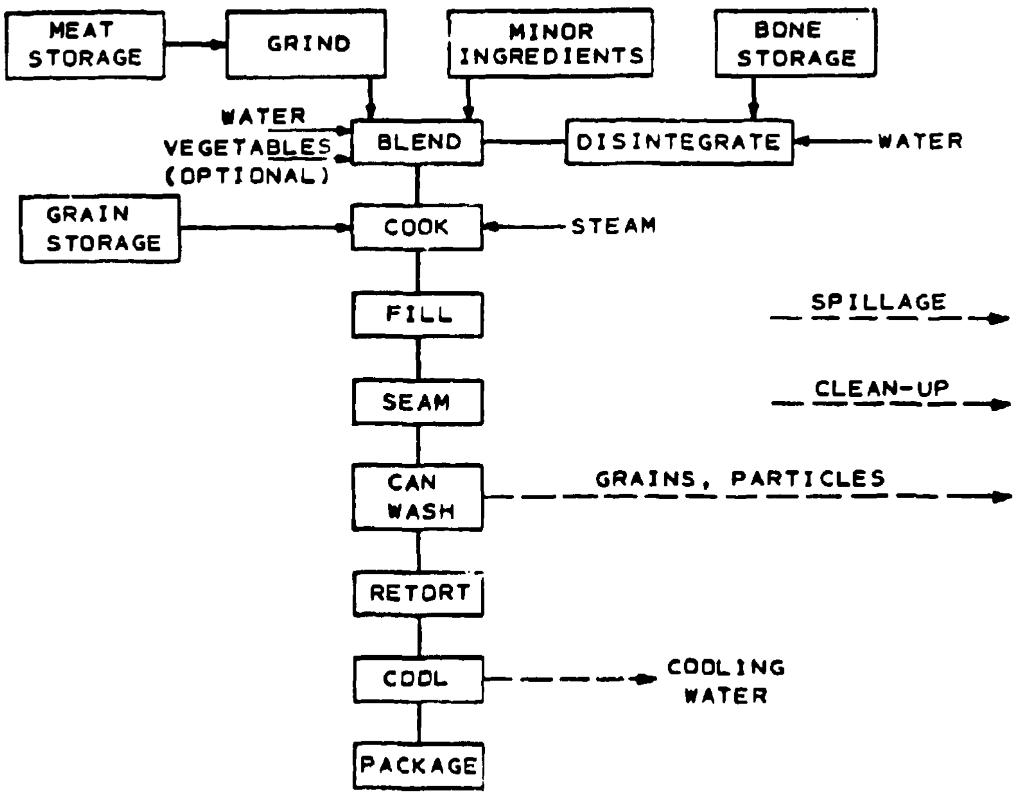


FIGURE 9
PROCESS FLOW DIAGRAM FOR
CANNED PET FOOD
RATION TYPE

DRAFT

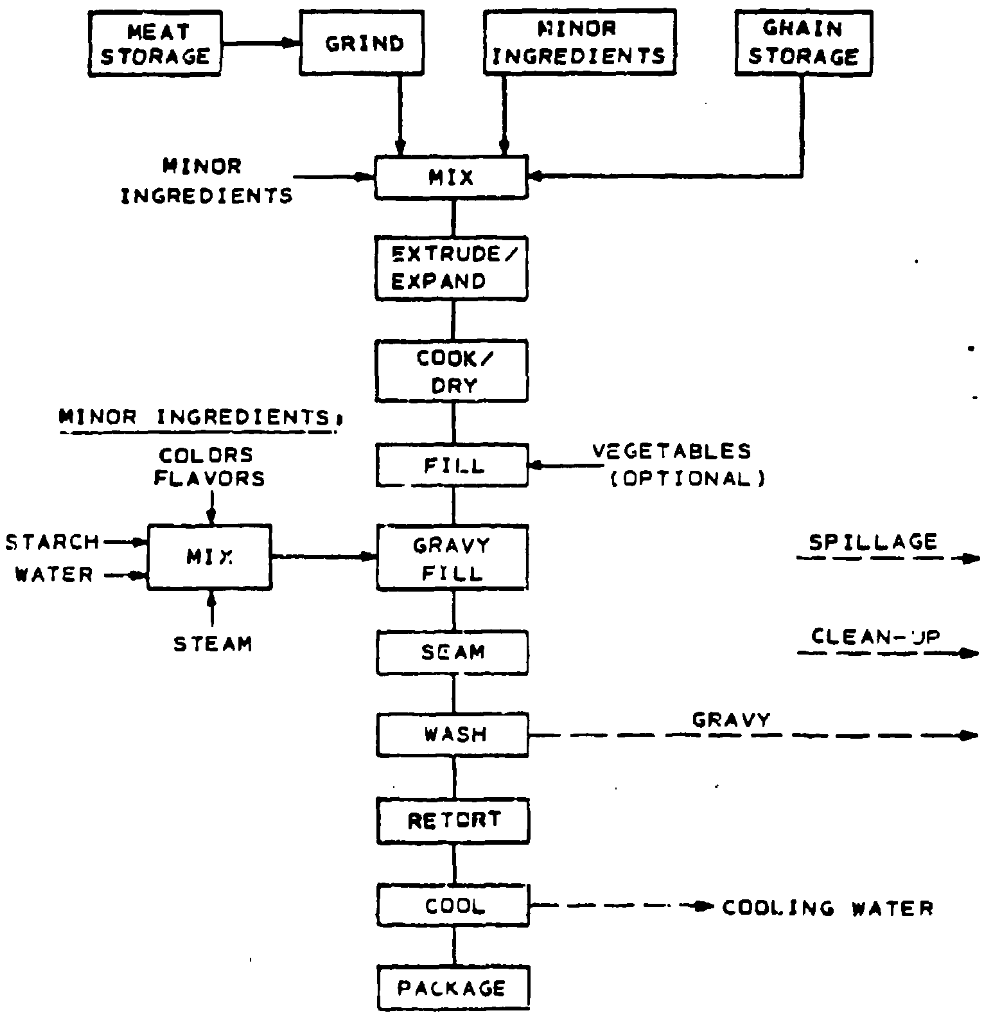


FIGURE 10
PROCESS FLOW DIAGRAM FOR
CANNED PET FOOD
GOURMET TYPE

may be as high as 316°C (600°F). The dried chunks are tumble-filled into cans, frozen or dehydrated vegetables may be added, and the containers are topped with hot gravy (starch-water-flavoring-coloring mistures). The cans are seamed, washed, retorted, cooled, and packaged.

Meat (fish) and meat (fish) by-products, fresh or frozen, are taken from cold storage and ground to the desired piece size and conveyed to a mixer-blender. Similarly, fresh bone may be disintegrated and added to the blender. Minor ingredients such as vitamins, minerals, and flavorings are added as well as any desired slurries of starches or gums (for thickening) or grains (textured soy products). Typically, at least 50 percent of the weight is meat and/or fish. The entire meat mixture may be filled cold at this point or it may be heated with steam to produce different product characteristics. If the products are filled "cold," steam-flow must be used on the seamers to achieve adequate package vacuum. The product is pumped to the filler, and the cans are filled, seamed, washed, retorted, cooled, and packaged.

All of the canned styles described above are typically pre-cooked to some extent before being filled, and they are consequently filled into cans at temperatures above 66°C (150°F). Stew products, however, are sometimes "cold-filled" so that cooking and sterilization are both achieved in the retorting cycle.

The lethal effect of heat on bacteria is a function of the time and temperature of heating and the bacterial population of the product. To design or evaluate an in-package heat process, it is necessary to know the heating characteristics of the slowest heating portion of the container (normally called the cold zone), the spoilage organism present, and the thermal resistance characteristic of the spoilage organisms. The various methods of retorting, cooking, and subsequent cooling utilize various principles to achieve commercially sterile products. One of the simplest applications of heating food in containers is sterilization of cans in a still retort; that is, the cans remain still while they are being heated. In this type of retort, temperatures above 121°C (250°F) generally may not be used or foods cook against the can walls. This is especially true of solid-type products which do not circulate within the cans by convection, but it also can be a problem with liquid products. Because of the temperature limit and because there is relatively little movement in the cans, the heating time to bring the cold point to sterilizing temperature is relatively long; for a small can it is about 40 minutes. The cooling cycle may be accomplished by either carefully flooding the chambers with cool water or air or by placing the cans in cooling canals.

The sterilization time can be markedly reduced by shaking or agitating the cans during heating, especially with liquid or semi-liquid type products. Not only is processing time shortened, but product quality is improved. This is accomplished with various kinds of agitating

DRAFT

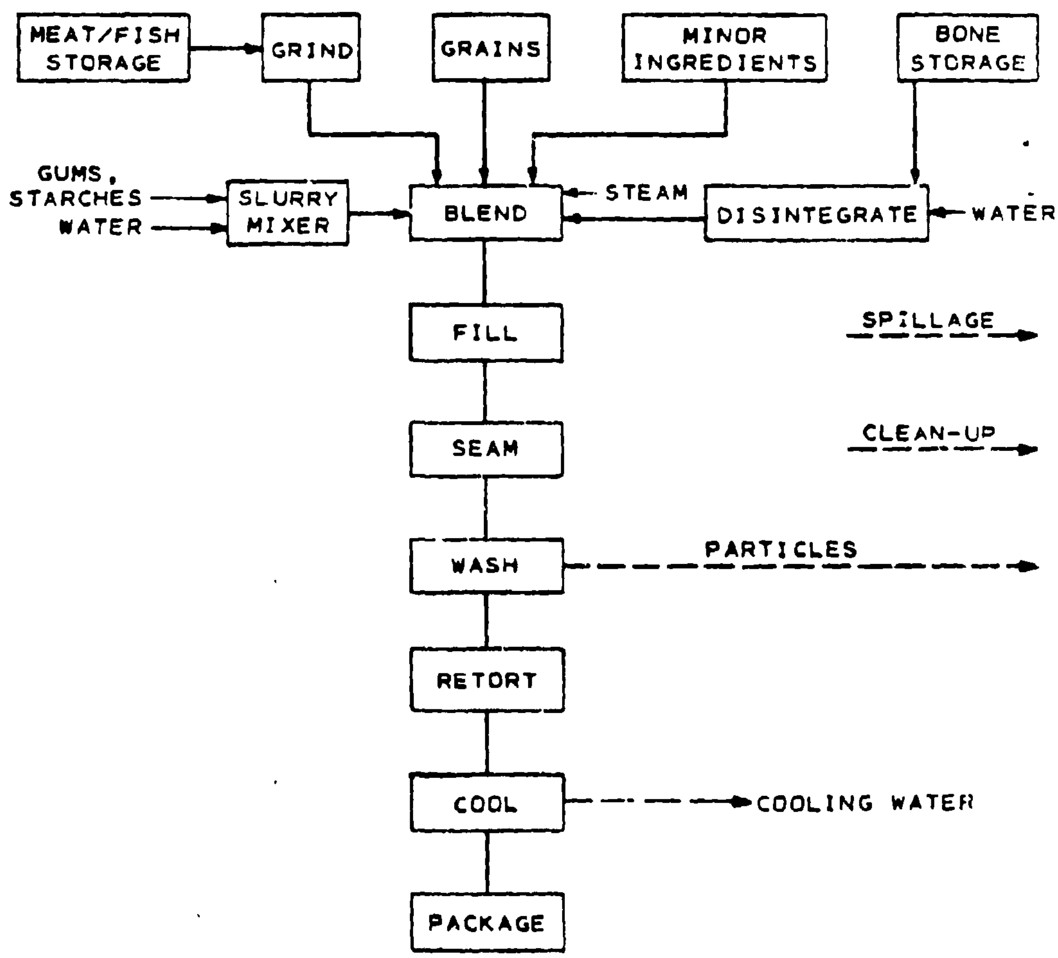


FIGURE 11
PROCESS FLOW DIAGRAM FOR
CANNED PET FOOD
HIGH MEAT/FISH TYPE

retorts. The cans rest in reels which rotate and thereby stir the contents. Forced convection within cans also depends upon degree of can filling, since some free headspace within cans is necessary for optimum food turnover within the cans. In addition to faster heating, since the can contents are in motion, there is less chance for the product to cook onto the can walls. This permits the use of higher temperatures than the 121°C (250°F) upper limit for a still retort and decreases heating times.

Agitation may be of more than one type; for example, cans may be made to turn end over end or to spin in an axial fashion with their length. Depending upon the physical properties of the product, one or another method may be more effective. These substantial reductions in time with associated quality advantages are not realized in foods that heat primarily by conduction. These cookers all have as a last step a cooling chamber which slowly exposes the container to either cool water or air or both until desired final temperature is achieved.

Continuous retorts (usually of the agitating type) are pressure-tight and built with special valves and locks for admitting and removing cans from the sterilizing chamber. Without these, pressure conditions would not be held constant, and sterilizing temperatures could not be closely controlled. Another type of continuous pressure retort which is open to the atmosphere at the inlet and outlet ends is the hydrostatic pressure cooker.

This type of heating equipment consists essentially of a "U" tube with an enlarged lower section. Steam is admitted to the enlarged section, and hot water fills one of the legs of the "U" while cool water fills the other leg. Cans are carried by chain conveyor down the hot water leg, through the steam zone which may involve an undulating path to increase residence time, and up the cool water leg. These legs are sufficiently high to produce a hydrostatic head pressure to balance the steam pressure in the sterilizing zone. If a temperature of 127°C (260°F) is used in the sterilizing zone, this would be equal to a pressure of about 1.36 atmospheres, which would be balanced by water heights of about 16.77 meters (46 ft) in the hot and cold legs.

As cans descend the hot water leg and enter the steam zone, their internal pressure increases as food moisture begins to boil. But this is balanced by the increasing external hydrostatic pressure. Similarly, as high pressure cans pass through the water seal and ascend the cool water leg, their gradually reduced internal pressure is balanced by the decreasing hydrostatic head in this cool leg. In this way, cans are not subjected to sudden changes in pressure.

Process Description for Dry Pet Food - As shown in Table 4, dry pet food has rapidly increased its share of the pet food market in recent years and now represents approximately half the total pet food sold by weight.

Figure 12 shows a typical flow diagram for dry pet food manufacture. Various grains such as soybean meal, corn, wheat, barley, milo, and oats are measured from storage silos into a large mixer/blender. Other items such as poultry meal, meat meal, liver meal, etc., may also be added as per specific formula. In addition, micro-ingredients such as calcium and potassium additives are introduced into the blender. Agitation is sufficient to produce a homogeneous blend. The entire mixture is sent through a hammermill. Oversized particles are removed by screening and recycled to a storage tank where they become an initial ingredient and are remilled. The ground fraction of acceptable particle size is conveyed directly to a surge tank.

The mixture at this point may be fed directly into an extruder/expander or it may be preconditioned with steam. Preconditioning softens the product and raises its moisture level from a dry range of 12 to 14 percent, to approximately 20 percent. This also aids in gelatinization during the extrusion process. Additional steam is injected into the mix at the extruder/expander to raise the moisture level to 22 to 30 percent.

The moist meal is fed into the extruder chamber, which is a stainless steel tube containing a stainless steel screw. Water jackets around the outside of the extruder maintain proper temperature. Temperatures in the extruder range up to 148.9°C (300°F), and the product can be in the unit from 30 to 60 seconds. During this time, the grains and starches are cooked, and all of the ingredients are well blended. The product is forced through the extruder die and cut by a series of whirling knives. Moisture of the product leaving the extruder is 19 to 27 percent.

The moistened and expanded product is conveyed to a drying oven, where the moisture level is reduced to approximately 10 percent. After the product leaves the oven, it goes over a series of screens and then flows through the fat and coating drum. Additional ingredients such as flavorings and fat soluble vitamins may be added to the animal fat.

The finished product is either stored in bulk for several days or directly packaged into desired container sizes.

Because of its low moisture content, dry pet food has excellent shelf life without further preservation. Antioxidants and mold-inhibitors are sometimes added to the final coating.

DRAFT

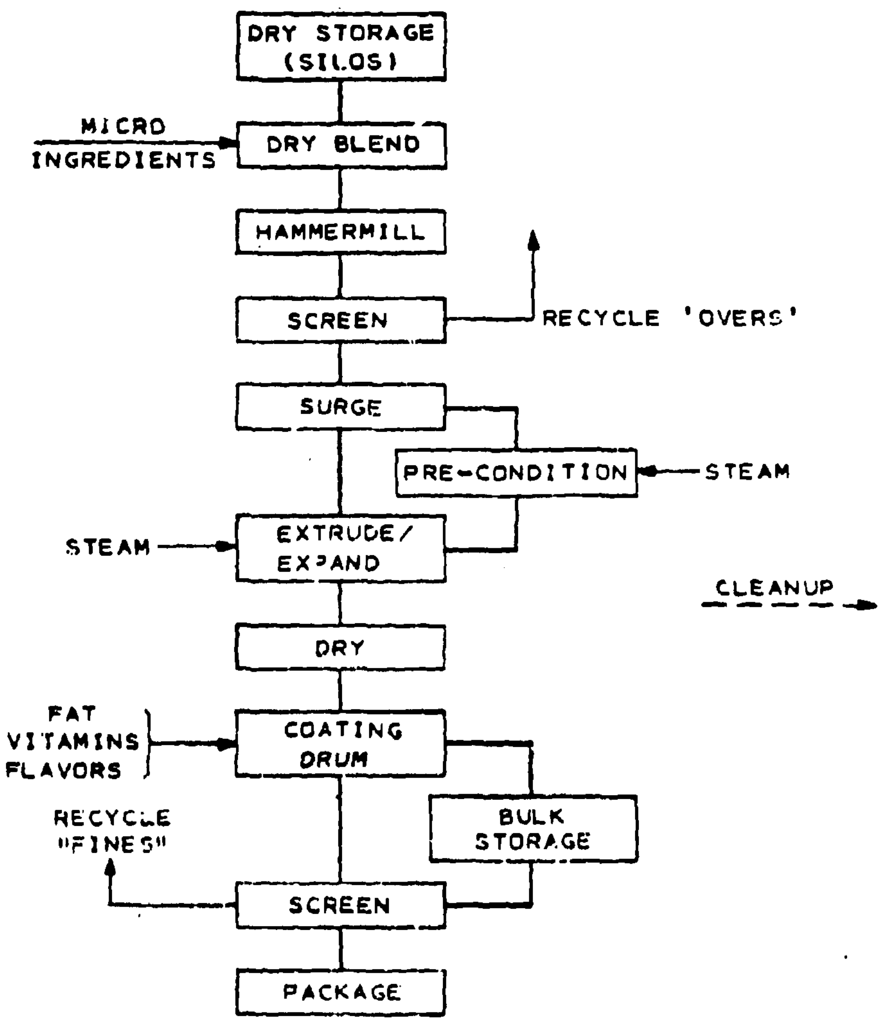


FIGURE 12
PROCESS FLOW DIAGRAM FOR
DRY PET FOOD

DRAFT

SIC 2051 - Bread and Other Bakery Products, Except Cookies and Crackers

Background of the Industry - The bread, cake and related products industry includes establishments primarily engaged in manufacturing bread, cakes, and other perishable bakery products. This industry also includes establishments producing bakery products for sale by home-service delivery or through one or more non-baking retail outlets.

Bakeries tend to specialize in the products they make with the major divisions along the lines of the following: (a) bread types and items such as donuts, snack cakes, snack pies, and sweet yeast goods; and (b) bakeries which produce primarily full size cakes or pies.

Most bakeries, when baking specialty items such as snack cakes and snack pies, do not bake larger cakes or pies. Larger cakes and pies are produced by bakeries engaged only in the production of these items. Such bakeries normally do not also manufacture bread and buns.

Raw materials used in bakeries differ little from materials used by homemakers. Flour is the principal ingredient and is purchased in larger quantities than any other raw material. Sugar, salt, shortening, preservatives, and other additives are also used in the production of bakery products.

Present Magnitude of the Industry - The baking industry represents a $10 billion annual business, including smaller, retail bakeries. The U.S. Department of Commerce (5) reports that a total of 3,302 bakeries were operating in 1972 with nearly half of them with 20 or more employees. Bakeries tend to be located near their market. They are concentrated in the eastern portion of the country and are usually situated in urban areas. Nearly two-thirds of all bakeries are in the northeastern states.

Bakeries are generally owned by large corporations which have bakeries throughout the United States. Many of these bakeries at one time were independent or owned by smaller corporations and have subsequently been acquired by larger companies.(6).

Future Outlook - Most bakeries are located in older buildings which have been built onto over the years. Generally, these buildings are located in urban areas, and additional expansion is limited because of neighboring buildings or street locations. There appears to be little construction of new buildings in the industry. If additional floor space is needed, neighboring buildings will be purchased when possible and equipment installed. If neighboring buildings are not available, remote buildings are purchased. New buildings represent about 10 percent of new bakery construction, while 90 percent represents the use and renovation of existing buildings for expansion of bakeries.

Description of the Conventional Mix Bread Process - The conventional or batch mix method of producing bread is the most extensively used processing method, accounting for more than 60 percent of all bread made in this country. This method yields a somewhat coarse and unevenly textured bread compared to the continuous mix process. The conventional method is described below. Figure 13 presents a typical process flow diagram.

Raw materials used in the baking of bread are purchased in bulk and stored in bins, vats, or bags. Flour requires larger storage facilities than does shortening, yeast, sugar, salt, and other lesser ingredients. Fruits used in snack pies or regular pies are purchased frozen and with addition of sugars and syrups are used as pie fillings. Other ingredients which are used in lesser quantities, such as raisins, sesame seed, and rye meal, are purchased in paper sacks and stored in rooms with temperature and humidity control.

From its 18,000 to 50,000 kg (40,000 to 110,000 lb) storage bins, the flour is pumped or screw conveyed to a sifter which removes undesireable foreign matter. From the sifter, the flour is transferred directly to the mixer where ingredients are either added automatically or manually depending on the type bread being made. This mix is referred to as a "sponge mix" and contains flour, shortening, water, and yeast.

The mixing equipment is cleaned each day by scraping the walls of the mixers to remove any dough which may adhere. Material removed from the mixers is either used for animal feed or is taken to a sanitary landfill for disposal. No water is used during the daily cleaning process unless mixing has been completed for the day because the action of water and flour together could impede any mixing which would occur soon after cleanup. Water is used to clean mixers after all mixing has been completed for the day or during a down day when a major cleanup of the plant occurs. This allows the mixers to dry sufficiently before the next day's operation.

Once the sponge mix is completed, the dough is placed into large greased troughs. The troughs are rolled into a fermentation room where the fermenting action of the yeast produces carbon dioxide which causes the dough to rise. The fermentation room has controlled temperature and humidity for optimum results. The dough remains in this room for about five hours or until it has risen fully.

When fermentation is completed, the troughs are removed from the room and the dough beaten down by hand. The trough is raised above the second mixer, where it is tipped, and the sponge mix falls into the hopper of the mixer below.

The greased troughs are not cleaned except for the occasional removal of dough which may stick to the trough. Generally, the troughs are wiped out with rags when necessary and regreased to accept the next batch of dough.

In the second mixer, additional water, flour, sugar and other minor ingredients are added, and the dough is given its final mixing period.

DRAFT

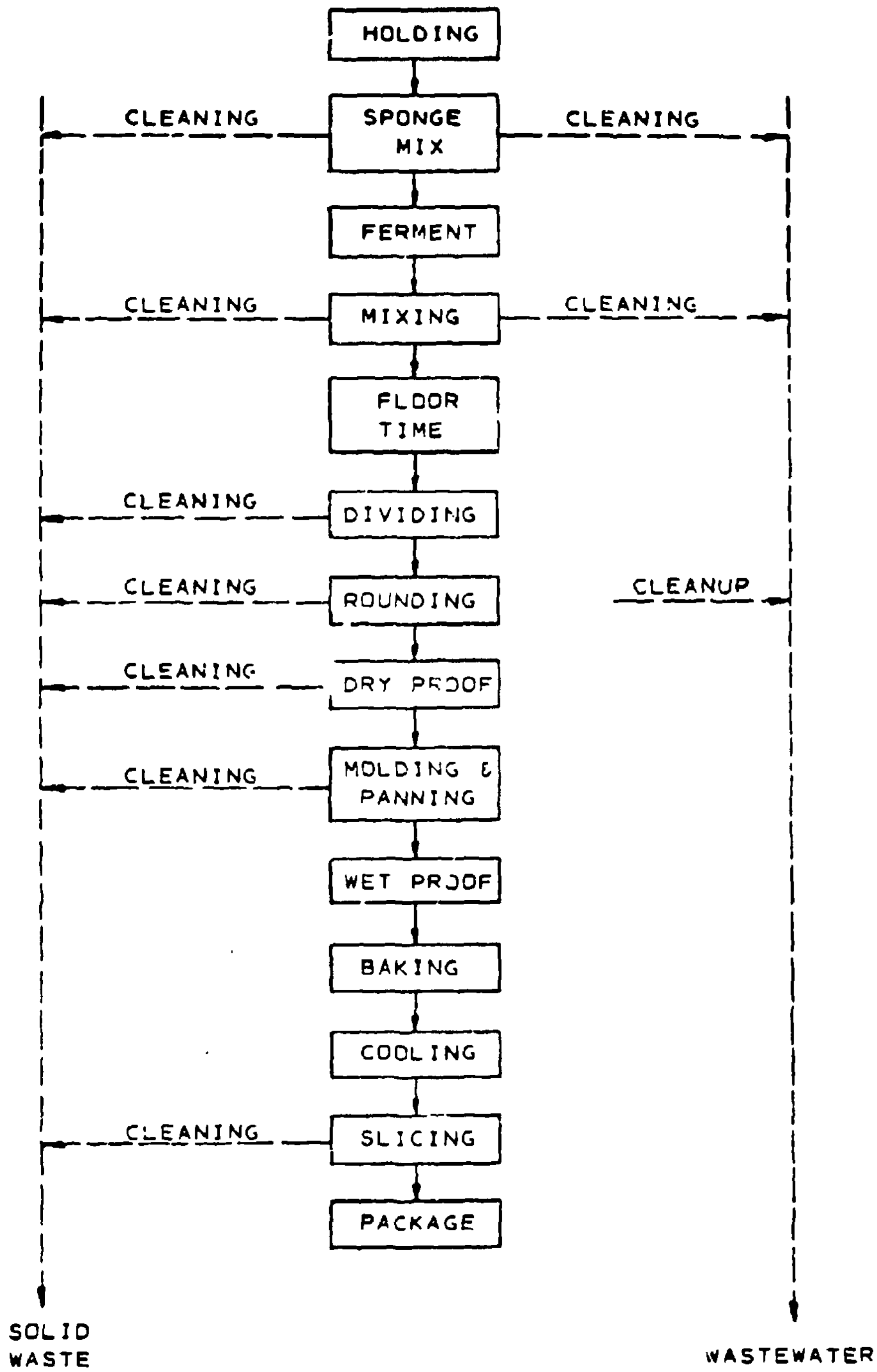


FIGURE 13

BREAD - CONVENTIONAL MIX METHOD
PROCESS FLOW DIAGRAM

of about 20 minutes. After the second mix, the dough is emptied back into a greased trough where it remains for an additional 20 minutes. This is referred to as "floor time" and allows the dough a second rising. The second mixer is cleaned in a manner similar to the sponge mixer.

When floor time is complete, the dough is emptied into the divider, which divides the dough into prescribed portions by weight for one loaf of bread. At the end of each production day, the divider is dry cleaned to remove excess flour and dough. Useable dough is returned to the divider hopper for further use. Dough which cannot be used is handled as solid waste.

Once divided, the dough is conveyed a short distance to the rounder. The rounder is a centrifuge which forms the dough into round shapes and discharges it. The rounder generates a considerable amount of solid waste which is normally removed by dry cleaning.

The next processing step is called "dry proofing." The rounded dough is dropped into pans or into a dry proofer which has captive trays where it remains at room temperature from 8 to 20 minutes for further rising. Again, the pans or trays used for dry proofing are usually dry cleaned.

After completing the dry proofing, dough is conveyed to the sheeter. In the sheeter, the dough is first rolled into a pizza-like shape and then through a molder to form it into the familiar blunt cigar shape of a loaf of bread.

After shaping, the dough is put into pregreased pans. If a pullman or sandwich loaf is to be made, a pan lid will be placed over the pans. This creates the familiar square sandwich loaf by preventing the dough from rising to form a rounded top. The pans are then conveyed into a wet proof box and remains there for about 40 to 70 minutes. The wet proof box is heated considerably above the room temperature (up to 53°C, 125°F) and the humidity is increased. This causes the dough to rise and fill the pans before baking. When removed from the wet proof box, the panned dough is conveyed to ovens. The bread moves slowly through the ovens where it bakes for about 20 minutes.

The pans of bread are then conveyed to a depanner which removes the bread from the pans. This is accomplished by blowing air into the pans to free the bread. The pans then pass under a series of suction cups which lift the bread out of the pans. The bread is deposited onto a conveyor and the pans go to a separate conveyor where they are returned to the production line for further use. Bread pans are seldom washed. Generally they are regreased and used continuously until the glaze inside the pans begins to show wear. When this occurs, the pans are sent to a contractor to be thoroughly cleaned and reglazed.

The loaves of bread are air cooled while being conveyed to the packaging area where they are fed through high speed knife bands which slice the bread. After slicing, the bread is automatically bagged and placed on racks for distribution to the loading and shipping areas. The slicing generates substantial amounts of crumbs. These, along with raisins from raisin bread, are swept from the equipment and floor and handled as a solid waste.

Wet cleanup methods are used infrequently in most bakeries. During special cleanup shifts or when a production line is shutdown, equipment and floors are dry cleaned as thoroughly as possible using air to blow residues from equipment and brooms and vacuum cleaners to clean the floors. This is followed by wet cleaning the floors and the mixing equipment. The floors are cleaned using mops and buckets or scrubbers which vacuums the water from the floor as it is used. Mops, buckets, and scrubbers are then cleaned and emptied as needed. Mixers are cleaned using a mixture of water and mild detergents followed by a thorough flushing with fresh water.

Description of the Continuous Mix Bread Process - The continuous mix method of making bread is used at some bakeries. It produces bread in less time than the conventional process; however, the finished product has an extremely fine texture and is considered less flavorful then bread made using the conventional process. Figure 14 is a process flow diagram for this method.

In the continuous method, a slurry of ingredients is produced. The slurry is much less viscous than the dough produced in the sponge mix for the conventional process. This slurry is pumped into a refrigerated holding tank in which it is slowly agitated and some fermentation takes place. The slurry is then transferred to a premixer where additional flour and other ingredients are added.

From the premixer, the dough is then pumped through a developer and the dough is extruded and divided into individual loaf size portions and deposited directly into pregreased pans. After being deposited in the baking pans the dough is processed in the same manner as in the conventional method.

The continuous mix method eliminates the fermentation time, second mixing, floor time, dividing, rounding, and dry proof operations of the conventional mix method.

Mixing equipment is cleaned daily because everything up to the mixer is liquid in form. The slurry and holding tanks are flushed with fresh water each day and small utensils are washed continuously. Floors are cleaned with brooms or vacuum cleaners throughout the area except for the mixing room which is generally mopped. Because continuous mixing is primarily liquid, the mixing area is wet and requires frequent mopping.

Description of the Snack Cakes Process - Snack cakes, which are widely produced by bakeries, are products requiring special equipment for its manufacture and handling. The equipment is designed to make a specific

DRAFT

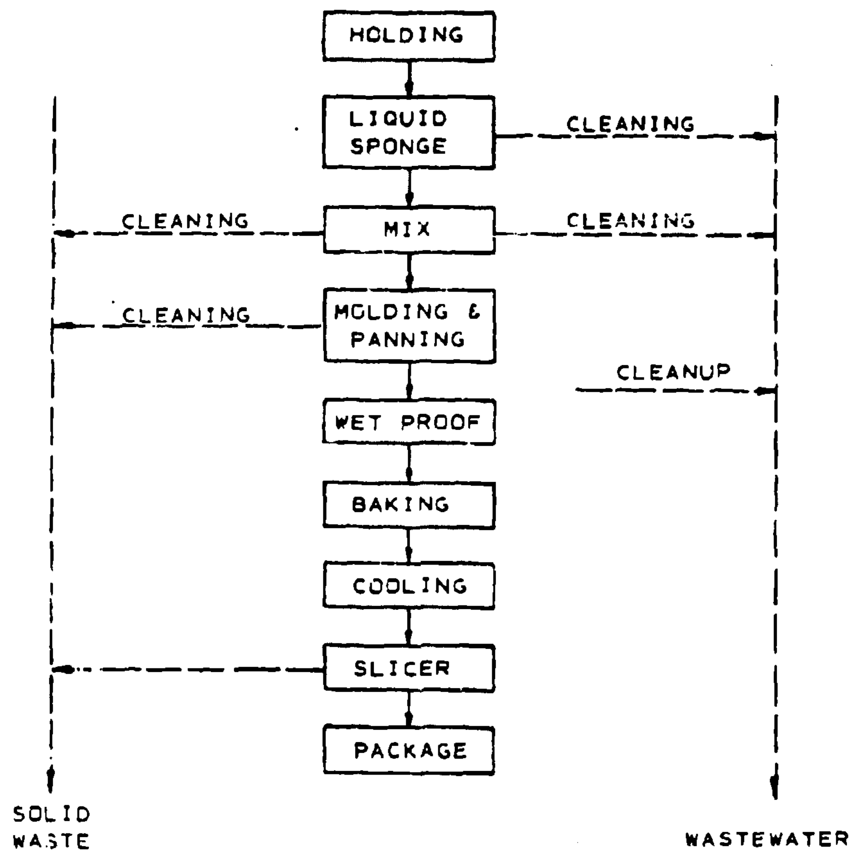


FIGURE 14

BREAD - CONTINUOUS MIX METHOD
PROCESS FLOW DIAGRAM

DRAFT

product. A typical process flow diagram is shown in Figure 15 .

Raw materials for snack cakes include the basics of flour, shortening, and sugar, plus minor ingredients such as leavening agents, preservatives, artificial flavorings and colors, and ingredients for fillings. Storage of raw materials involves bulk tanks, drums, and bags.

Some ingredients are premixed in vats or tanks prior to transfer to a mixer. In the mixer, other ingredients are added and blended into the batter. The batter is then pumped to a depositor which releases the proper amount into pregreased baking pans. Snack cakes require a large number of smaller utensils such as small tubs and beaters for the mixing and are cleaned frequently. Each time a different line of snack cake is made, all related mixing equipment must be thoroughly cleaned in the wash room. This is done using a high pressure spray. Solid waste is in the form of flour, paper sacks, and other ingredient containers which are discarded when emptied.

The pans are then conveyed through an oven for baking. In some plants, air is bubbled into the batter to aid in the rising process. When baking is complete, the cakes may be dumped out of the pans for further processing or may be filled with creme. This filling is accomplished by injecting the creme using a series of needles. Filled cakes are then dumped from the baking pans for further finishing or packaging.

Most of the equipment used in producing snack cakes is water cleaned. The mixing vats, mixers, piping, and depositors are normally washed daily, or when the cake variety is changed. The washing of cake pans is the source of the strongest wastewater in most bakeries and occurs due to pans being washed after each use. In-plant studies (7) at one bakery noted a BOD of 54,000 mg/l in the pan wash water. Pans are washed as infrequently as possible. At least one bakery has completely eliminated pan washing with a resultant decrease in waste load.

After being dumped from their baking pans, snack cakes pass through a series of finishing operations. These include slicing, icing, filling, dusting, and enrobing. These operations generate large amounts of solid waste and require wet cleaning. In particular, the enrobing machine, which coats the entire cake with icing, must be water cleaned and yields a strong waste stream; however, it may require only infrequent cleaning depending on its degree of usage. The solid waste generated at these and other steps in cake baking are often sold as additives for animal feed.

Packaging follows finishing. Snack cakes are automatically wrapped singly, in pairs, or in larger groups in plastic wrapping material. They then pass through a metal detector which removes packages containing metal.

<u>Description of Process - Cakes</u> - The production of full-size cakes is similar to that of snack cakes, except for the lack of finishing steps other than icing. Figure 16 illustrates the process flow for cake baking.

DRAFT

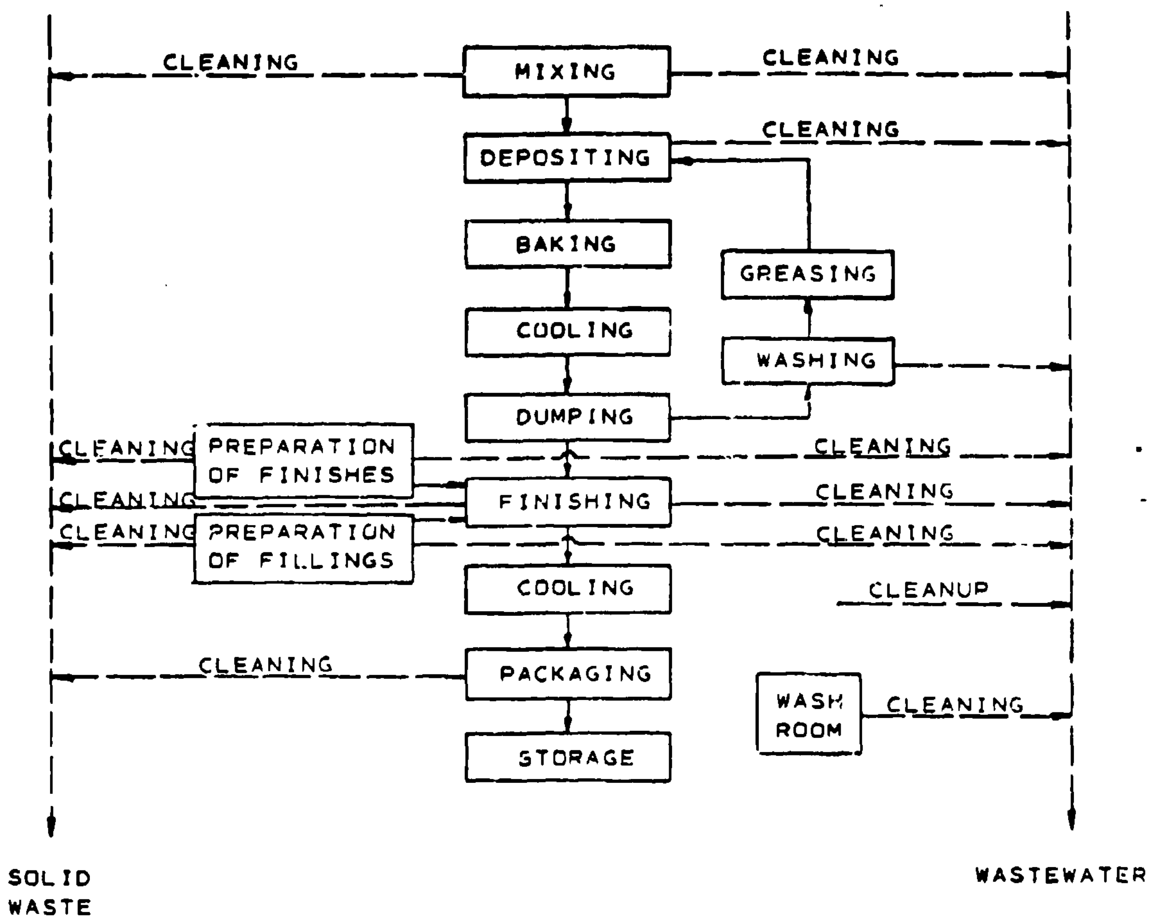


FIGURE 15

SNACK CAKE PROCESS FLOW DIAGRAM

DRAFT

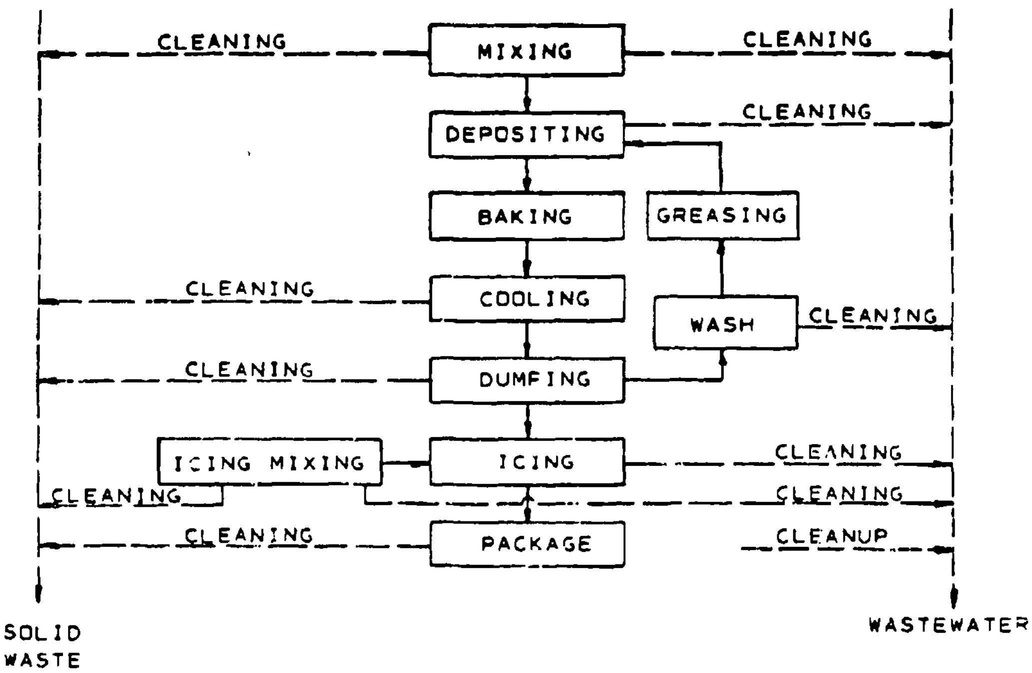


FIGURE 16

CAKE PROCESS FLOW DIAGRAM

Manufacturers of full sized cakes normally produce a greater variety of product than do snack cake bakers. This large product variety results in a frequent (every few hours) change of production from one item to another. The cleanup of the equipment between products results in larger volumes (estimate: two to three times) than in snack cake plants which produce a single product on a given production line. Wastewater is also generated during daily mechanical scrubbing of the floors and occasional mopping of accidental spillages. Cake pans are washed with high pressure spray in a tunnel type washer with a recirculating reservoir which is normally emptied and refilled every eight hours.

Solid wastes result from the disposal of ingredient shipping containers, breakage of the baked cakes, malfunctions of the packaging machinery, incorrect baking and mixing formulation errors.

Description of Process - Snack Pies - Snack pies are made from refrigerated dough and contain one or more fruits or other fillings. Snack pies can be either baked or fried but are generally baked. The two major elements of pies are the dough and the filling. Figure 17 illustrates a typical process flow.

Flour, shortening, sugar, preservatives, flavorings, and additional ingredients are mixed together. After thorough mixing, the dough is dumped into a hopper which feeds the dough through an extruder to form sheets of dough. This is referred to as sheeting.

When sheeted, the dough is placed on racks and then into a refrigeration unit for approximately 20 minutes. When refrigeration is complete, the dough is removed and placed into a second hopper located at the production line. When the dough is extruded or sheeted a second time, it is the proper thickness and width and is a continuous ribbon of dough.

Mixers and extruders are cleaned daily by scraping excess dough from their surfaces. Excess dough which cannot be used further is used as animal feed or is disposed of as a solid waste. If the production line is shutdown for an extended period of time, the equipment is thoroughly washed with water. The production area is dry cleaned then mopped with mops and buckets as a part of the daily cleanup program.

Fruit used in these pies is purchased frozen in 14 kg (30 lb) containers. The fruit is first cooked in a vat then conveyed to a mixer where additional ingredients are added for sweetners and for substance to prevent the fruit from bleeding through the crust. When thoroughly mixed, the fruit is pumped to the depositor located at a point where the fruit is added to the pies.

All related fruit processing equipment is washed each time a different variety of fruit is used. Wastewater from this process is from cleanup water with some solid waste going into the sewer or on the floor.

As the dough is extruded and the ribbon of dough proceeds to the depositor

DRAFT

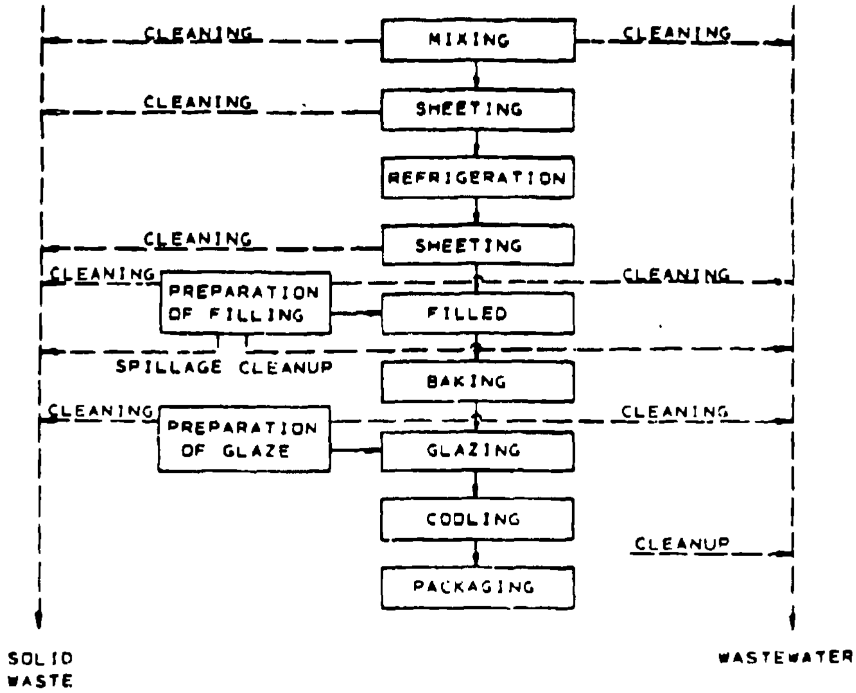


FIGURE 17

SNACK PIES
PROCESS FLOW DIAGRAM

DRAFT

for fruit filling, it is cut to the proper length to include the top of the pie. When cut, the dough rests on a forming machine which folds and crimps the pie after it is filled with the fruit filling. Once formed, the pie is then inspected for quality before being conveyed to the oven or fryer. After baking or frying, the pie passes through a spray of sugar glaze for finishing and is conveyed to the final inspection and packaging area. Pies are individually packed in cellophane or glasene wrappers for distribution.

Cleanup of the production equipment is generally dry unless the line is shutdown for an extended period of time. Daily cleanup consists of dry cleaning the floors and equipment with brushes and brooms. Water is used for cleaning fruit filling mixer, cooker, and depositor. During down days, floors may be wet mopped or cleaned with scrubbers. Wasted dough is substantial where the pies are cut, formed, and crimped. Rejected pies, doughs, and other solid wastes are used as animal feed or go to sanitary landfills.

Description of the Pie Making Process - Pie making is very similar to the process of making snack pies in that dough is mixed, refrigerated, sheeted, formed, filled, and baked. After the dough is mixed it is sheeted and refrigerated once or twice to produce a flaky crust. The dough is put into a hopper located above the sheeter and then is extruded in continuous ribbons which are placed on racks and then refrigerated. After cooling, the dough may be put through a second sheeter. See Figure 18 .

The dough is then conveyed to a point where it is placed over an aluminum pie pan and is pressed and formed into the pan. Immediately following the forming of the dough, the dough-lined pan is trimmed of excess dough which is reused. After the pie is trimmed, it is moved to the filler where the fruit or other filling is deposited. If a top crust is desired, the unbaked pie is conveyed to a second extruder which extrudes a sheet of dough over the pie, forms it to the desired shape, and crimps the edges. The trimmings of dough from both lower and upper crusts are recycled and used again for pie crusts. The pies are then placed on a continuous conveyor which conveys them through an oven where they are baked. After baking, the pies are placed on racks and permitted to cool sufficiently before packaging. If a finish on the pie crust is desired, a mixture of sugar and egg white is sprayed on the crust immediately after baking to produce a glaze. The pie is then inspected, packaged, and boxed for distribution.

Fruit used in pie fillings are purchased frozen in 14 kg (30 lb) containers and cooked in a vat. From the cooking vat, the fruit is pumped to a large hopper where additional ingredients are added for sweetness and to give the fruit filling more substance. After being thoroughly mixed, the fruit is pumped to the filler where it is deposited into the pie shells. When pies are made with no top crust, the filling, as in creme or lemon pies, is deposited after the pie shell has been baked. Additional finishes or toppings may be applied. The pies are then inspected and packaged in boxes.

DRAFT

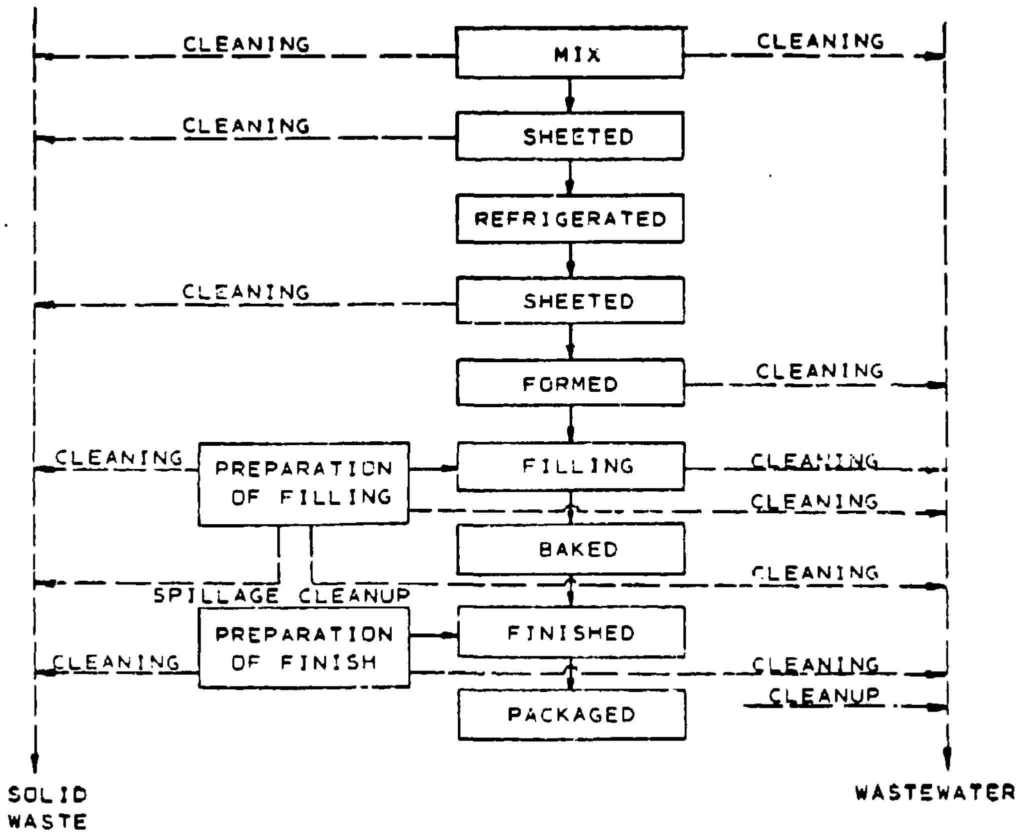


FIGURE 18

PIES
PROCESS FLOW DIAGRAM

Cleanup of the pie production area generally follows a daily dry cleanup routine. The fruit cooking and mixing utensils are cleaned with water each time a different fruit filling is desired. The fruit mixing area is generally clean except where spillage may occur and this is removed by shovels with water being used where needed.

During down days or days when the line is not in production, a major cleanup of all equipment is done by washing thoroughly with water. The bulk of solid waste is generated by containers such as cans, cardboard boxes, and cardboard containers which contained frozen egg whites, frozen fruit fillings, or minor ingredients. A small amount of dough, flour, and fruit fillings also contribute to the solid waste.

Description of the Cake Doughnut Process - The ingredients for doughnuts are similar to those for yeast doughnuts and are stored and handled in nearly the same manner. The principal dry ingredients are, in some cases, purchased premixed. Water is added to the premix in a large vertical mixer with secondary ingredients mixed separately and added manually. Figure 19 illustrates a typical process flow.

Doughnut batter is transferred to an extruder. This machine forms the doughnuts and deposits them into the cooking oil. Both the mixer and the extruder are dry cleaned to the extent possible and then cleaned with water.

Doughnuts are fried in a hot oil bath. They are conveyed through the oil cooking on one side. Midway through the oil bath, the doughnuts are turned over in order to cook the other side. Upon completion of frying, the doughnuts are removed from the oil and conveyed through a spray screen of sugar glaze. If any finish is required other than sugar glaze, the doughnuts are reheated by infra-red lights located above the conveyor belt while a spray of any one of several finishes is applied to the doughnut. They are then cooled and conveyed to the packaging area where they are inspected and packaged. Packaging is normally in bags or boxes containing a dozen doughnuts.

Wastewater from the mixing, finishing, and packaging operations is generated by the washing or related utensils such as mix bowls and beater blades. Floor cleaning is done daily using brooms or vaccum cleaners with occasional wet mopping for spills. During down days or when time permits, the floors are thoroughly washed with wet mops or with scrubbers, which pick up the dirty water.

Description of the Yeast Doughnut Process - Yeast type doughnuts are made using yeast, rather than baking powder, as in the cake type, for leavening. Generally, the mix is purchased in bags with all the needed dry ingredients blended together as an alternative and primary method to making doughnuts from scratch and mixed with only water to complete the doughnut dough. See Figure 20.

DRAFT

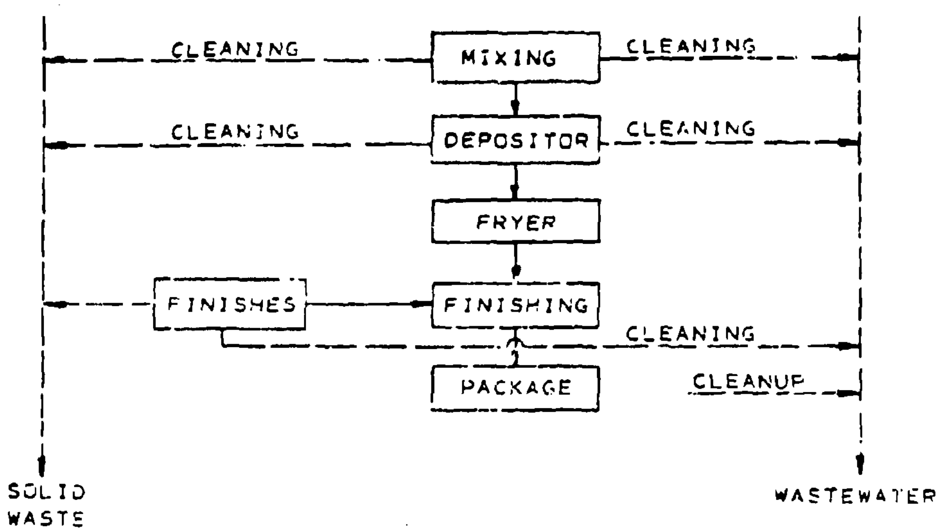


FIGURE 19

DONUTS - CAKE TYPE
PROCESS FLOW DIAGRAM

DRAFT

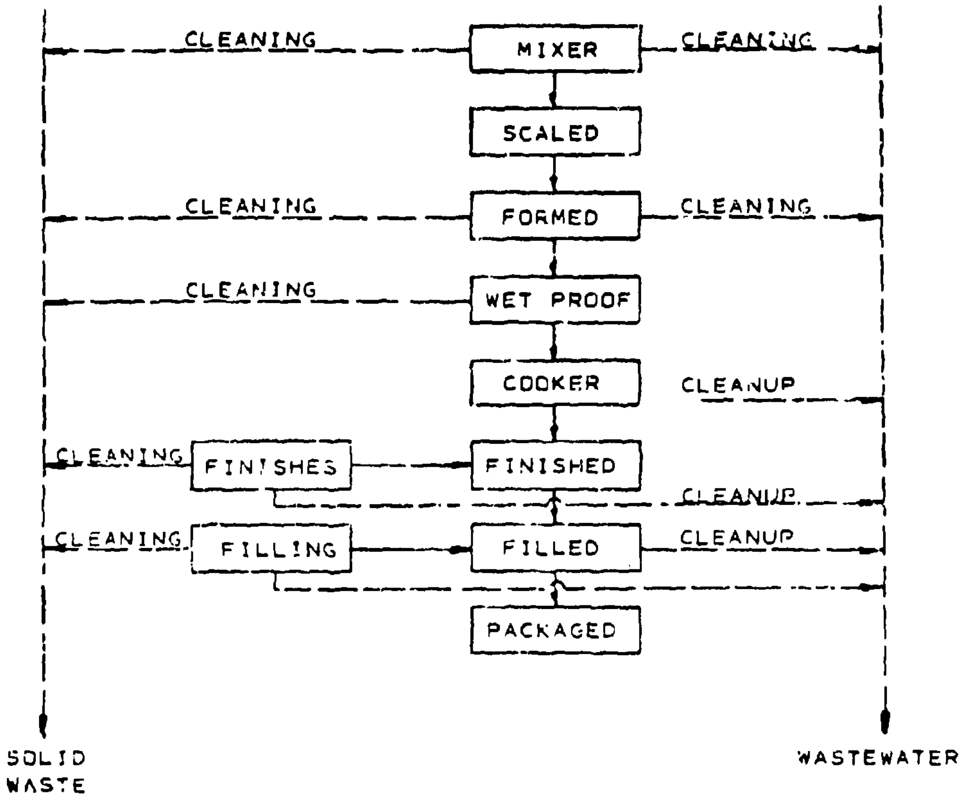


FIGURE 20

DONUTS - YEAST TYPE
PROCESS FLOW DIAGRAM

The dough is then scaled to verify that the proper amount of water has been added. After scaling, the dough is fed into a hopper which extrudes the dough in sheets and the doughnuts are stamped out. Excess dough is returned to the hopper for further use.

The doughnuts are then pl[illegible] trays which are conveyed to a wet proof room for about one hour to [illegible]te rising. After completing the wet proof cycle, the trays are tipped, and the doughnuts fall into the hot oil bath. Midway through the hot oil bath, the doughnuts are turned over in order to cook the other side.

Upon completing the frying period, the doughnuts are removed from the oil and conveyed for finishing with any one of several finishes, such as glazing or powdered sugar. Finish and filling equipment is cleaned each day to prevent clogging of the equipment. Creme fillers generate substantial amounts of solid waste and must be cleaned frequently.

When the doughnut has been finished and cooled, fillings may be injected by needle. After finishing and filling, the doughnuts are then inspected and packaged in consumer size packages of 6 or 12 doughnuts.

Floors are dry cleaned by sweeping or swept with brooms during normal daily cleanups. Related equipment for mixing doughnuts is washed at the end of each shift to prevent clogging of equipment. Excess dough is constantly being scraped free of equipment and is handled as solid waste.

SIC 2052 - Cookies and Crackers

General - The cookie and cracker industry is primarily engaged in producing crackers, cookies, pretzels, and other "dry" bakery products. In 1972, the industry consumed 1.10 million kkg (1.21 million tons) of flour, 0.32 million kkg (0.35 million tons) of sugar, 0.27 million kkg (0.[illegible] million tons) of fats and oils, and 0.05 million kkg (0.055 million tons) of other ingredients. There are a total of 311 plants, 40 percent of which are located in the northeast. The total employment for the industry is 41,000. According to the Biscuit and Cracker Manufacturers' Association (8), of the total $1.69 billion value of cookies and crackers shipped in 1974, large national and regional corporations were responsible for approximately 70 percent.

According to the Bureau of the Census (2), the trends in the cookie and cracker industry are a decrease in the number of plants and employees, and an increase in the quantity and value of products produced. Thus, the industry is apparently becoming more automated and consolidated. A few new cookie and cracker plants are being constructed. These will rely almost entirely on computer-controlled processing, thus decreasing the manpower requirements and waste due to human error.

Description of the Cookie and Cracker Process - Process flow diagrams for cookies and crackers are shown in Figure 21 . Ingredients used in large amounts for the manufacture of cookies and crackers are received and stored in bulk. These include flour, sugar, shortening, invert syrup, and corn syrup. The flour is sifted before these dry ingredients are weighed and pneumatically conveyed into the mixers. The liquid ingredients are metered and conveyed to the mixers.

Ingredients which are used in small quantities are received and stored on pallets in their shipping containers. These materials are measured, sometimes premixed, and added to the mixers manually. Normally, the only source of wastewater generation from raw materials storage is the periodic cleaning of the liquid storage tanks.

The mixing operation is normally performed in batches in one or two stages, or continuously by either a vertical or horizontal mixer. The vertical mixer has a series of mixing blades attached to three vertical arms. The entire mixer can be raised and lowered and is designed for use with a dough trough which is wheeled under the mixer. This mixer is preferred for use in two-stage mixing processes since the dough from the first mixing does not have to be added at the second mixing stage.

Horizontal mixers are more common and have a single mixing blade which is horizontally positioned. The mixing chamber is rectangular with a concave bottom to allow the mixing blade to incorporate all the ingredients. In this type of mixer, shortening and sugar are normally added first, followed by the liquids, and then the flour. The temperature of the dough is regulated by adjusting the temperature of the ingredient water.

Batches of dough range from 135 to 450 kg (300 to 1000 lb), primarily depending on the capacity of the mixer. In the case of dough which tends to dry out while standing, batches of less than maximum capacity are used. According to the Biscuit and Cracker Manufacturers' Association (9), mixing time ranges from four minutes to one hour, depending on the product.

In the plants of the major producers of cookies and crackers, mixing equipment usually operates continuously five or six days a week. Mixers are cleaned out on varying schedules. In near-continuous operations, they are cleaned on down days. In other situations, mixers are cleaned daily or between varieties of product. Cleaning consists of scraping the mixers as clean as possible and then rinsing with hot water. The ingredients that are scraped out are handled as solid waste, which minimizes the wastewater load from this cleaning process.

After mixing, the dough is emptied into a dough trough mounted on casters. From this trough, the dough is transferred to the forming machinery. There are five basic types of forming machines as follows:

1. The stiffest dough is formed by a rotary machine. The forming is accomplished by forcing the dough against an engraved cylindrical die and scraping away the excess with a knife edge.

DRAFT

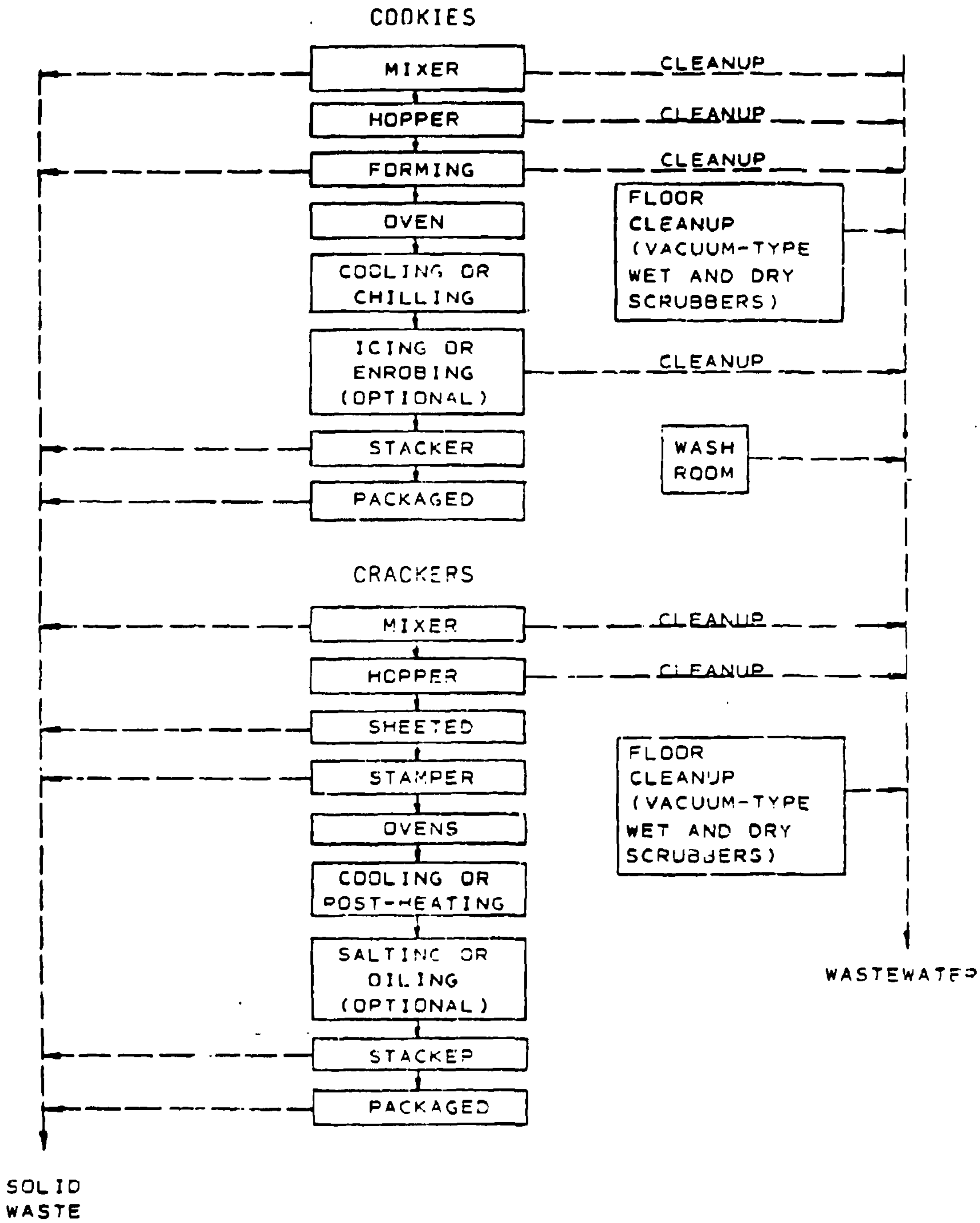


FIGURE 21

COOKIE & CRACKERS
PROCESS FLOW DIAGRAM

The top surface of the cookie retains the design on the cylinder, as examination of a sandwich or butter cookie will show.

2. Fairly stiff and extensible (stretchable) dough is formed into sheets and cut into cookies by a cutting machine. All crackers and some cookies, such as ginger snaps, are made using this machine.

3. Bar forming machines use dough which is considerably softer. These machines extrude the dough from a die (with a number of different openings) onto a moving belt which carries them through the oven. The strips of dough are cut into bars either before or after baking.

4. The wire cutting machines operate in a manner similar to the bar forming machines except that as the dough is extruded from the die, it is cut into individual cookies with a taut wire. For most products commonly formed with this machine, such as oatmeal cookies and vanilla wafers, the cookies drop onto the baking surface.

5. Deposit forming machines deposit the dough as individual cookies without the use of a wire. This method is similar to the cookie press used by homemakers. These machines are similar enough to wire cutting machines that a slight modification in formula permits, for example, oatmeal cookies to be made by the deposit method.

Pretzels, sugar wafers and ice cream cones utilize specialized forming equipment. Pretzels are extruded and cut into sticks or tied by mechanical equipment. Batter is injected onto plates or matching dies for baking sugar wafers and ice cream cones.

Wastewater is generated in the forming process during the cleanup of the machinery. Rotary formers and the nozzles from extruding machines are commonly water or steam cleaned in a wash room. Other forming machines are wet cleaned or dry cleaned in place with compressed air.

The standard oven in the industry is a long (normally 90 m) tunnel oven. The baking surface is a continuous metal belt. In cracker production, wire mesh belts are often used in the ovens. Baking time varies from 2 to 15 minutes depending on the type of product. Saltines and snack crackers normally have the shortest baking time. Cookies such as fig bars and chocolate chip are baked from seven to eight minutes. No wastewater is generated as a result of the baking process since the ovens are dry cleaned and wiped down with an organic solvent.

After baking, the product is protected from cold drafts to prevent checking. Sandwich cookie bases are applied warm thereby reducing product breakage. For most other cookie and cracker products, ambient air cooling is all that is required. These temperature control processes do not produce a wastewater load since the equipment is dry cleaned.

Cracker products are salted and/or sprayed with oil. The salting machinery is dry cleaned. The oil spraying equipment recirculates the oil it uses and does not normally require cleaning.

Sandwich cookie bases, marshmallow cookies, sugar wafers and similar products are iced and/or enrobed (coated) after baking. The icings and coating are mixed in stainless steel vats and carted or piped to the appropriate machines. In large more modern plants, the vats and piping are usually cleaned by a "clean-in-place" (CIP) system which utilizes pre-rinse, wash, and final rinse cycles. In older plants, the smaller mixers and other equipment are wet cleaned manually with hoses. The mixing vats, pipes, and enrobing equipment are scraped and not cleaned at the end of each product run, which may occur several times a day for each line. This is a significant source of waste load within the cookie production process.

Packaging of the final cookie and cracker products is designed to minimize breakage and maximize shelf life. According to the Biscuit and Cracker Manufacturers' Association (8), both cookies and crackers may be tumble packed or shingle stacked for packaging. Packaging containers include bags, overwrapped plastic trays, and cartons. Moisture proof materials are used to seal the packaged product. The packaging is performed mechanically. The equipment is dry cleaned with compressed air weekly.

The steam room and the CIP system are the largest contributors to a plant's waste load. All equipment associated with icing and enrobing is cleaned by these methods, and these materials have high concentrations of sugar and other organic materials.

General cleanup is a dry process. Wooden floors may be found in some sections of cookie and cracker plants, evidence that the cleanup processes in those areas are dry (vacuum and sweeping). Areas which are subjected to liquid and semi-liquid spillage are wet cleaned using hoses, mops, and vacuum-type wet scrubbers.

SIC 2065 Confectionery Products

Background of the Industry - Included in this classification are those establishments primarily engaged in manufacturing candy, including chocolate candy, salted nuts, other confections and related products. Confections have been produced since pre-historic times, however, the extensive production of refined sugar based candies did not occur until the late 18th century. Candy-making machines were invented during this period and the industry has grown steadily since then. Today there are over 2,000 different varieties of confections and an average per capita consumption of 8.5 kg (18.7 lb).

The confectionery industry marketed $2,472 million in products in 1972, an increase of 32 percent compared with 1967. The growth of the industry will likely continue in the future, but probably at a reduced rate due to increased raw material costs and a leveling of consumer demand.

In 1972 there were 993 establishments processing confectionery products (2); however, of this number only slightly more than one third employed more than 20 persons. Most of the larger plants are concentrated in the north central and northeast region, the smaller establishments being more widely distributed. The following process descriptions concentrate on the basic production techniques which are common to most of these varieties.

Description of the Candy Bar Process - Figure 22 shows a typical flow diagram of a candy bar process. Although the range of candy bar types is diverse, the manufacture of all bars is basically a single process, in which there are two stages. In the first stage, the candy nougat or center is prepared by cooking together varying quantities of sugar, corn syrup, water, starch, cocoa, milk and other ingredients. The type of ingredients utilized depends on the variety of nougat desired. The amount of moisture removed in cooking of the various constituents determines the density of the finished nougat. One of two types of cooking is generally employed: 1) Pre-cooking, which is usually accomplished in open batch or continuous- type cookers, and 2) vacuum cookers, which evaporate off excess moisture from the mixture under vacuum. A combination of both types of cooking can be utilized in a two step operation.

After cooking, the nougat is either cooled and aerated, or blended with other ingredients. In the first case, the nougat mass is cooled, then subjected to physical working. For lighter, soft nougats, this physical working is called aeration and is accomplished by some form of pulling or whipping action, while for hard nougats, kneading is used to work the mass. In the second case, numerous ingredients of various kinds may be added to the nougat to modify its flavor, texture, and appearance. Such ingredients include vegetable oil, coconut, milk powder, peanuts, and caramel.

DRAFT

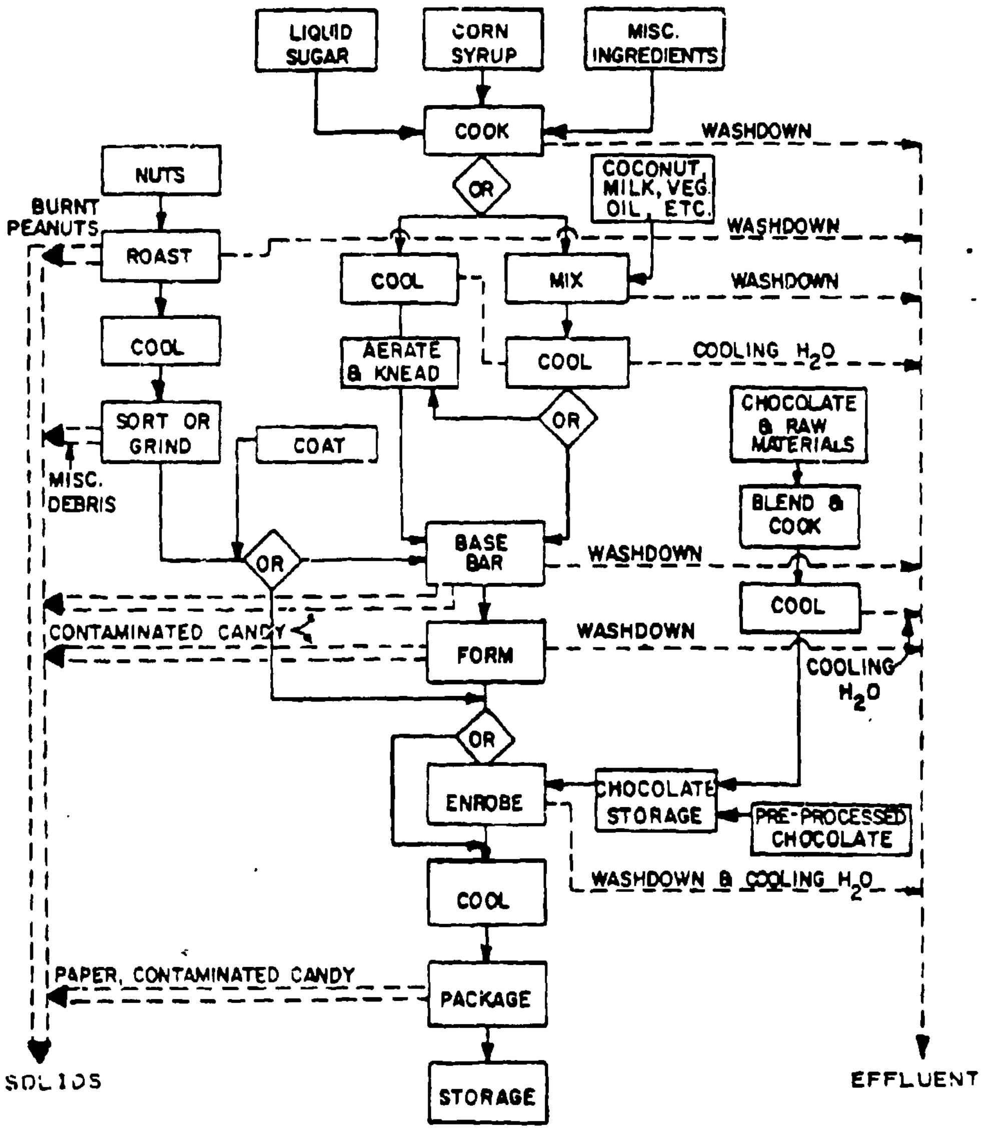


FIGURE 22

CANDY BAR PROCESS

The cooled nougat, or "base bar", is then either molded or formed and cut to size. Two types of molding are utilized for the base bar: 1) A compressed corn starch mold or 2) metal molds, some of which may be teflon coated. Formed candy nougats may be extruded or passed through rotating spinners to form candy ropes before cooling and cutting to bar size. Some candy bar producers utilize various types of nuts in the base bar production.

Nuts can be added to the nougat before or after forming the base bar. The nuts, if not previously prepared, are first cleaned of stones, loose skins and extraneous materials. The nuts are then roasted, cooled, and sorted or graded. The good nuts are used in the product, and culls are removed as solid waste material. Peanuts, which are used most extensively in base bar production, are either sent to grinders for peanut butter type bars, or added directly to candy bars in whole or broken form. If the nuts are processed at the plant, solids resulting from the cleaning and sorting operations are the primary source of wastes.

The second step, which is not utilized for all candy bars, is to coat the base bar, normally with chocolate. The coating process is termed "enrobing". Enrobing is usually a totally automated recirculating system which coats both the top and bottom of the base bar.

Milk chocolate, which is usually used for enrobing, is prepared by blending cocoa powder, powdered milk and sugar. After blending these ingredients, vegetable oils are added to produce liquid chocolate. The mixture is cooked and then cooled prior to being transferred to heated storage tanks. Chocolate coatings may be purchased and stored in heated tanks prior to being pumped to the enrobers. Enrobers use warm water jackets to keep the chocolate fluid. This water is continually recirculated in most instances.

Whether the candy bars are enrobed or come directly from the base bar formers, they pass through cooling tunnels. The cooling tunnels utilize recirculated chill water systems. From the cooling tunnels, the finished bars are inspected and individually wrapped and packaged.

The major waste water flows originate during washdown operations. Washdowns may be in the form of C.I.P. (clean-in-place) units, which are used on conveyors, cookers, etc., or from minor cleaning and major washdown operations at the end of a processing day. The wastewater from such washdown operations is high in dissolved solids, detergents, and carbohydrate.

Most plants recycle the majority of the chill and cooling waters used in their operations. Nevertheless, some plants do discharge some or all of this non-contact cooling water. These streams contribute significantly to flow volumes but not to waste loadings. Other small periodic wastewater discharge result from cleanup of spills, pump seal leakages, steam condensates and other minor sources. Flows varied significantly between plants depending on plant size, type of product, recirculation technique, and washdown procedures from 3,800 l/shift (1,000 gal/shift) to well over 1.3 cu m/shift (350,000 gal/shift). This large range of flows gives some indication of the diversity encountered in the candy bar industry.

Description of the Soft and Chewy Candy Process - Figure 23 shows the process flow diagram of a typical soft candy plant. Corn syrup, sugar, and water are the three major raw materials used in the manufacturing of chewy candies. Dry ingredients, such as cooking starches, cerelose, and cocoa, can be added to the syrup base. Various blends of the above constituents are either pre-mixed in slurry tanks prior to cooking, or in the cooking kettles themselves. After mixing, the syrup is cooked between 117°C (243°F) and 155°C (34°F). The cooking and mixing area is termed the "kitchen," and is the location where most of the clean-up wastewater is generated. The cooking kettles, either batch or continuous, utilize steam for cooking from which the condensate is generally recirculated back to the boiler. Cooking takes from five to ten minutes, depending on the percentage of moisture desired. Following cooking, which is closely regulated, the processing steps change somewhat depending on whether the finished candy is to be a fondant creme, soft or hard gum, pastille, or jelly.

Fondant cremes, after cooking, are cooled continuously by taking them from the cooker to a large slowly rotating metal drum cooled internally by water sprays. The syrup is cooled from 117°C (243°F) to approximately 38°C (100°F) and by means of a scraper knife the syrup is removed from the drum and discharged into a beater. The quality of the fondant is largely controlled by the efficiency of the beater which, in addition to bringing about rapid crystallization, must remove the latent heat by sufficient flow of water through a cooling jacket. If the fondant is allowed to sit, the result is normally a rather dense product; a lighter texture is obtained by the inclusion of "Frappe." Frappe, or whip, is prepared by dissolving egg albumen or a substitute in water and then mixing with sugar/glucose syrup. This mixture is then beaten to a foam by means of a high speed whisk, either under normal or increased pressure. Frappe may be used in fondant base in varying quantities depending on the ultimate density desired.

Lozenges are a combination of corn syrup, sugar, and starch. This combination is heated and mixed or lightly kneaded. Next, rollers are used to roll out the candy into a sheet approximately 1.3 cm (0.5 in.) thick. The sheet is fed into lozenge plungers which shape the lozenges to their circular configuration. During the subsequent inspection, broken and misshaped lozenges are removed and reused in the process. The accepted lozenges are placed on drying boards and air dried until hard.

Gums, pastilles, and jellies comprise a large group of soft and chewy confections. The prime differences between individual products are the gelatinizing agents used and the moisture content. Most recipes for gums rely on gum arabic or gelatin as the gelatinizing agent, but certain

DRAFT

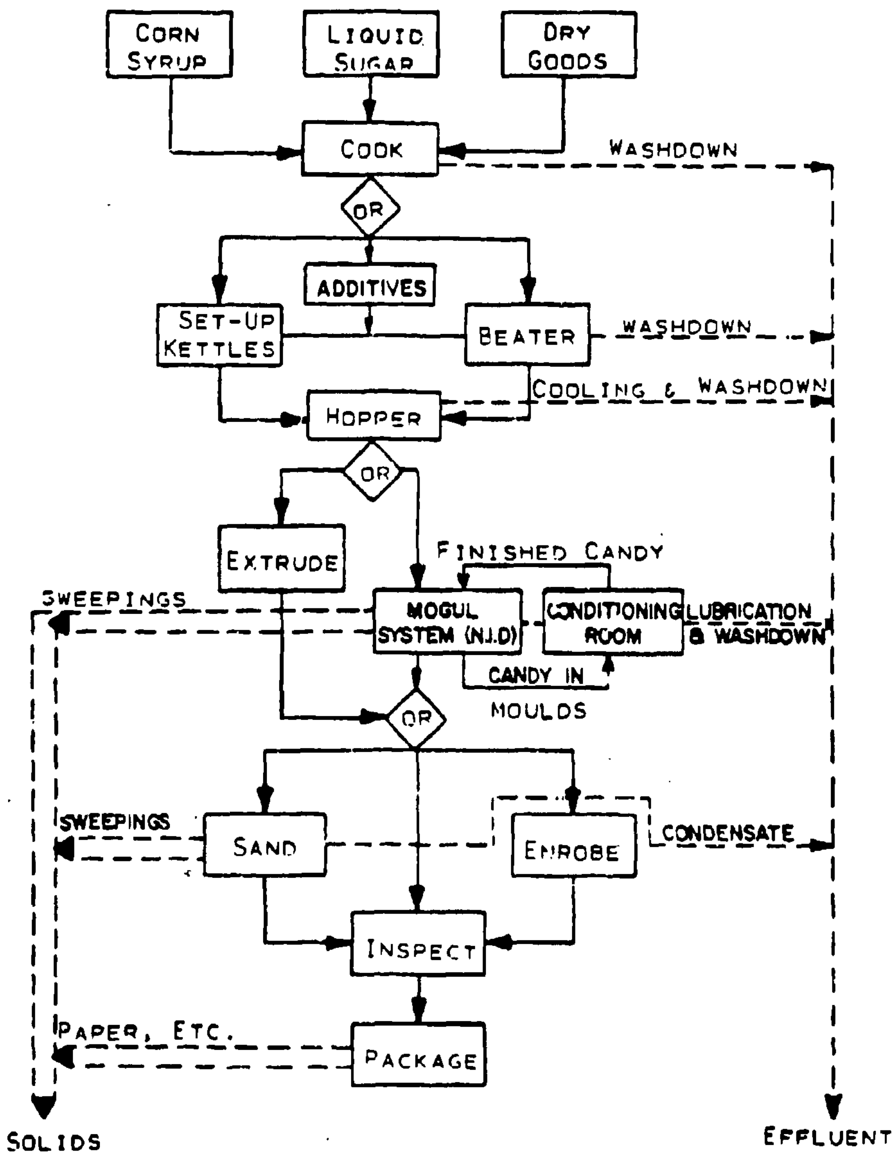


FIGURE 23

CHEWY CANDIES

modified starches are also used. The syrup mixture is poured in the gum solution and gently mixed. Flours and coloring are then added to the mixture prior to deposition in starch molds. With the softer gums and pastilles, it is usual to include gelatin as well as gum arabic, and the glucose syrup content is therefore higher.

Jellies may be made with the use of agar, gelatin, or pectin as the gelling agent. Different textures are obtained. Agar produces short textures, gelatin is inclined to produce toughness, and pectin gives soft tender jellies with good keeping properties. Refractometers are generally utilized for determination of the soluble solids end point during cooking. The flavors and coloring are added to the setup kettles after the cooking process. From the set-up kettles the candy is transported from the kitchen area to the candy hopper where it is discharged in measured amounts into starch molds.

The starch molds are used to form the confection into desired shapes The starch employed is usually the finest dry corn or maize starch, which takes the mold imprint in detail and is quick to absorb moisture from the semi-liquid confectionery. Most plants utilize a fully mechanized machine known as a "mogul" or N.I.D. The mogul automatically prints a tray of starch, which is then moved by conveyor to a multiple depositer which in turn is fed by a hopper. The depositer works on the piston principle, supplying precise volumes of liquid candy to each starch impression. The starch trays are fed into one end of the machine and, after filling, are removed at the other end and allowed to cool and set in the conditioning room. After setting, the confectionery is removed and brushed free of loose starch. Excess starch is then cleaned and recycled along with makeup starch back through the machine to refill the starch trays.

The drying (conditioning) room may or may not be heated. Fondants are usually held for 5 to 16 hr, depending on moisture content, in the conditioning room at 13 to 16°C (55 to 61°F). The relative humidity is maintained between 55 and 60 percent. Hard gums are generally dried for 6 to 10 days at 49°C (120°F). Soft gum and pastille drying times vary between one and seven days. Jellies have higher moisture contents, so drying times are reduced and vary with desired moisture content. At six to eight percent moisture a 5 to 8 hr storage is required, while at 9 to 11 percent moisture a 16 to 24 hr storage is necessary.

After de-molding and cleaning of adhering starches, the candy proceeds to the coating process. Fondants are generally enrobed with chocolate, whereas gums and jellies are "sanded." Sanding is a process whereby the candy is slightly steamed to make the surfaces sticky thus holding the crystal-sugar dusting. The sugar coated candy is then subjected to a slight drying in a warm room prior to packaging.

The main wastewater source emanating from the starch molding/packaging area is washdown water. Lubricating water and steam condensate from the sanding machine are also two minor sources of wastewater originating in this area.

Washdown from the "kitchen" or cooking area is the primary source of waste effluent; however, many plants save the initial washdown of cooking kettles and hoppers to be recycled, after cleaning with carbon filters.

Description of the Hard Candy Process - There is a wide variety of hard-boiled sugar confections, all having a basic formulation of sugar and glucose syrup with color, flavor, and a number of other added ingredients. Figure 24 shows the flow diagram for a typical hard candy process. The first step in the hard-boiled sugar operation is pre-cooking of liquified sugar and glucose until all traces of sugar crystal are dissolved completely. The candy then goes to a vacuum cooker. Vacuum cooking takes approximately 10 minutes, depending on the cooking temperature, which varies between 137° and 143°C (250° and 290°F). When the desired consistency is reached, the syrup may be deposited in starch board molds analogous to soft and chewy candies, but more commonly the syrup is taken to the kneading machine (Burk's mixer). At this point citric acid, colors and flavoring are added, also scrap candy is sometimes added to form a seed. The kneading process incorporates air into the candy and cools it to the desired texture. Chill water is used to keep the kneading table cold so the syrup will solidify. This water is normally recirculated. After the candy has been kneaded to the desired texture, it is fed into machines, known as drop rolls, which press the pliable sugar into shapes. Alternatively, the pliable sugar is supplied to a "spinner," (parallel rollers) which forms it into a "rope" which is then fed into a candy forming machine. This machine cuts the rope into small sections and forms the candy into desired shapes. Another continuous plant for the production of fruit drops and similar products uses the principle of pouring the high bodied syrup into multiple metal molds where they pass through coolers and then are demolded on belts.

After the candy has been formed, it is cooled either by a series of cooling tunnels or by direct air cooling. The candy is then cleaned and inspected. Some candies do not require a cleaning operation and are simply sized and inspected prior to packaging.

The major wastewater flow associated with the hard candy process comes from washdowns. Another source of wastewater is the vacuum cookers which utilize water to draw off the condensate from the cookers when forming a vacuum. Additionally, water is used to cool compressors, condensors and other machinery. This non-contact cooling water is generally recirculated.

DRAFT

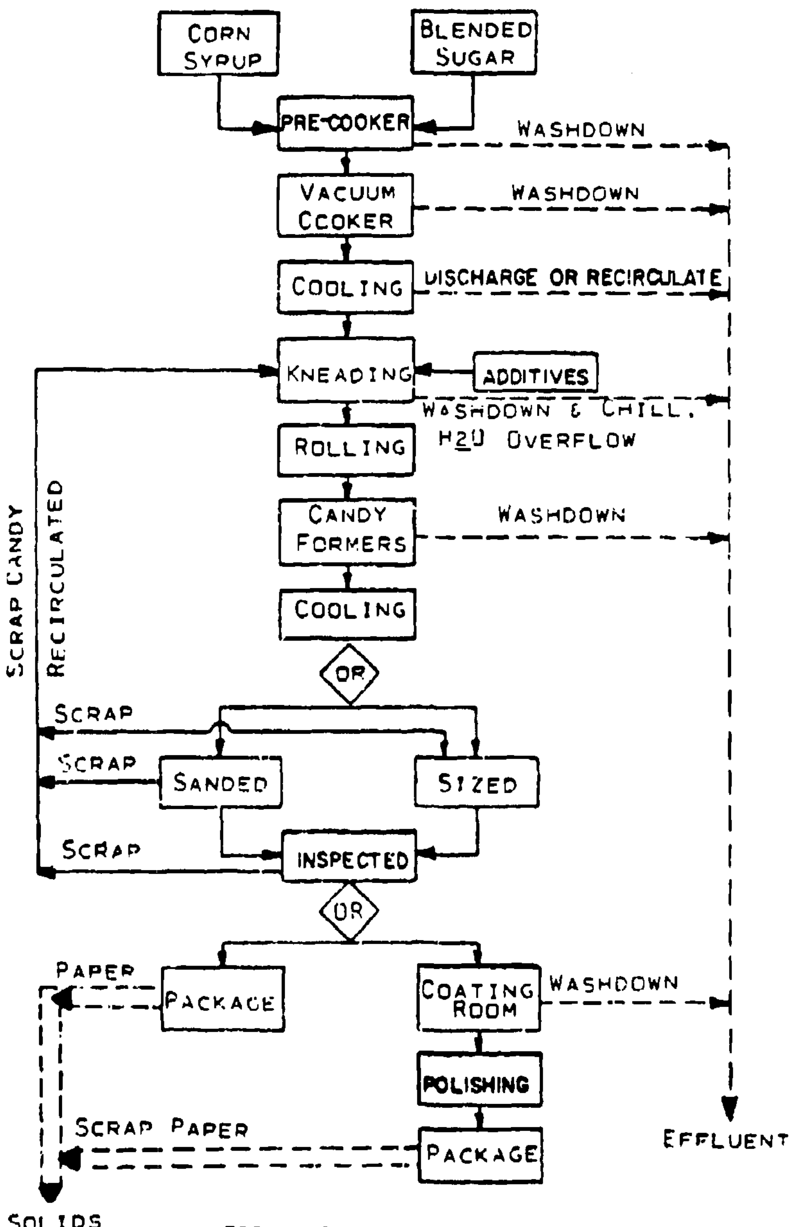


FIGURE 24

HARD CANDY
(HARD-BOILED SUGAR)

Description of the Cold Pan Candy Process - Figure 25 shows the flow diagram for a typical cold pan candy process. A large variety of confectionery cores can be used for this process. Some of the various types of cores utilized are jellies, marshmallows, caramels, nuts, and licorice.

Cold panning is essentially a cold process in which the cores are rotated in a pan coated internally with a sugar layer. The cores may be in any shape and are dumped into the pans in measured amounts. Glucose syrups (60 to 65 percent concentration) are applied alternately with caster sugar and flavors until the correct size and shape is obtained. The circular motion of the turning pan causes the cores to become evenly coated with a wetting agent (glucose syrup) prior to the addition of sugars. The final sugar dustings are with icing sugar which gives a smooth surface. Following dusting, the candy is put into trays and allowed to set for 16 to 24 hr in a dry (but not hot) atmosphere. The candy is then given a luster usually by the addition of beeswax, carnauba wax, or spermocet. The wax is usually applied in a molten form, in sufficient quantities to coat the candy with a thin layer. The candy is then tumbled until a gloss is obtained.

The major waste source from this process is washdown water. Flows from washdown operations have a wide range with observed values from 2000 l/day (500 gal/day) to 4000 l/day (1000 gal/day). Very little water is utilized in the actual production of the product.

Description of the Hot Pan Candy Process - Hot panning is done in rotating copper or stainless steel pans which are provided with some form of heating, such as steam jackets, direct heating, or injection of hot air into the pan. Figure 26 shows the flow diagram for a typical hot pan candy process.

Many types of cores are utilized for this process but mainly they consist of hard candies and nuts. Various types of coatings may be utilized, i.e. nuts use a gum/syrup or chocolate coating after a preglaze of gum arabic. The coatings are poured onto the cores while the pan is rotating and a slight heat is being applied. As the coated cores approach dryness, icing sugar is dusted on and further applications of syrup and starch are made. The rotating cores enlarge gradually with each application of syrup and sugar. The operation continues until the desired size is obtained. Between wettings, the confections are continually rolling and rubbing against one another and the sides of the pan. This aids in grinding of the high spots and smoothing the surface. During the last stages of tumbling, colors and flavorings may be added. Sometimes these additives are dissolved in the syrup prior to addition to the centers.

DRAFT

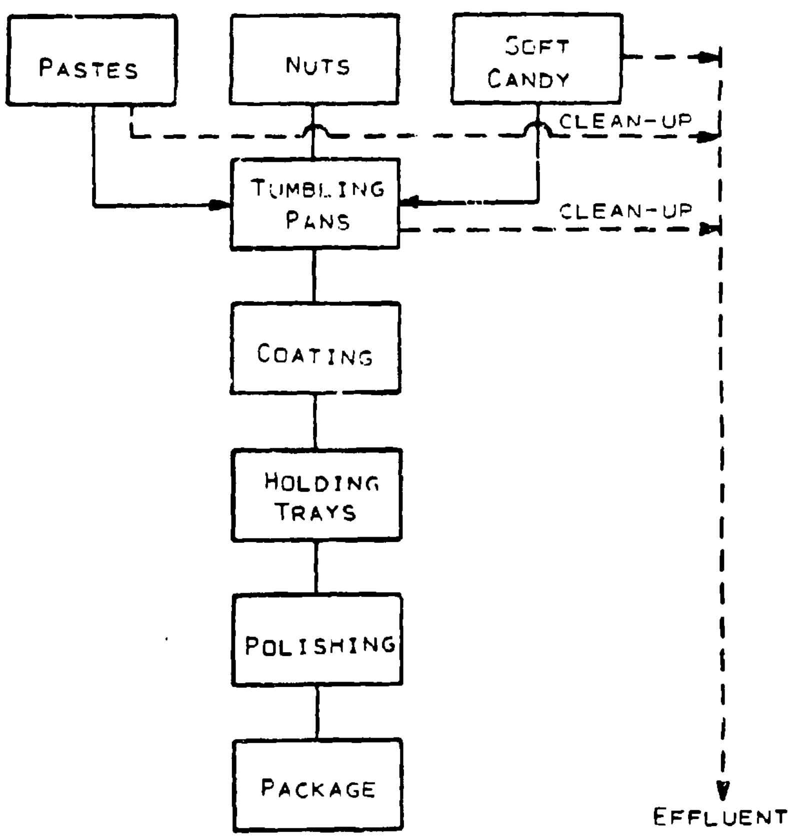


FIGURE 25

COLD PAN CANDY

DRAFT

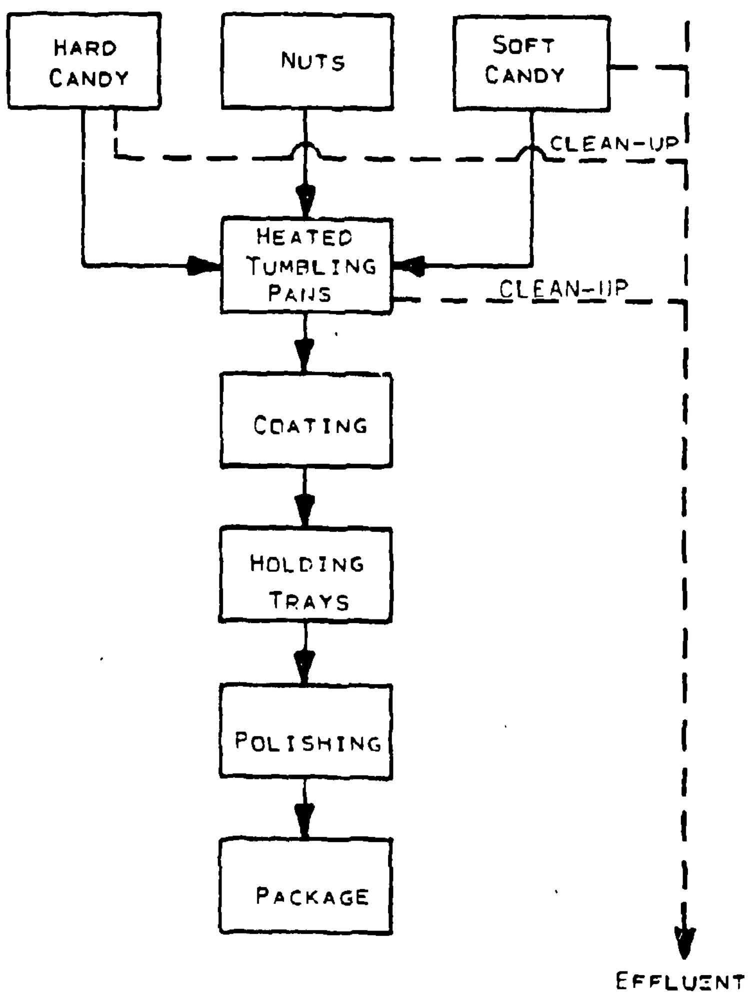


FIGURE 26
HOT PAN CANDY

After the candy has been built up to the desired weight or thickness it is transferred to holding trays and taken to conditioning rooms. The candy remains in the room for approximately 24 hr at a relative humidity of 45 percent. The candy is then polished with a coating of wax, generally beeswax, carnauba or paraffin, and packaged. Wastewater flows are the same as the cold candy operations described previously.

Description of the Marshmallow Process - Figure 27 shows the flow diagram for the typical marshmallow process. There are many varied recipes for marshmallow products; however, all contain sugar/glucose syrups which are aerated with gelatin, egg albumen, Hyforam, or other whipping agents. The texture and density of marshmallows can be varied by adjusting the quantity of such constituents as egg albumen and gelatin or by the inclusion of various gelatinizing agents or gums.

The first step in manufacturing is the weighing out of the various ingredients before blending. Sugar and glucose are first dissolved in water and boiled at approximately 112°C (233° F) to the proper consistency. After cooking, dissolved gelatin and egg albumen are then added to the syrup which has been cooled to about 71°C (160°F).

This mixture is then beaten to a thick foam. Many types of beaters are utilized, with the main purpose being to incorporate air into the product. Beating can sometimes be done under pressure to better control the density of the product.

The marshmallow form is then augered through a scraped surface heat exchanger which cools the product to approximately 61°C (110°F). Sometimes water cooled surge tanks are utilized for this operation. The cooling operation generally uses recycled chill water that does not contact the product. Some wastewater may be derived from this operation in the form of make up water; however, the waste loadings are insignificant.

After cooling, the product is formed by pouring into starch molds, by piping through nozzles, or by extrusion. The last two methods are used most extensively in the industry. Extrusion of the cooled foam directly into jars yields marshmallow cream, whereas for marshmallows, extrusion is into long "ropes" onto corn starch covered conveyors.

The marshmallow ropes, which may vary in diameter from 1.3 to 2.5 cm (0.5 to 1 in.), then receive an overhead application of corn starch. The starch must be dried to a moisture content of 4 to 6 percent and the temperature should be below 55°C (100°F). If these conditions are not met, the marshmallow foam may partially soak into the starch and cause a starch crust to form. After extrusion the marshmallow ropes are conveyed through automatic choppers and cut to designated lengths.

DRAFT

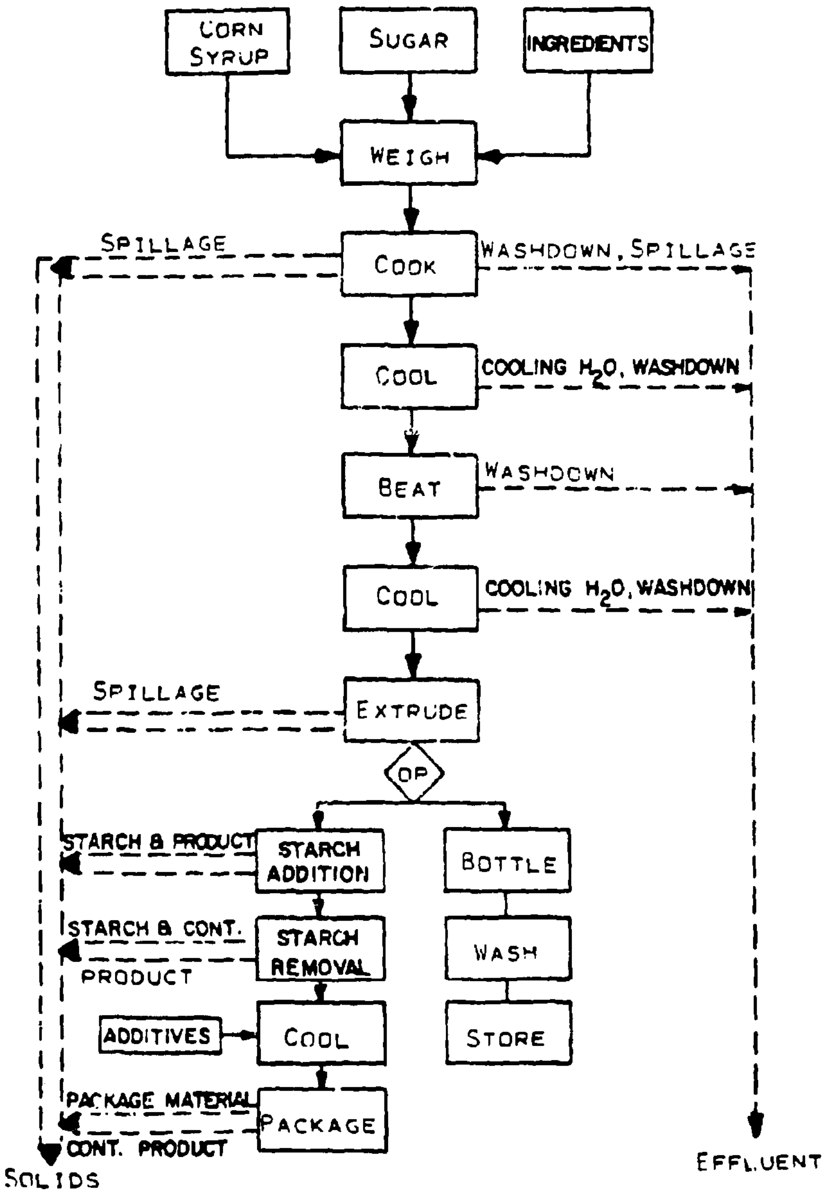


FIGURE 27

MARSHMALLOW PROCESS

The starch covered marshmallows are then conveyed to a humidified rotating drum. This drum "sets" the marshmallows and helps to prevent sticking. From this operation the product is conveyed to a starch removal drum. The removed starch is circulated back through the process after screening and refining. The product may then go through a cooling drum where a light application of powdered sugar is applied. If enrobing with chocolate or other coatings is to be done a sugar application is not employed. Marshmallows then proceed to the packaging area.

The major wastewater flow originates in the "kitchen" area where washdowns occur. Virtually no water is used past the cooling steps, since water in the drying and forming areas would inhibit the quality of the final product. Dry sweeping, cleaning, and vacuuming is done in the drying and forming areas.

Most plants have a "cleaning room" which is an additional source of waste water. This room is used periodically for cleaning equipment and machinery. Many plants utilize dust collectors in the drying areas to remove starch and sugars which are suspended in the air. The collectors are usually dry collection systems, utilized to recover products for recirculation, but wet scrubbers are incorporated for dust collection in some plants. Effluents from the scrubbers are high in dissolved solids and add significant short term waste loads.

Description of the Candy Tablets Process - Tablets are a mixture of flavorings, lubricant, binding, and loose material which have been stamped or compressed so as to form a hard, cohesive confection which contains very little moisture. Stamped, or "cut" tablets are termed "lozenges." A lozenge is a sugar dough which has been flavored, cut to shape, and subsequently dried to remove most of the added water (see Figure 28). Lozenge dough is prepared by mixing together a solution of gum arabic, gelatin, icing sugar, and flavoring. According to Lees, (10), efficient mixing is the key to satisfactory production of lozenges. Mixing times must be standardized to produce homogenized paste without excessive flavor loss.

When the ingredients are thoroughly mixed, the dough is removed and sent to the sheeting machine where it is rolled into a continuous smooth sheet. This sheet is delivered directly to the lozenge-cutting machine.

The tendency of the lozenges to stick to the conveyor or stamping machine can be reduced by sprinkling the dough surface with a food grade dusting powder. Stamped lozenges are then removed and deposited in one layer on drying trays. The lozenges are then either put into circulating hot air drying rooms or allowed to air dry until they are sufficiently hardened. Glazing the lozenges can be achieved by light steaming and drying.

DRAFT

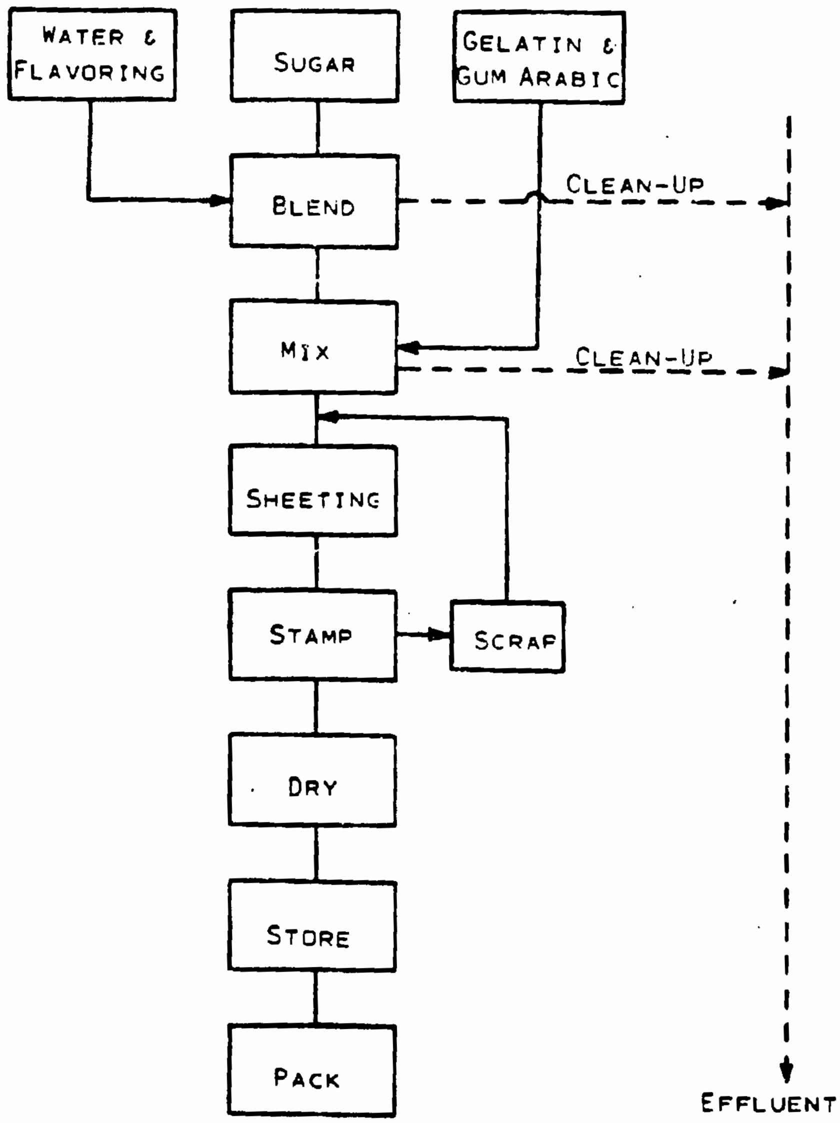


FIGURE 28

LOZENGES

The scrap paste which is left after stamping is then recycled back to the sheeting machine before excess hardening can occur.

Washdowns are the primary sources of waste effluents, and are derived primarily from the blending and mixing areas.

Figure 29 depicts a typical candy tableting operation. Tableting is essentially a dry process in that ingredients such as powdered sugar, corn syrup, gelatin, and requisite flavorings are compressed.

The actual production of tablets begins with mixing corn syrup, sugar, and gelatine in a "masticator." This material is then dried and transferred to a blender where flavorings and a small amount of water is added, such that the dry particles will adhere better after passing through the tablet forming machine. The tablet forming machine molds the candies under pressures of about 1.9 atm (14 psi) into the desired configurations. Tablets are then inspected and conveyed to the packaging area. Rejects are recycled back to the blender to be reprocessed.

Any water used in the forming areas would affect the handling of the dry materials. If machinery is to be cleansed, it is removed from the area and taken to a separate cleaning room. The masticator is the major piece of machinery that is washed on a daily basis. Cleaning of floors in the processing area is generally done by vacuuming or sweeping.

Description of the Popcorn Ball and Treated Popcorn Products Process - There are several varieties of glazed popcorn products. Figure 30 depicts a typical flow diagram of a glazed popcorn operation. Corn is brought in from the field in kernel form, cleaned, and fed into gas fired corn poppers. After popping, the corn is passed over shaker screens to remove to mixers where it is combined with some type of coating.

Popcorn coatings are derived from the cooking of various combinations of corn syrup, sugar, molasses, and vegetable oil. These ingredients are first pre-cooked together to blend and liquify the constituents and the mixture is then cooked to a viscous syrup. Other ingredients, such as, coconut, margarine or butter, honey, and corn or vegetable oils, may be added to the syrup.

When the final cooking step is accomplished, the syrup is mixed with the popcorn in either a continuous or batch process. After mixing the glazed popcorn is either formed into popcorn balls or sent to cooling drums. Two major types of cooling drums are utilized. One type consists of a rotating wheel which uses baffles to break up the adhering popcorn as it cools; the other type is a large rotating wire mesh screen. Both kinds of drums employ air injection systems to cool the glazed popcorn. The glazed popcorn is then separated from clumps and chaff by shaker

DRAFT

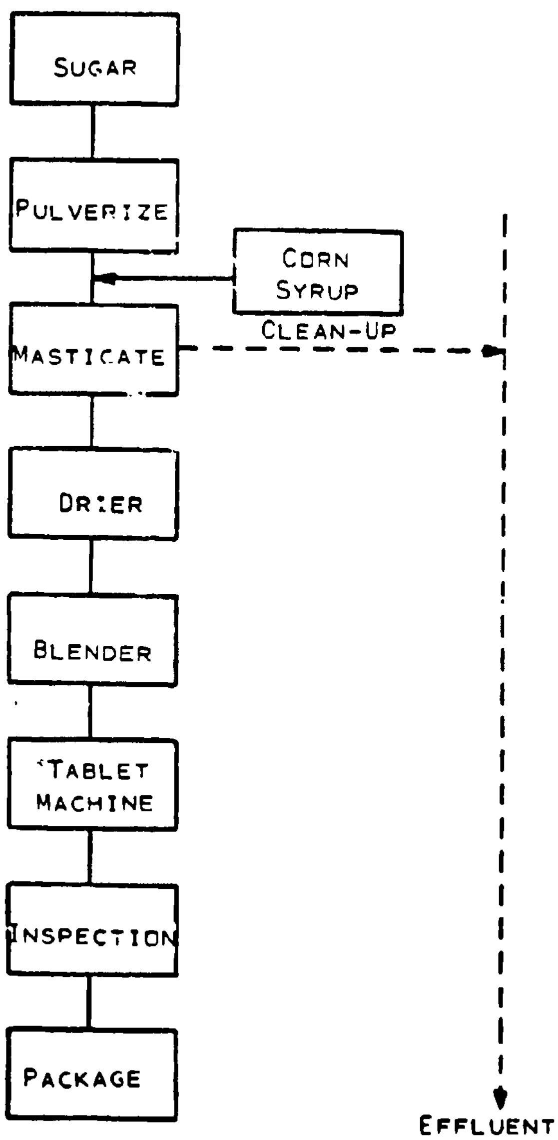


FIGURE 29

CANDY TABLETS

DRAFT

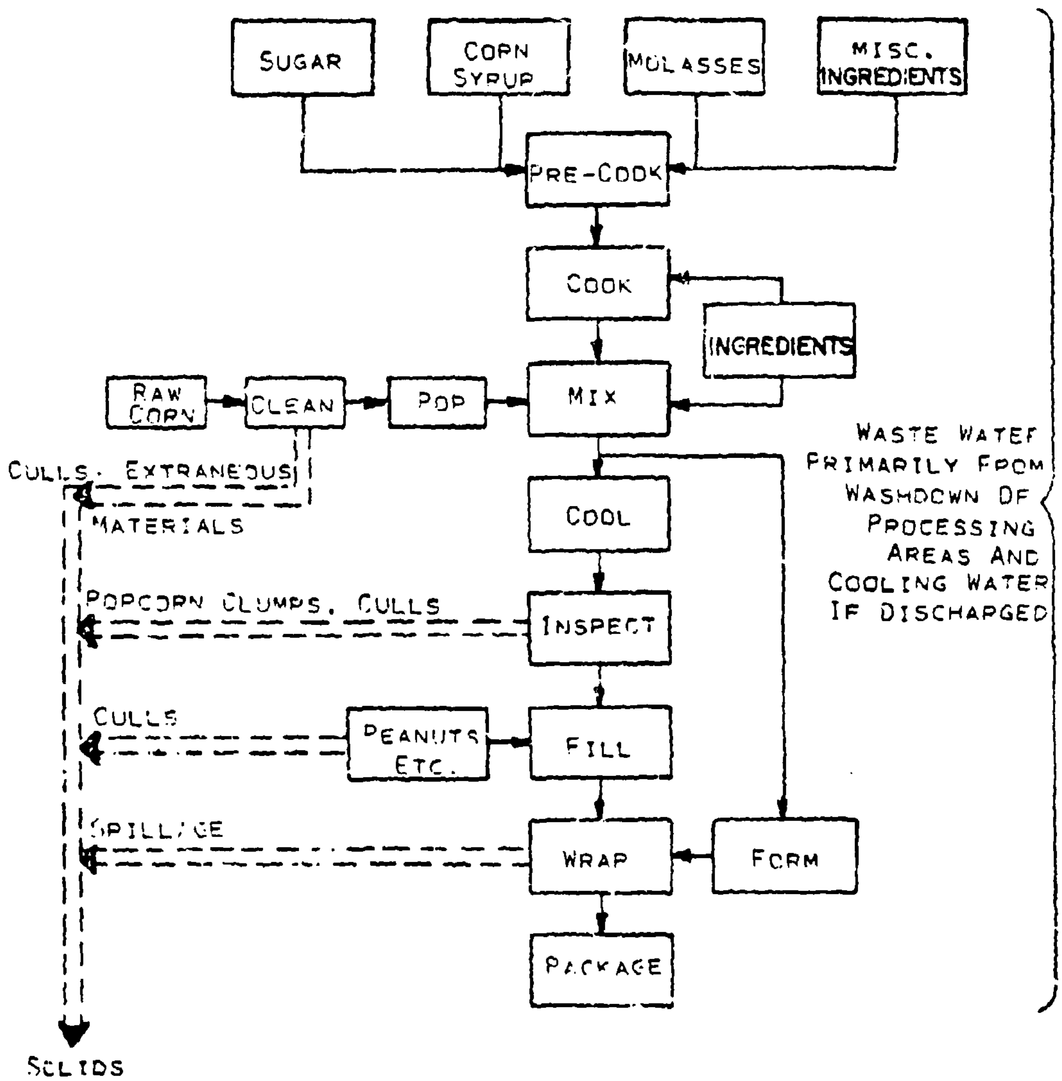


FIGURE 30

POPCORN BALLS AND TREATED POPCORN PRODUCTS screens located at the end of each cooling drum. The finished product goes into hoppers where it is stored until packaged. Other ingredients, such as peanuts, may be added to the popcorn at the packaging area.

Wastewaters from the glazed popcorn operation are primarily derived from washdown operations. The volume of wastewater from washdown comprises approximately 35 percent of the total flow, with the remainder being comprised of various cooling water and other non-contact flows. This percentage will be much higher for washdown flows if cooling waters are not discharged. With the use of corn and vegetable oils, either for coating containers to prevent product stickage or in the product itself, some spillage results. This spillage creates grease and oil in the washdown waters.

Steam rooms are employed in most plants to clean equipment and containers of adhering syrups and solids. Therefore, the steam rooms are a primary source of waste effluents which are comprised of detergent, germicide solutions, corn oil and kernels, peanuts, and molasses and syrups.

Most solid wastes are removed by sweeping prior to washdowns and separated into edible and non-edible wastes. Edible wastes are sold for animal feed while non-edible materials are taken to land fill areas by contractors.

The majority of plants visited during this study recirculate the cooling and chill waters used in processing. Any water lost from cooling operations would be in the form of overflow or make-up waters.

Description of the Candied, Glazed and Crystallized Fruit Process - Glazed (candied) fruits and peels are confections which have had the water in the product replaced with a high sugar content syrup. Figure 31 shows the flow diagram for a typical glazed fruit process.

Many makers of glazed fruits first bleach the fresh fruit in a "brine" solution prior to blanching and addition of flavor and color. Although processors use various components in somewhat differing ratios, according to Soderquist (11), a typical brine contains 1.5 percent sulfur dioxide, 1.5 percent calcium chloride, and 1.0 percent slaked lime in a water solution. Fruits may also be stored in brine solutions for extended periods to insure a continuous production.

Next, the fruits and peels, whether fresh or brined, are "blanched" or cooked. This is necessary to break down the fruit tissues and to improve the penetration of syrups into the product. Futhermore, blanching helps to remove chemicals from the fruits which have been brined. Blanching may be accomplished with the use of steam or boiling water. Times allowed for blanching vary from 2 to 15 minutes depending on the softness of the fruit.

DRAFT

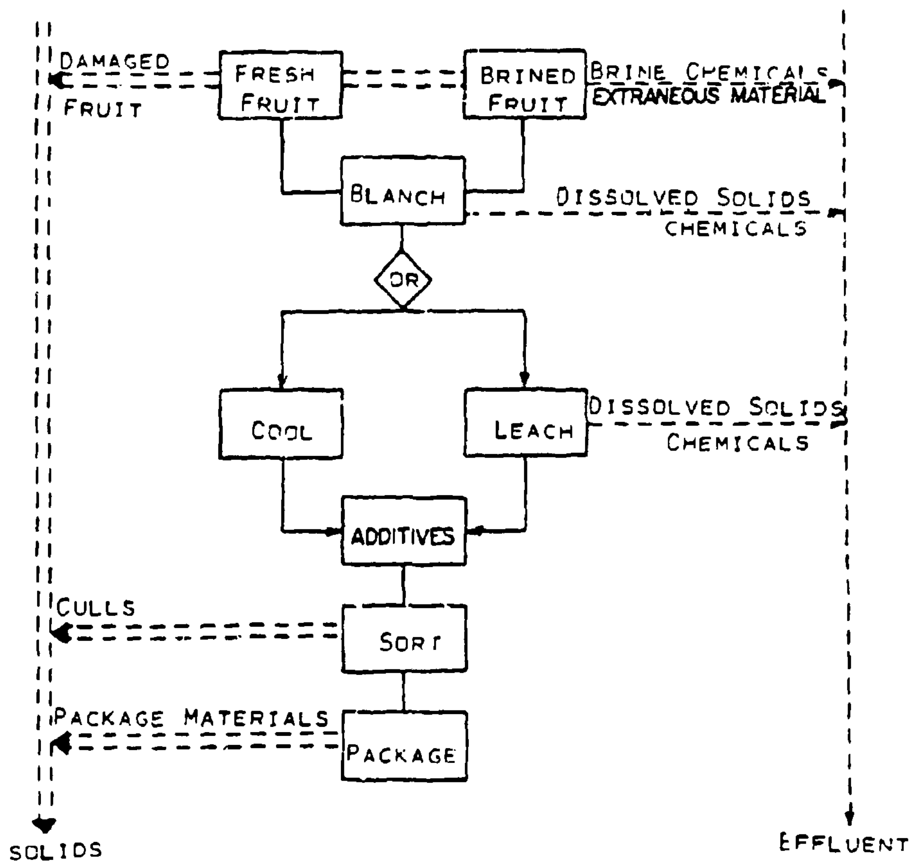


FIGURE 31

GLAZED FRUIT

DRAFT

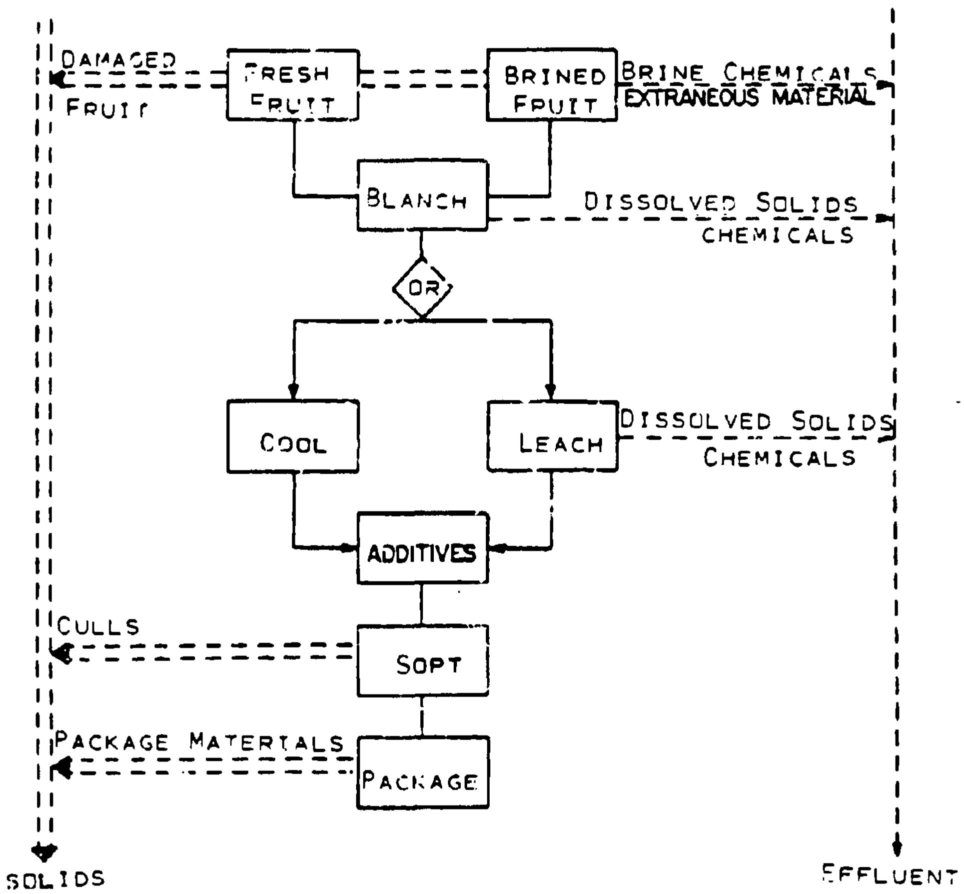


FIGURE 31

GLAZED FRUIT

After blanching, fresh fruits are cooled, whereas brined fruit is generally leached in water. Water leaching serves the purposes of removing additional chemicals and cooling the product. The fruit is then ready to be immersed in hot sugar syrup in concentrations between 70 and 80 percent. The amount of sugar transferred into the fruit is of particular significance in connection with the product's keeping qualities. As reported by Lees (10) candied fruit should contain at least 75 percent sugar and candied peel around 65 percent. Some loss of coloration and flavoring may occur during brining. This is artificially restored during the syrup diffusion stage.

The syrup application phase may be repeated several times, following short drying times, to bring the candied fruits up to desired sugar concentration levels. The glazed fruits are then sorted and dryed prior to packaging.

The major waste loadings are derived from washdowns and dumping of blanching tanks. If leaching is employed, significant waste loadings occur in the form of trace minerals such as SO_2. Brine solutions are generally reused, but periodically must be dumped resulting in low flow, high concentration surges.

SIC 2066 - Chocolate and Cocoa Products

Background of the Industry - This classification includes establishments primarily engaged in shelling, roasting, and grinding cocoa beans for the purpose of making chocolate liquor from which cocoa powder and cocoa butter are derived, and in the further production of solid chocolate bars and chocolate coatings. The value of shipments from this industry reached $735 million in 1972, an increase of 41 percent compared with 1967.

The present technology for the manufacture of chocolate has evolved over the last 200 years, starting with the defatting of the cocoa bean by French and Dutch processors during the late 18th Century. This and other innovations lead to the preparation of a more palatable cocoa powder and the first solid eating chocolate. The present consumption of chocolate and cocoa in the United States is approximately 300,000 kkg/year, equivalent to about 1.6 kg per person. This consumption represents the processing of over 1.5 million tons of cocoa beans.

The industry is concentrated in the northeastern states and primarily in the state of Pennsylvania. Of the 48 plants located throughout the United States, 30 employ more than 20 persons; however, the majority of the production is done by a few large manufacturers.

DRAFT

Description of the Cocoa and Chocolate Process - Bulk cocoa is received in this country in a relatively clean and also pre-processed condition. This pre-processing consists of initial fermentation drying, and preliminary cleaning of the cocoa beans. The first step of chocolate manufacture is the further cleaning of this "raw" material. The beans are passed through screens, brushes, airlifts, and magnetic separators to insure the removal of any extraneous material such as grit, sand, metal, jute fibers, and bean cluster which may interfere with later processing.

As shown on Figure 32 the next step is the roasting of the beans. Roasting helps develop the characteristic flavor, color and aroma, reduce the moisture content, and loosen the shell from the cotyledons or nibs. The roaster may be of either the batch or continuous type and depending upon the primary disposition of the beans, i.e., for cocoa powder, chocolate, or cocoa butter, the temperatures and times of the roast may vary considerably.

The beans, the shell now loosened by roasting, are crushed in breaking rolls so that mainly large pieces of nib and shell are produced with a minimum of dust. The mixture of nib and shell is subjected to an air flow which carries away the shell and dust discharging two main size classes of nibs, large and small. The large nibs yield the highest quality chocolate due to the proportions of cocoa butter, moisture, shell and germ (Table 5). Small nibs may be used in blends or exclusively for the expeller pressing of cocoa butter. The shell is recovered for use primarily as cattle feed supplement or garden mulch.

The reduction of the nib to a fluid state ("liquor" or "paste") is the next step in the process. Grinding of the nibs in any of a variety of mills liquefies the fat portion of the nib suspending the solid cocoa particles in a fluid paste. The nib may be subjected to the "Dutch Process" which is the alkinization and subsequent drying of the nib to give a desired color and flavor. The liquor may be directed to milk chocolate processing or to the pressing operation. The latter route will be considered first.

As noted in Table 5 , approximately 55 percent of the nib is made up of cocoa butter. Separation of the particles of cocoa matter and the cocoa butter is effected by subjecting the liquor to a pressing operation. Hydraulic pressing of the liquor yields liquid cocoa butter and also a press cake of cocoa with a fat content ranging from 12 to 25 percent depending on how the cocoa is to be used. The operation of the presses is completely automatic wherein the ultimate fat content of the cocoa cake is controlled by adjustment of the pressure/time cycle. At the completion of each cycle the ram travel direction is reversed and the solid cocoa cake is dropped into a bin or onto a conveyor for transport to the grinding operation.

DRAFT

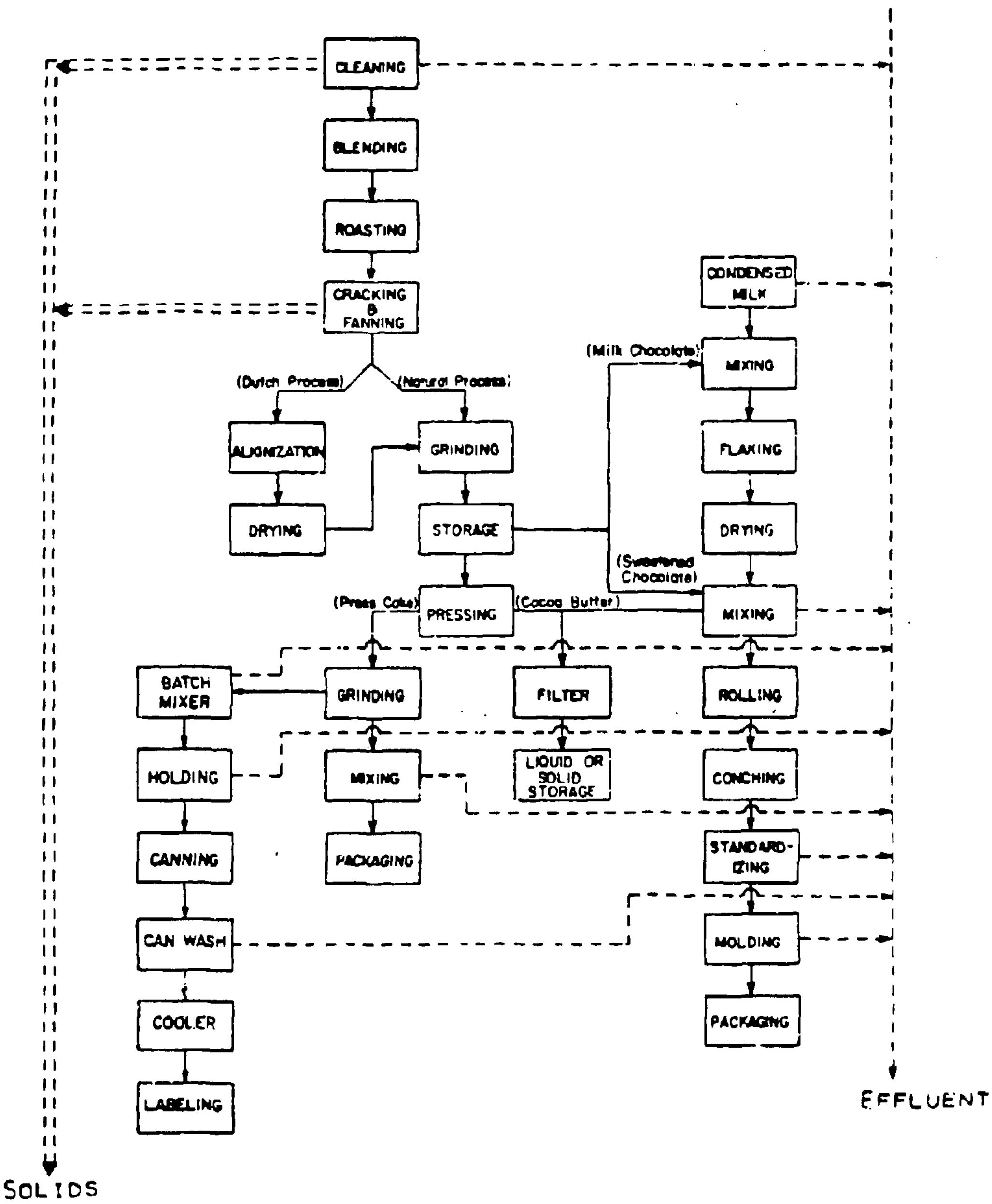


FIGURE 32

CHOCOLATE

DRAFT

TABLE 5

CONSTITUENTS OF COCOA NIBS

Moisture	2.0 - 3.5 (depending on degree of roast)
Cocoa Butter	52.5 - 55.5
Shell	0.2 - 1.5
Germ	0.1 - 1.5 (depending on winnow setting)

SMALL NIB

Moisture	3.8 - 7.5
Cocoa Butter	35 - 36

DRAFT

The cocoa butter expelled from the press may be directed either to the milk chocolate line or into solid liquid storage.

The reduction of the cocoa press cake to a fine, high quality powder is accomplished by the cocoa mill which incorporates several processes in a single unit. Pulverizing of the press cake to a powder begins by first passing the hard, compacted cake through breaker rollers and subsequently through hammer mills or peg disintegrators in conjunction with sifters. The final particle size, however, is dependent on that achieved during the liquor grinding process. During the pulverizing of the press cake, set temperature limits are maintained by cooling air to avoid liquefication of the cocoa butter fraction. The powder is delivered by an air stream through cooling pipes and subsequently to a cyclone for separation of the cocoa from the air.

Cocoa powder may be marketed in a pure form or mixed with other ingredients to make drinking chocolates. The latter are usually prepared by mixing with sugar, corn syrup, and flavors under controlled conditions to achieve desired particle characteristics which impart the qualities necessary for quick dispersion in hot or cold liquids.

In addition to the production of cocoa powder and cocoa butter, the chocolate liquor may be molded into blocks of unsweetened chocolate, or processed into milk and sweetened chocolate.

As noted on Figure 32 the production of sweetened chocolate begins with combining the liquor with additional cocoa butter and sugar. Milk chocolate is produced by mixing sweetened condensed or dry milk with the liquor and, in the case of condensed milk, subjecting the mixture to a drying process to drive off the moisture. Chocolate must be relatively moisture free in that a trace of water can cause staleness and if more than one percent moisture is present it may become moldy. In addition the presence of moisture renders the product stiff and difficult to work.

In order to achieve a homogeneous mixture and aid in the development of a fine texture, the chocolate is passed through a series of water cooled refining rolls before being subjected to period of agitation in a process known as conching. Conches of various design function to produce the final flavor and texture characteristics of the product. The chocolate is agitated from a few hours up to several days before removal to liquid storage or molding.

The final step in the manufacture of chocolate is that of molding it into the desired size and shape for distribution. Because of cocoa butter bloom, air bubbles, and other problems which may occur, molding is a carefully controlled process. First the chocolate is brought to the proper temperature during tempering and injected into metal molding pans. The filled pans are then passed onto a shaker belt which functions to distribute the chocolate evenly in the pans and liberate air bubbles. After or during the shaking process, the pans are passed through a refrigerated chamber to reduce the temperature of the chocolate under controlled conditions. Once set, the chocolate is knocked out of the pans and proceeds to some form of storage or packing.

As previously mentioned the presence of water is not compatible with the production of cocoa products; therefore, the open use of water is controlled so as to avoid entrainment in the product. Fortunately the characteristics of chocolate and the high production temperatures are not conducive to spoilage of the product. This eliminates the need for continuous use of clean-up or sanitizing water. A variable amount of wastewater is generated during the periodic cleaning of holding or mixing tanks, transfer buggies, and molding pans. The production area floors are also cleaned on a periodic basis, usually preceeded by dry collection and then mopping, and/or using industrial floor sweepers. Cocoa butter may often be used as a cleaning solvent with the later recovery of the cocoa butter and chocolate material.

The primary source of water is that used for cooling. Cooling water discharge is quite variable in that it may be recirculated through a cooling tower for reuse. The cooling water is non-contact and therefore does not contribute to the strength of the total plant effluent.

Most large chocolate manufacturers also have a milk condensing plant for the preparation of sweetened condensed milk for the preparation of milk chocolate.

SIC 2067 - Chewing Gum

Background of the Industry - This industrial classification includes those establishments primarily engaged in the manufacturing of chewing gum and/or chewing gum base. According to the United States Department of Commerce Census of Manufacturers (2), there were 19 establishments processing gum in 1972. The majority of these plants are located in the eastern area of the United States. The value of products shipped in 1972 totalled $383 million, an increase of 26 percent over 1967.

The manufacture of chewing gum is most conveniently considered as two separate industries: 1) the processing of raw latex and additives into gum base, and 2) the processing of gum base into various styles of chewing gum. Both processes may occur at a single plant location; however, they are more commonly separated with a single gum base plant supplying several chewing gum processors.

Description of the Gum Base Process - Conventional chewing gum base consists of a combination of natural gum latex, synthetic resins and rubbers, and plasticizers. The highest quality natural gum, chicle, possesses the ideal characteristics for chewing gum but, due to fluctuating price and supply, it is most often "extended" by addition of other natural gums and/or synthetic gums. Various plasticisers, e.g., lanolin, oils, waxes, and glycerine may be added to the gum blend to achieve the desired softness.

As noted on Figure 33, the production of gum base begins with the grinding of the crude gums and subsequent filling of the gums into steam jacketed kettles. Water is added and the gums are preheated to a state soft enough to allow mixing with agitator blades. After the gums are mixed to form a homogeneous mass, the mixture is bleached with a weak solution of sodium hydroxide for several hours. The gum is then subjected to a succession of hot water washes for two to six hours. The wash cycles serve to remove extraneous material as well as the caustic bleaching solution. The excess water is drained and the gum is subjected to another cycle of mastication.

After the gum is dried to a three to five percent moisture content, it is mixed with other natural and synthetic gums and softeners in heated mixing kettles. The hot mixture is pumped through fine screens and then through a centrifugal separator to effect a thorough removal of all extraneous material. The gum is subsequently poured into molds and, when cool, the blocks of gum base are removed from the molds and stored for later processing into various chewing gum products.

Wastewater of significant volume and loading is generated by three phases of the process: 1) hot water washing of the gums, 2) contact cooling water, and 3) daily clean-up of floors and equipment. In addition, there are wastewater sources of low waste loading (but of relatively high volume) which include non-contact cooling water and air scrubber water.

Description of the Chewing Gum Process - The manufacture of chewing gum is generally quite similar throughout the industry with slight variations employed in processing to achieve product differentiation. A typical process is shown in Figure 34 . In the first step of manufacturing the ground gum base s placed in mixers, vats capable of holding up to 900 kg (2000 pounds) each, equipped with slowly revolving blades. These mixers blend together gum base, powdered sugar, corn syrup or glucose, seed gum, plasticisers, and flavorings. Corn syrup or glucose additions help sugar and flavorings to amalgamate with the gum base while keeping the gum moist and pleasant to chew. Powdered sugar is used as a thickening agent which has an effect on the brittleness or flexibility of the final product. As reported by Cook (12), plasticisers

DRAFT

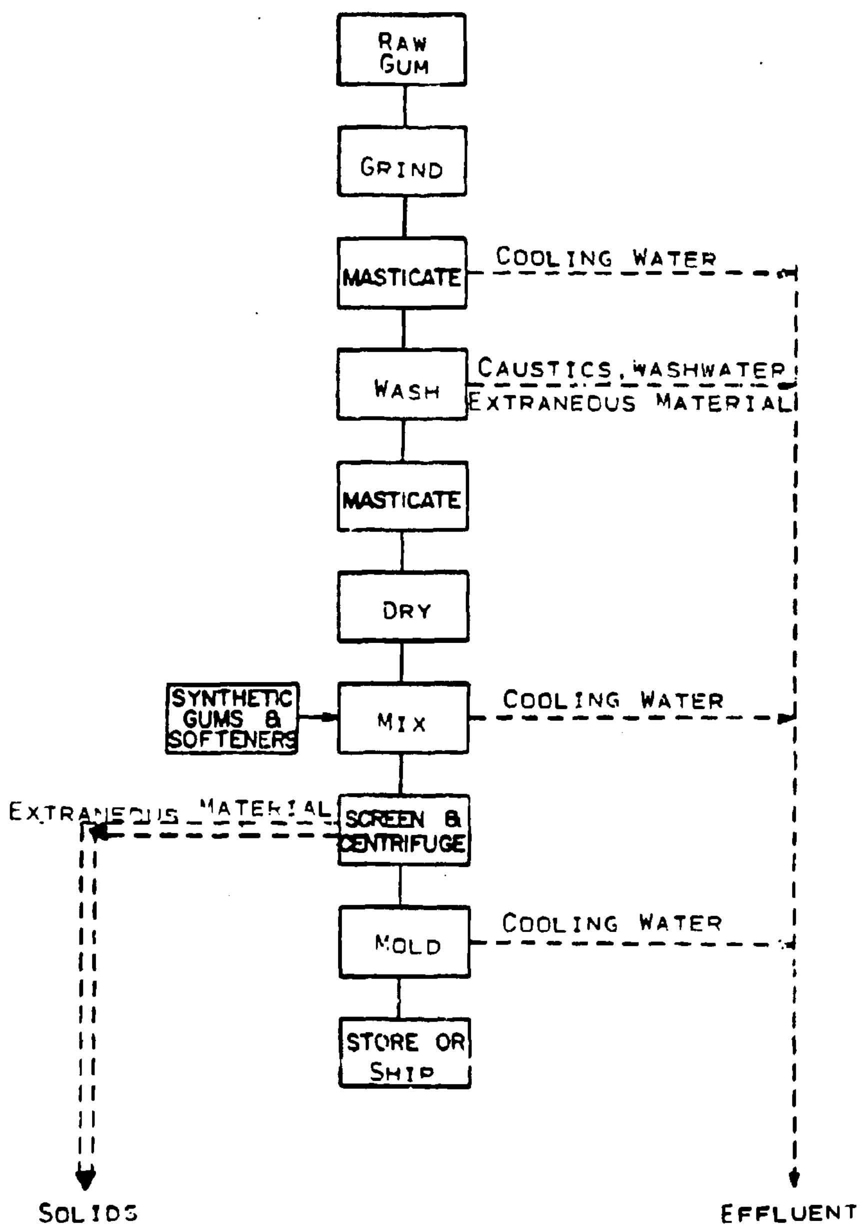


FIGURE 33

GUM BASE

DRAFT

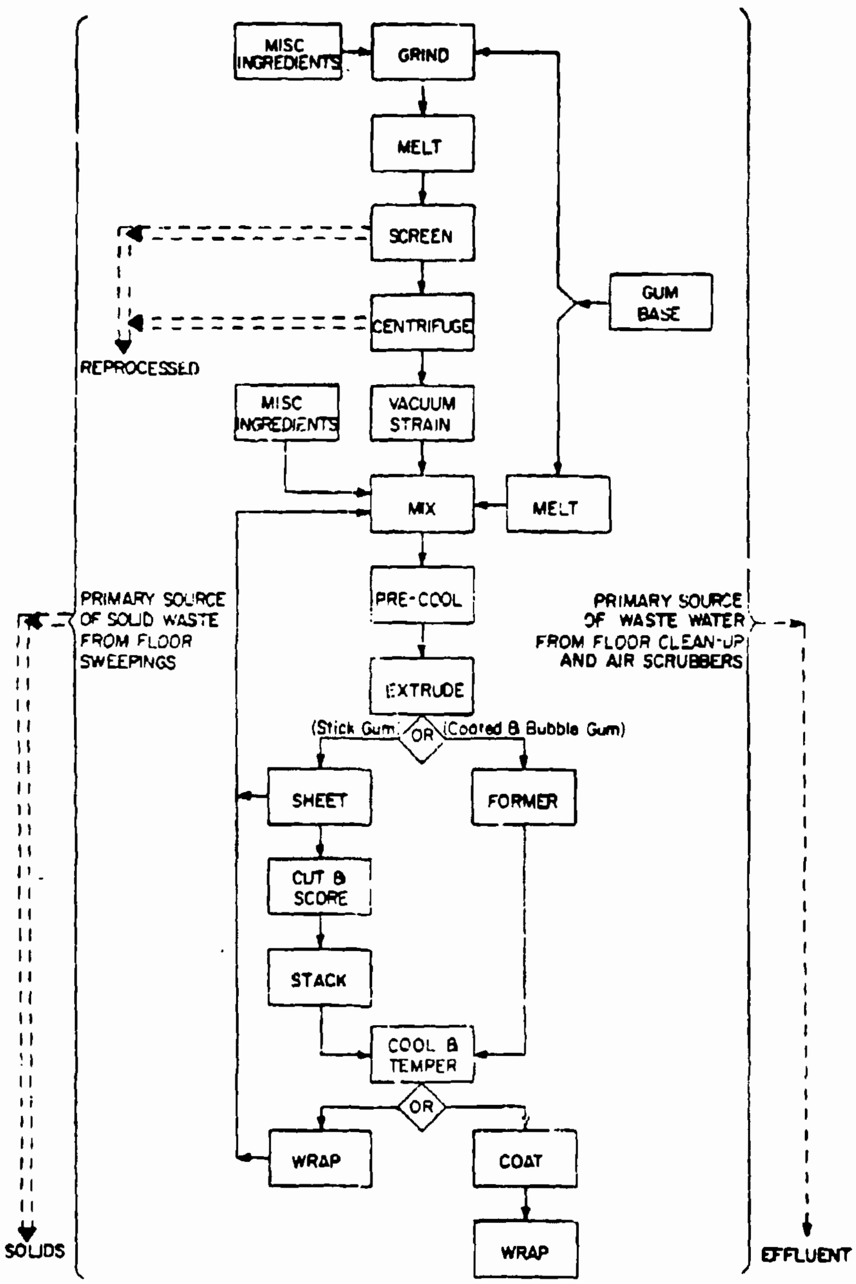


FIGURE 34

CHEWING GUM

such as glycerin are extensively used to help reduce the viscosity of the gum base to a desirable consistency and to improve texture.

When the blending is completed, the gum base is "tempered" or pre-cooled to reduce its temperature. After pre-cooling, the gum is mechanically kneaded to a smoother and finer texture. The gum then passes to a series of rollers that produce a sheet of varying thickness; the final thickness of the gum sheet determining the type of gum to be made. Stick gum comes from the thinnest sheets, candy-coated gum from a thicker sheet, and bubble or ball gum from the thickest sheets or ropes.

Stick gum, after expulsion from the extruder, then moves to the sheeting machine. This machine is made up of a series of rollers, each pair of rollers set closer together to reduce the thickness of the gum in stages. A light coating of finely-powdered sugar is used as an adhesion agent to prevent the gum from sticking to the rollers as well as to enhance the flavor. After passing through the sheeting machine, the gum is cut into rectangular sheets, approximately 43 by 43 cm (17 by 17 in.), and scored in a single stick pattern. The gum is then stacked automatically on trays and allowed to "set" in an air conditioned room for at least 48 hr. From the conditioning room the gum is taken to specially designed packaging machines which individually wrap and seal the gum. The individually wrapped gum is then packaged in multiple-stick packs.

The candy coating process for gums starts with sheets of scored and flavored gum which are broken into small squares or oblong pellets. Alternately, ball gum is extended in pencil shape and passed through specialized forming machines. These different types of gum pieces are then placed in panning machines which are simply rotating drums equipped with blowers so designed as to deliver low humidity air. A solution of corn syrup and sugar syrup is added and the drum is set in motion until the pieces receive a uniform coating. A small quantity of flavor is then added and thoroughly distributed. An addition of finely powdered sugar is made at intervals and partially coated gum is removed and allowed to season.

A coating is gradually built up with sugar syrups, starch, and gum Arabic and dried rapidly by means of the blowers after each application. A final polish is given to the coated gum by rotating the pieces in drums lined with beeswax impregnated canvas.

Bubble gum is essentially a plastic base which allows for considerable expansion when a volume of air is introduced. The gum base used for bubble gum is made with various combinations of Jetutong rubber, resins, and plasticisers. This gum base is then mixed with icing sugar and glucose syrup in steam jacketed mixing kettles. After mixing, the gum loaf is fed into an extruder hopper. From the hopper, the loaves are picked up by two auger-type screws comprising the kneader and forced under pressure through round holes. These continuous ropes of gum are then conveyed by rollers to cutters where they are cut into uniform lengths. Bubble gum may also be formed in sheets and cut to size. The gum is then put into racks and tempered from one to seven days. After tempering, the gum is formed into a variety of shapes such as pencil, kiss, ball, or square. The gum is then lightly coated with powdered sugar, individually wrapped and boxed.

Wastewaters from chewing gum manufacturing are derived from three primary sources: washdown, cooling waters, and (if used) air scrubbers. Washdowns are the primary source of waste loading, averaging less than 7500 l/day (2000 gal/day) for stick-gum processing and slightly more for candy-coated gum. Daily clean-up operations consist mainly of dry sweeping or scraping and wet mopping with solvent, disinfectant and water. Very little actual water flushing is done in the plant, except in certain specified areas. Many plants also utilize automatic scrubbers for cleaning floor areas.

Non-contact cooling water is generally recirculated; however, some plants do discharge some or all of their water. This water, if discharged, has a negligible waste loading, but may contribute significantly to the total flow.

Many plants utilize air scrubbers to clean and humidify the air. The water used in these scrubbers, due to sugar dust in the air, may be relatively high in BOD and suspended solids. The flow and strength of loading will vary with the number and size of air scrubber and the frequency of discharge.

SIC 2074, 2075, 2076 Vegetable Oil Mills

Mechanical extraction of vegetable oil from seeds originated with the "stump press" utilized by the Egyptians, Phoenicians, and Chinese. Dunning (13) reports that the process consisted of a burned-out stump with a heavy pole driven by oxen that rotated upon the seed, thus crushing the seed and extracting the free oil. The industrial revolution brought many mechanical improvements, including the invention of the hydraulic press in 1795. The hydraulic press remained the major oil extraction device until the beginning of the present century, at which time the development of the mechanical screw-press allowed continuous extraction of oil.

Today in the United States, the oilseed crushing industry represents a major industry utilizing a variety of mechanical and chemical extraction methods for the removal of vegetable oils from oilseeds such as soybeans, cottonseed, flaxseed, peanuts, safflower, and other miscellaneous oilbearing seeds.

A U.S.D.A. Marketing Research Report (14) states that the marketing and processing of oilseeds and vegetable oil has been significantly affected by increases in production and an expanding export market over the past two decades. As a result, the industry has witnessed changes in organizational structure, processing technology, and the size and number of processing mills. As indicated in Table 6 , vegetable oil production in terms of plant numbers has shown a mixed pattern of growth. This is best illustrated by the 62 percent increase in the number of soybean crushing facilities in the last two decades, while cottonseed mills decreased by 64 percent during the same period.

Approximately 67 percent of vegetable oil production is used in the manufacture of shortening, salad and cooking oils, salad dressings, mayonnaise, and margarine. Refining is usually separated from crushing, the former prefering proximity to farm lands and the latter to marketing areas, and over 70 percent of the final product manufacture occurs at or near the refineries.

Since World War II, more efficient solvent extraction methods have for the most part, replaced hydraulic and mechanical screw press methods. During the same period, other striking technological developments have included hydrogenation, deodorizing, and plasticizing of oils. These processes have substantially increased the range of uses of vegetable oils.

Other important developments in recent years have included an increased use of safflower and sunflower oils in food products and the development of meat analogs from oilseed products. The meat analogs, which compete with lower cost meats such as hamburger, are expected to exert an increasing demand on vegetable oil production.

The United States Department of Commerce reports (15) that approximately 19.4 million KKg (21.3 million ton) of soybeans were crushed at 142 oil mills throughout the country during 1974. Soybean oil mills are located principally in areas of heavy soybean production or meal use with the greatest concentration of plants in the Eastern Corn Belt states of Illinois, Iowa, Minnesota, Missouri, Indiana, and Ohio. Arkansas and Mississippi represent the other major areas of soybean crushing in the lower Mississippi Valley. Production data provided by the National Soybean Processor's Association from 15 plants shows production ranging from 62 to 2,310 KKg (68 to 2,550 ton) per day with an average production of 1000 KKg (1100 ton) per day.

The vegetable oil industry is expected to continue the steady growth shown over the past two decades. Further development of new technologies are expected and the worldwide demand for oilseed products continues to increase.

Soybean Oil - Smith (16) reports that during the past 40 years soybeans have made more rapid progress in the feed and edible oils industries than other oilseeds because of their (1) low cost of production (less than 10 man-minutes of labor per bushel); (2) adaptability to solvent extraction processing; (3) economic importance to the feed and edible oils industries; and (4) demand by foreign markets. The United States

DRAFT

TABLE 6

THE NUMBER OF COMPANIES AND ESTABLISHMENTS PROCESSING OILSEEDS FROM 1954 TO 1974

Industry and Year	Companies	Establishments
	Number	Number
Cottonseed oil mills:		
1954	145	286
1958	125	214
1963	115	188
1967	91	150
1974	74	102
Soybean oil mills:		
1954	55	88
1958	66	117
1963	68	102
1967	60	102
1974	36	142
Other vegetable oil mills:		
1954	N.A.	63
1958	38	46
1963	39	47
1967	34	41
1974	N.A.	N.A.

Department of Commerce reports (14) that the crushing and solvent extraction of soybeans alone represented America's number one cash crop in 1971, producing more revenue than corn, wheat, or cotton. In addition, soybeans were the largest single farm export from the United States with sales abroad in excess of 1.3 billion dollars a year.

Protein rich soybean meal, a by-product in the production of soybean oil, is a key ingredient in the nation's expanding livestock and poultry industries. Supplies of soybean meal were more than adequate for domestic consumption until mid-1972 when the United States entered an unparalleled soybean and soybean meal supply demand situation. Winner (17) reports that developments such as (1) unusually large purchases by Russia; (2) a poor 1972 harvest; (3) curtailment of Peruvian fish meal production, a protein source for feed grains; (4) reduced peanut meal exports by India and Senegal because of drought and: (5) increasing worldwide consumption, placed a heavy burden on American farmers and consumers as prices for these products were propelled from $118/KKg ($130/ton) in mid-December 1972 to more than $363/KKg ($400/ton) by early June 1973.

Production data provided by the National Soybean Processors Association (NSPA) from 14 soybean oil mills found typical plants operating in the range of 450 to 2300 KKg (500 to 2,500 ton) per day. Today 95 percent of the industry processes soybeans by use of prepress solvent and direct solvent extraction methods.

Cottonseed Oil - Cottonseed ranks second in total oilseed production in the United States with approximately 4.4 million KKg (4.8 million tons) crushed in 1973. The National Cottonseed Processor's Association (NCPA) indicates that there are 102 active cottonseed crushing plants in the United States with the major concentration of production occurring in the states of Texas (28 plants); Mississippi (18 plants); Arkansas (9 plants); California (7 plants); and Alabama (6 plants). Production data provided by the NCPA for five crushing facilities ranged from 230 KKg (250 ton) to 700 KKg (750 ton) per day and averaging about 390 KKg (430 ton) per day. Table 7 provides a summary of the cottonseed industry listing total numbers of plants per state and the type of extraction methods used.

Linseed Oil - The crushing of flaxseed to produce inedible linseed oil was the third largest oil bearing crop produced in 1973 with 0.53 million KKg (0.58 million ton) produced (about 2 percent of the total oil seed crushing production). Flaxseed production is centered in the states of North Dakota, South Dakota, and Minnesota which produce about 95 percent of the nation's crop, with North Dakota alone accounting for about half. According to the National Flaxseed Producers Association (NFPA), there are presently a total of six active crushing plants ranging in production from 550 to 800 KKg (600 to 900 ton) per day. The four largest flaxseed crushing facilities utilize the prepress solvent extraction process. Flaxseed crushers also process soybeans periodically depending on the market value of soybeans.

DRAFT

TABLE 7

COTTONSEED MILLING OPERATIONS BY STATE AND TYPES
OF EXTRACTOR METHODS UTILIZED 1974

State	Number of Plants	Hydraulic	Extraction Methods Mechnical Screwpress	Prepress Solvent Extraction	Direct Solvent Extraction
Alabama	6	-	6	-	-
Arizona	3	-	-	3	-
Arkansas	9	-	3	3	3
California	7	-	2	5	-
Georgia	7	1	4	-	2
Louisiana	4	-	3	-	1
Mississippi	18	-	7	2	9
Missouri	2	-	-	2	-
New Mexico	2	-	2	-	-
North Carolina	4	-	3	-	1
Oklahoma	4	-	3	-	1
South Carolina	5	1	4	-	-
Tennessee	3	-	3	-	-
Texas	28	1	20	4	3
TOTAL	102	3	60	19	20
PERCENT	100%	2.9%	58.8%	18.6%	19.6%

Source: National Cottonseed Producers Association.

Peanut Oil - Peanuts ranked fourth in total oilseed crushing in 1973 and totaled 0.284 million KKg (0.313 million ton). This represents less than one percent of the total oilseed crushing production. Information provided by the Southeastern Peanut Association indicates that there are presently eight active peanut crushers located in the States of Virginia, Alabama, Georgia, and Florida. Daily production at these facilities ranges from about 100 to 180 KKg (120 to 200 ton) per day. Sixty-two percent of the industry processes peanuts using prepress solvent extraction methods with the remainder, usually smaller capacity operations, using mechanical screw press methods.

Olive Oil - Olives utilized for production of olive oil in the United States are grown exclusively in California. Of the approximately 12,900 hectares (32,000 acres) of olives harvested annually, about ten percent are processed for recovery of olive oil.

The production of olive oil can be divided into two product segments--virgin and refined oil. Virgin oil, the finer quality oil, is produced by mechanical pressing of whole, ripe olives. The poorer quality refined oil is obtained by the solvent extraction of olive cannery pits, culls, and from the pressing of low quality, whole, ripe olives. The extracted oil is then refined and blended with virgin oil. Currently, there are two major producers of olive oil in the United States. However, there are numerous "backyard" producers who press out the valuable virgin oil by any means available.

Virgin oil is in great demand but short supply due to the fact that roughly 0.9 KKg (one ton) of raw olives is required to produce 100 liters (30 gallons) of virgin olive oil. The low oil yield is attributable to the material makeup of the olive. A good quality ripe olive is composed of about 55 percent water, 25 percent pomace, and 20 percent oil.

Generally, olive oil is produced between the months of October and June and continuous production during that period is dependent on the availability of laborers to harvest the fruit. Although demand for olive oil exceeds supply, it is unlikely that the number of major producers will increase since uncertainty of crop yield will continue to cause a reluctance to invest in equipment thereby hindering the production of olive oil on a large scale.

Miscellaneous Oils - The demand for a variety of other miscellaneous vegetable oils such as safflower, sunflower, and seasame seed oils has been increasing in the United States since 1960. The demand for these food materials has been most evident in the margarine industry where food nutritionists and technologists have been utilizing safflower oil as a source of polyunsaturated vegetable oils, important in controlling plasma cholesterol levels in the diet. Doty and Lawler (18) report that food use of safflower oil in 1970 totaled 36,000 KKg (40,000 tons) and industrial use totaled about 9000 KKg (10,000 ton). Results of a telephone survey during this study indicated that there presently exists two safflower-sunflower seed crushing plants in the United States with one other under construction. All three facilities are located in California and utilize both prepress solvent extraction and screw press extraction techniques.

Description of Oilseed Crushing - The extraction of oil and the production of meal or cake from oil bearing seeds may be performed by direct solvent extraction, prepress solvent extraction, mechanical screw press or hydraulic press operations. As indicated in Table 3 direct solvent extraction is used primarily in the soybean industry; while prepress solvent extraction and screw press operations are utilized primarily in the cottonseed, flax-seed, and miscellaneous industries; and hydraulic press operations in a small number of old, small capacity plants.

The crushing of oilseeds by solvent extraction, prepress solvent extraction, or mechanical screw press, with minor variations in seed preparation, are generally similar operations regardless of the seed being crushed with one exception--the crushing of raw olives. Therefore, the following process descriptions will discuss oilseed crushing in reference to the extraction methods utilized by the major oilseed industries, while a separate discussion will be provided for the crushing of raw olives.

Direct Solvent Extraction: Soybeans are commonly processed in the United States today by the direct solvent extraction method. The manufacturing of crude soybean oil involves the crushing and solvent extraction of the crude oil from dehulled, conditioned soybean meats. The important by-products of the process are soybean meal and cakes which are sold commercially as a protein supplement in feed grains. Other oil-bearing seeds, such as cottonseed, present problems in that the seeds tend to disintegrate into fine particles, called "fines," which interfere with the operation of the solvent recovery system. Modern technology, however, has developed solvent extraction processes applicable to almost any type of oilseed. During 1974, 20 percent of all cottonseed processors utilized the direct solvent extraction process.

Cofield (19) reports that in general, the initial and operating costs of a solvent extraction plant are higher than mechanical screw press operations. More skilled labor is required in a solvent extraction plant and a several hundred metric ton capacity is required for economical operation. Skilled labor is often difficult to obtain and a large capacity requires large storage facilities due to the seasonal production of oilseeds. Another disadvantage of solvent extraction is the high cost of the solvent (usually hexane) and its explosive potential.

The disadvantages and problems of solvent extraction are generally more than offset by its primary advantage--increased oil yield. Currently, 95 percent of the soybean industry and 38 percent of the cottonseed industry use either solvent extraction directly or in combination with mechanical pressing.

DRAFT

TABLE 8

EXTRACTION OF OIL FROM OILSEEDS BY VARIOUS PROCESSES

Oil Extraction Process	Most Common Applications
Direct Solvent Extraction	Soybean Cottonseed
Solvent Extraction With Prepressing	Cottonseed Flaxseed Peanuts Sunflower Seed Corn Germ (wet process) Safflower Seasame
Mechanical Screwpress	Cottonseed Peanuts
	Olives Flaxseed
Hydraulic	Cottonseed Olives

As shown in Figure 35, raw materials arrive at the plant by rail or truck and are immediately dried and cleaned before storage to eliminate any foreign matter that could cause combustion, affect oil quality, or deteriorate equipment. Cleaning is accomplished by a combination of screens, air separators, and magnets.

A pretreatment step unique to cottonseed is that of delinting. Brennan (20) reports that any cotton fiber still on the cottonseed after cleaning is normally removed in two delinting steps, first-cut and second-cut. The first-cut is a short, high grade fiber used in cotton-felt manufacturing. The second-cut is usually sold to cellulose manufacturers. The motes, or remaining fibers, and foreign matter are removed by shaking and are sold for their cotton content. Cottonseed delinting is also required in prepress solvent extraction and screw press operations.

All oilseeds must be dehulled to increase the efficiency and capacity of the solvent extraction operation, and to reduce abrasion of equipment. Dehulling is normally accomplished in bar or disc hullers or corrugated cracking rollers, while screening and air separation are used to isolate the hulls from the meat. In modern, efficient plants, this operation creates little if any dust problem. However, in older installations, particularly in those processing cottonseed, a considerable amount of dust is created with a resulting loss in product quality and deterioration of working conditions. Rockwell (21) reports a number of plants have installed wet scrubber systems, bag filters, and "cyclones" to reduce airborne particulate matter in oilseed preparation areas.

In most cases the hulls are recovered for animal feed or fertilizer. In some plants, particularly in the peanut industry, the hulls are incinerated or used as boiler fuel.

Hutchins (22) reports that the hull-free disintegrated meats are sent to the "conditioner", usually a vertical stack cooker, where the meats are heated to 70°C (158°F) maintaining a moisture content of 10 to 11 percent for 15 to 20 minutes. Cooking ruptures oil cells, provides disinfection, and stabilizes the enzyme activity of the meats. Conditioned meats are then processed through flaking rollers where the meats are pressed into a flat flake. Pressed soybean flakes range in thickness from 0.02 to 0.03 cm (0.008 to 0.012 in.).

The flakes are conveyed from the milling preparation area to the solvent extraction building housing one of several types of extractor units. Although nearly all of the soybean extraction plants in the United States now have percolation or basket-type extractors, a few immersion types are still being operated on a small scale. It is not necessary to include a full description of all commercial extractor units available in this document; however, adequate descriptions are available from published references: Cofield (19), Encyclopedia of Chemical Processing Equipment (23), and Langhurst (24).

DRAFT

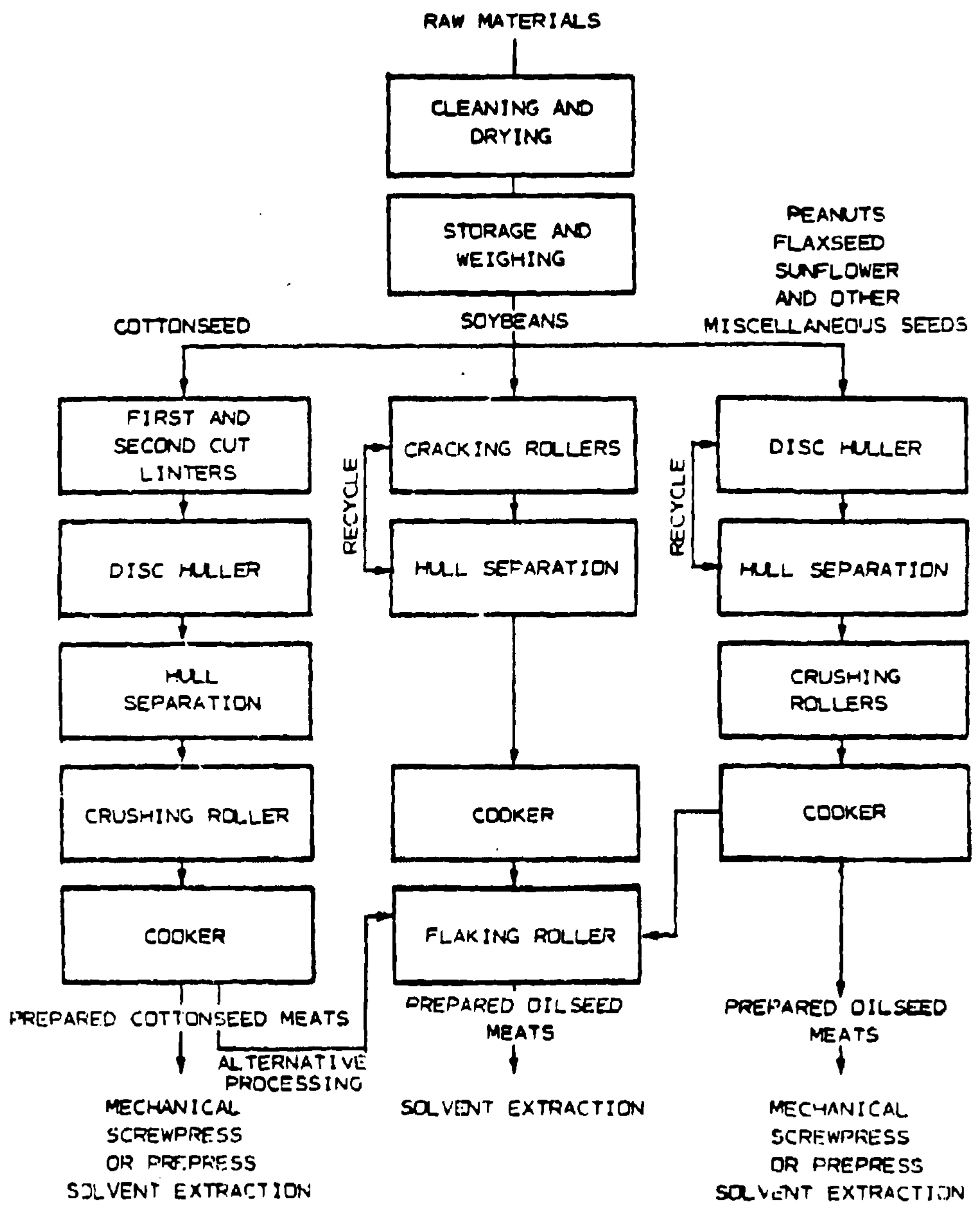


FIGURE 35

A SIMPLIFIED FLOW DIAGRAM FOR OILSEED PREPARATION BEFORE EXTRACTION FOR A VARIETY OF OILSEEDS

The oil bearing pressed flakes are deposited into steel baskets within the extractor unit and an organic solvent, usually hexane, is allowed to percolate through the flakes at a temperature of 48° to 54°C (120° to 130°F) from 25 to 45 minutes.

Solvent extraction removes oil from the meat of oilseeds by the diffusion of solvent and oil through the ruptured cell walls. Replacing the solvent outside the cell walls with solvent of lesser oil content prevents the process from reaching equilibrium, and the process becomes continuous. The hexane solvent reduces the oil content of the meats to about one percent or less with the flakes retaining 35 percent of the solvent.

Solvent extraction is accomplished either as a batch or a continuous operation. Batch methods have the advantages of low initial investment and the capability of processing relatively small quantities, thus being practical for the small processor. However, batch processing involves high labor costs and presents danger of flammable and toxic solvent vapor. The latter disadvantage has been overcome in recent years by the use of nonflammable trichloroethylene, and there are some small operations 22 to 27 KKg (25 to 30 ton capacity) which use batch operations. Most commercial operations use hexane in a continuous operation.

A number of continuous solvent extraction systems are employed by the oilseed industry, but all use the same basic operations of (1) passing the solvent over the conditioned, pressed meats to produce the oil-solvent mixture called miscella; and (2) recovering the solvent from the miscella and the extracted meats. A typical flow diagram of continuous solvent extraction is presented in Figure 36 .

Kingsbaker (25) reported that several desolventization methods are used for recovery of the solvent from the miscella and the extracted meats, with all having the object of removing the solvent at the lowest possible temperature and recovering the solvent with a minimum of loss. In cottonseed crushing particular care must be taken to quickly remove the oil from the miscella to prevent oil damage. This problem is not typical of other oilseeds. The recovery of the solvent from the miscella is usually accomplished in a long tube evaporator followed by a stripping column. Each unit evaporator removes approximately 90 percent of the solvent.

The first method of desolventization of meats, developed in Germany, is still used by perhaps a third of the solvent extraction plants in the United States. The method involves passing the meats via a ribbon conveyor through a series of steam jacketed tubes called "schneckens.". The schneckens are expensive, difficult to clean, and less efficient than more modern methods.

The next method of desolventization of meats that appeared in the industry was the solvent vapor-desolventizing system. About 99 percent of the solvent is removed from the meats by passing superheated hexane vapor over them. The heat from the vapor vaporizes the solvent. A final steam stripping removes the last of the solvent from the meats.

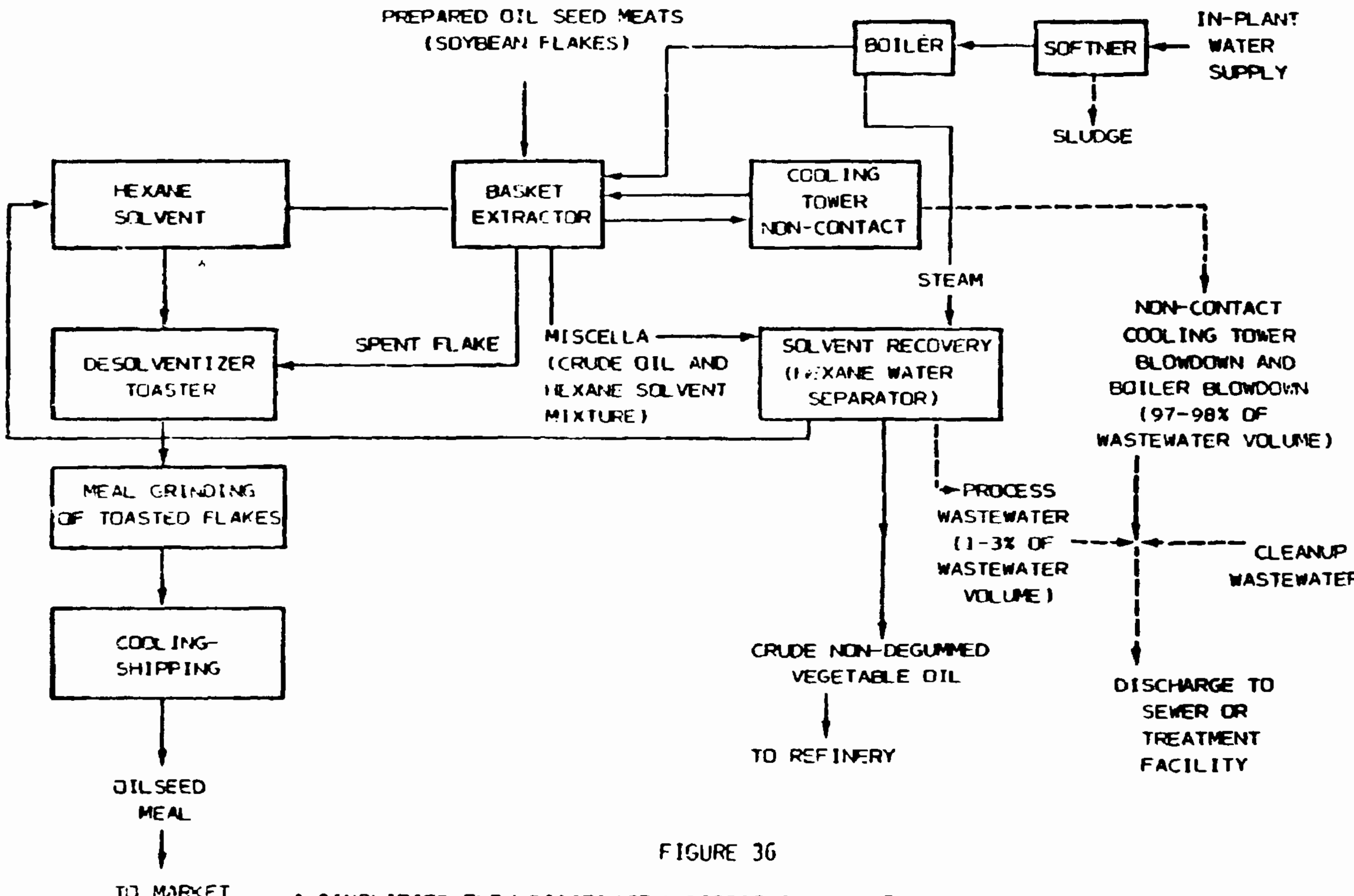


FIGURE 36

A SIMPLIFIED FLOW DIAGRAM OF A DIRECT SOLVENT EXTRACTION PROCESS

The desolventizer toaster is perhaps the most widely used method of desolventizing meats, particularly in the soybean industry. It consists of a vertical vessel with steam heated tray sections. The upper trays provide desolventization by steam sparging while the lower trays provide toasting by heating the flakes to about 106°C (222°F). The desolventized meats are then cooled, ground, screened and processed as finished meal for animal feed.

Solvent recovery in every phase or method of solvent extraction is of great importance to processors because of the high cost of hexane and its flammability. Solvent recovery is involved in all of the extraction equipment but is a special problem in the recovery of solvent from the final vent gas discharge. Various methods employed for this purpose include all adsorption systems, activated carbon, and refrigerated vent condensers, with the last being most extensively used.

Modern plants can expect a total loss of hexane of 2 liters (0.5 gal) or less per KKg (1.1 ton) of seeds processed and a concentration in the vent of less than 0.9 volume percent air. The total losses in some plants are considerably higher, as much as 4 to 6 l/KKg (1 to 1.4 gal/ton). These less efficient plants, besides having the danger of fire and explosions, will usually face economic problems.

The final product, crude soybean oil, is stored in oil storage tanks for later shipment via railway tank cars to area edible oil refineries.

Soybean Oil Degumming: There are a large number of solvent extraction plants in the United States which also process soybean oil for the recovery and refining of phosphatides. This process is generally known as degumming.

Bloomberg (26) reports that a typical soybean oil will yield a 3.5 percent gum-like material which is 35 percent water and 65 percent oil soluble; the oil soluble portion will be about one-third oil and two-thirds acetone-insoluble (lecithin). Lecithin is a complex mixture of phosphatides which consists chiefly of phosphatidyl ethanolamine, phosphatidyl serine, and phosphatidyl inositol, combined with various amounts of other substances such as triglycerides, fatty acids, and carbohydrates.

A typical plant for degumming soybean oil, operating at 13.6 metric tons (1.5 ton) per hour, is illustrated in Figure 37 . Oil, containing 3.5 to 4.0 percent gums, is pumped from the crude oil storage tank through heating coils where it is heated to 59 to 65°C (138 to 149°F); then through an in-line mixer, about one and one half percent on a weight basis, of water is added to the crude oil. The oil-water mixture remains in the hydration tank under continuous mixing for about 45 minutes. From the hydration tank, the oil-water mixture is pumped to a degumming centrifuge. The two products are discharged from the centrifuge. Degummed oil, containing about 0.2 to 0.3 percent moisture, goes to a refining process and lecithin, containing about 35 percent moisture,

DRAFT

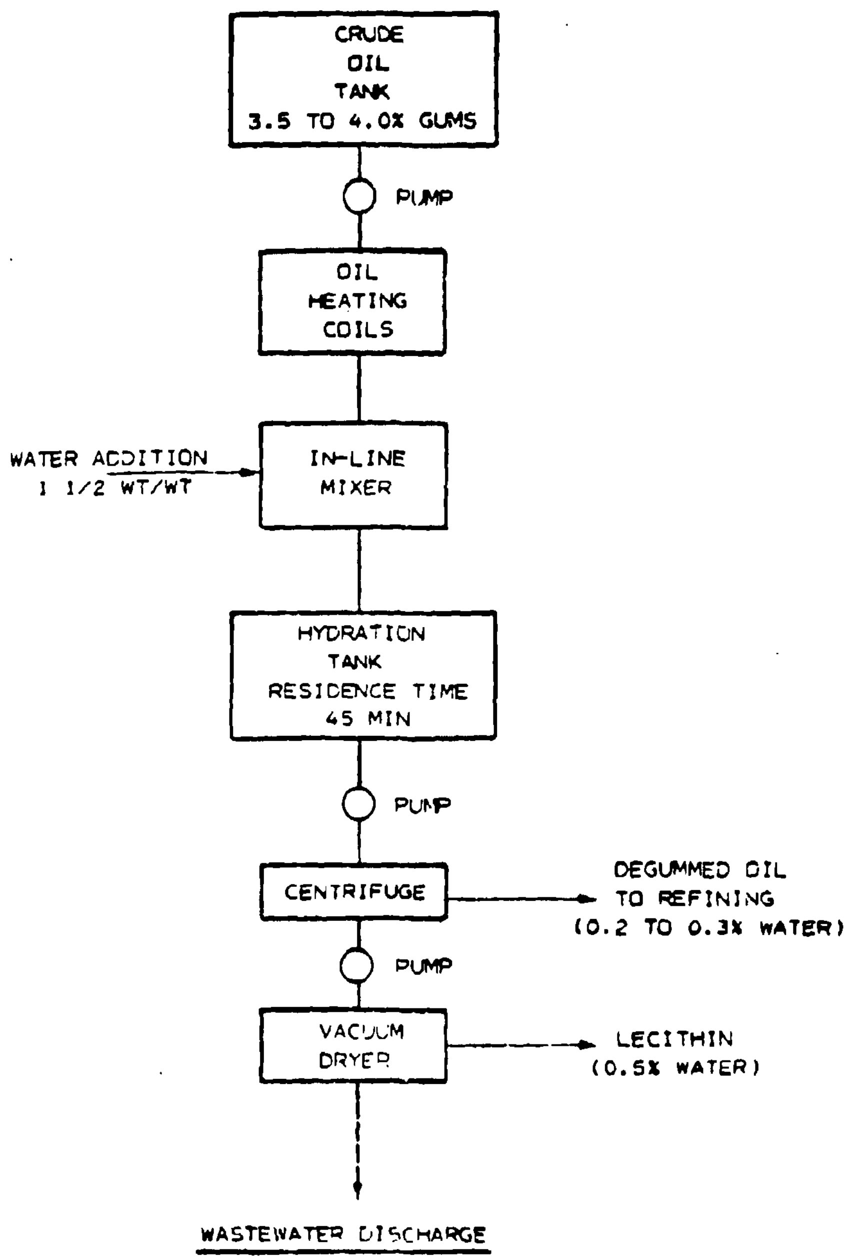


FIGURE 37

A SCHEMATIC DIAGRAM OF A TYPICAL DEGUMMING OPERATION is pumped to a vacuum dryer. Dry lecithin, containing about 0.5 percent moisture is discharged from the vacuum dryer. The moisture removed from the wet lecithin amounts to about 227 liters (60 gallons) per hour, and is discharged to a sewer or waste treatment system.

Mechanical Screw Press Operations: The primary emphasis of this description will focus on the cottonseed industry as 77 percent of the processing facilities in the United States still use mechanical screw presses, either for prepressing or complete extraction.

Cottonseed arrives at the plant by rail or truck and is stored in large warehouses. Cottonseed is prepared for pressing by cleaning and subsequent processing through the first and second cut linters (Figure 35). Brennan (20) reports that the first-cut recovered lint is baled and sold to cotton-felt manufacturers and the second-cut is sold to cellulose manufacturers. The delinted cottonseed is then dehulled by cutting the seeds in bar hullers with the meats being separated from the hulls by a series of shakers, beaters, and separators. Cottonseed meats are passed through a crushing roller to flatten the meats into flake form and to rupture a large number of oil cells. More importantly, crushing puts the meats into a form that permits uniform treatment of heat and moisture necessary for preserving good quality oil. Hutchins (22) reports that after crushing, the meats (30 to 34 percent oil content) are conveyed into a vertical stack cooker at a temperature of 84°C (138°F) and a moisture content of 12 percent. Cooked meats are then discharged into the mechanical screw press or expeller where about two-thirds of the oil content is removed and sent to a sump.

Figure 3? shows a simplified flow diagram for mechanical screw press extraction. Dunning (13) reports that the screw press extractor contains a main worm shaft that exerts a pressure of 700 to 2,000 atm (10,000 to 30,000 psi) on the meats being processed; the shaft is selected for the type of seed being processed and the pressure required by the seed. The particular shaft selected, however, can have its pressure adjusted for variations in the seeds.

A drainage barrel, consisting of rectangular bars set in a frame, permits drainage of oil from the pressing operation as well as acting as a filtering media. The spacing of the bars will vary along the length of the extractor and also according to the type of seed being processed.

The oil from the mechanical extractor is settled in a sedimentation basin to remove the settleable vegetable solids or "foots", which are normally about two percent by weight of the meats being processed. The final unit operation before storage is filtration.

The meat from the mechanical press is in the form of a cake. It may undergo additional oil removal by solvent extraction, or, if the plant is strictly mechanical, it is ground in the meal room. The grinding

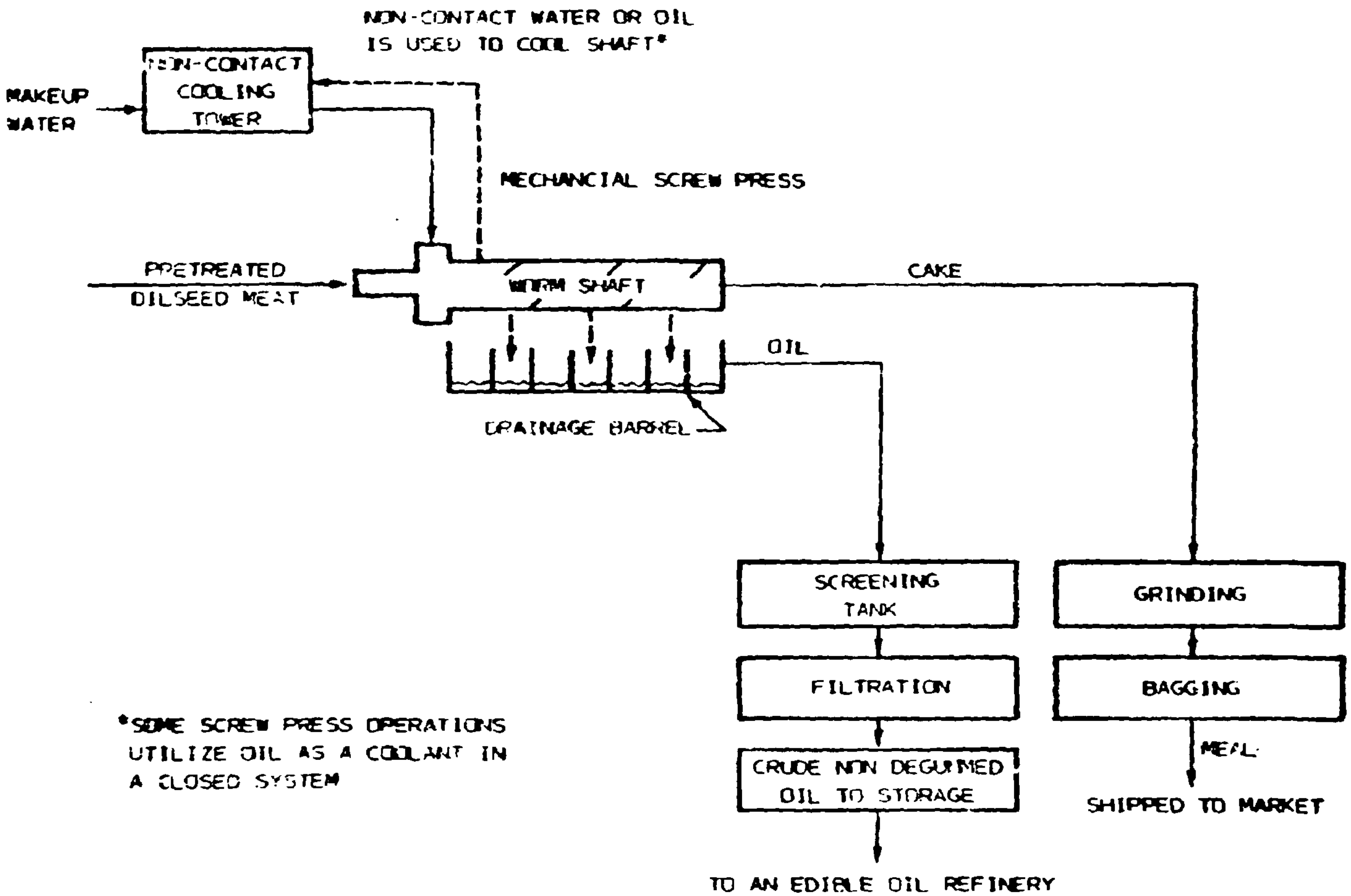


FIGURE 30
A SIMPLIFIED FLOW DIAGRAM OF MECHANICAL SCREW PRESS EXTRACTION

operation presents a potential dust problem, particularly in the grinding of cottonseed meal. At this point, ground hulls may be mixed with the meal for protein adjustment.

Prepress Solvent Extraction Operations: About 19 percent of the cottonseed, 50 percent of the peanut, and 50 percent of the flaxseed crushing industries utilize the prepress solvent extractor method. Typically, oil seeds are cleaned, cooked, and screw pressed in the same manner as normal screw press operations where two-thirds of the oil content of the meats are removed. However, the cooled granulated cake from the screw press contains about 10 percent oil (one-third of the oil content of the seed). This oil is recovered by the same continuous solvent extraction process described above. Solvent extraction reduces the oil content of the cake to less than 0.5 percent and the crude oil is sent to storage.

<u>Olive Oil Processing</u> - Crude olive oil may be produced from whole ripe olives by the mechanical screw press operation or by hydraulic press. Cannery crushed whole olives are processed for oil by direct solvent extraction. The screw press and hydraulic press produce both virgin and low grade oils while solvent extraction produces only low grade oil.

Mechanical Screw Press: Figure 19 illustrates the screw press process for olive oil production. The whole ripe olives are hopper-fed into a transport pump washer for prewashing before passing into an air percolation washer for final washing. The clean olives are then transferred into a hammer mill by means of a bucket elevator.

In the hammer mill the olives fall onto a metal screen and are struck by a rotating drum fitted with steel bars. The pulverized fruit falls through the screen into an open trough which is sloped slightly toward the discharge end. A rotating bar with interspersed. fan-like blades blends the crushed fruit into a meal and conveys it along the trough. The meal is then transferred into a screw press with the resulting pomace being hauled away for fertilizer, while the slurry, composed of oil, water and fine particles of olives, is centrifuged. Centrifiguation separates the slurry into sludge, oil and water, and fruit water fractions. The fruit water is recycled into the centrifuge to aid in separation of the slurry. The sludge has a low pH and is normally used for neutralizing alkaline soils.

DRAFT

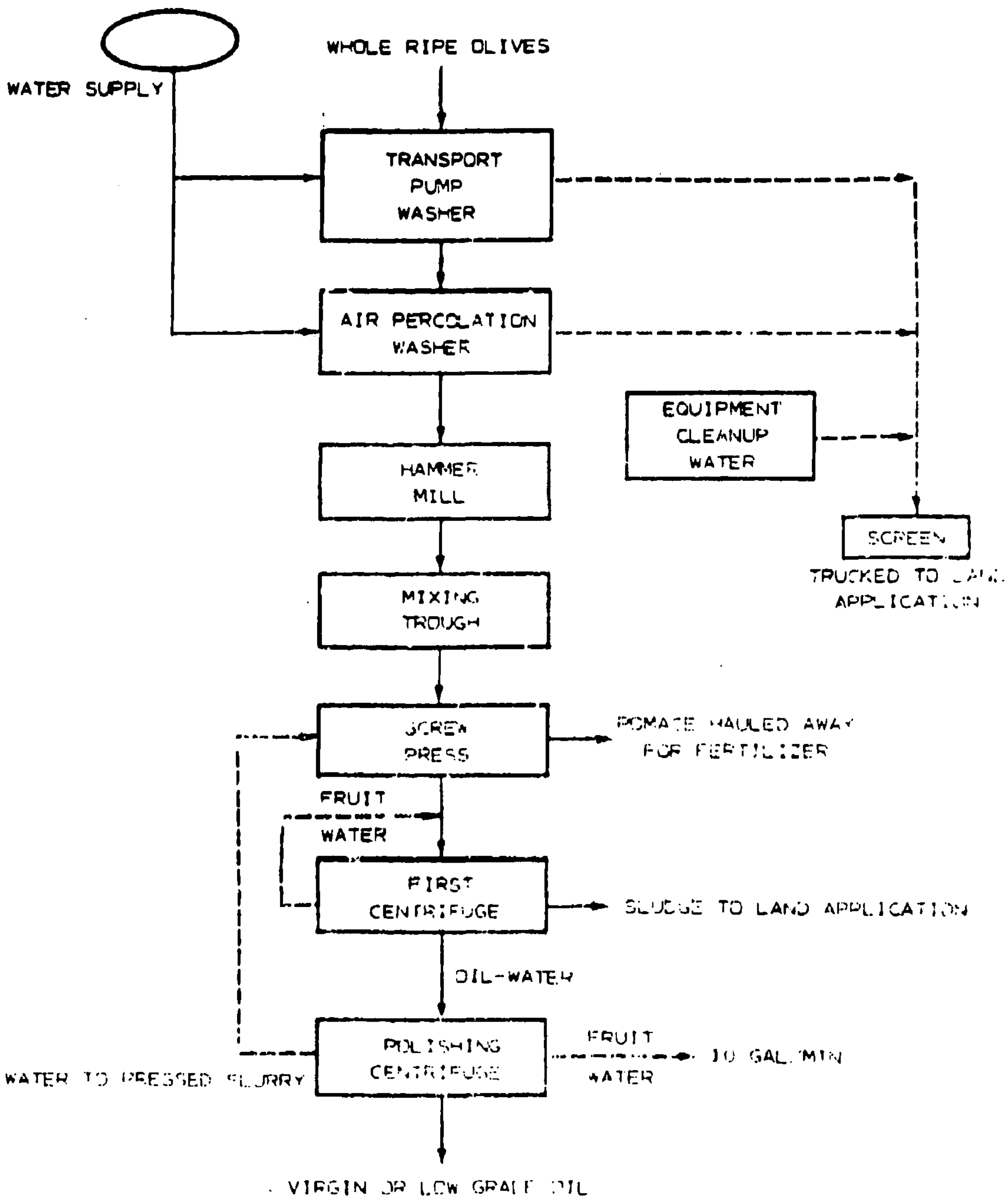


FIGURE 39

SCREW PRESSING PROCESS FOR RECOVERY OF OLIVE OIL

The oil-water mixture is separated in a polishing centrifuge with the water being recycled back to the screw press slurry and the oil collected in storage tanks. Finished oil is tested for taste, odor, and free fatty acid content to determine if refining is necessary. If the oil proves to be of high quality, it is retained for blending with refined oil, bottled as virgin olive oil, or sold in bulk.

Wastewater generated in the screw pressing process consists of periodic dump g of wash tanks, centrifuge effluent, and occasional equipment cleanup.

Hydraulic Press Operations: Figure 40 illustrates the recovery of olive oil by hydraulic pressing. After crushing in the hammer mill, the ripe olives are placed in burlap "press bags" which are subsequently layered into the hydraulic press.

Pressing is carried out in two or more stages, with the first press (at pressure of approximately 20 atm) (300 psi) yielding high grade, virgin oil. Successive presses at higher pressures yield a lower grade oil which must be refined. The extracted oil is then centrifuged to separate fruit water from the oil. Low grade oil goes directly to refining while the virgin oil is bleached by processing the oil through a pressure clay filter. The bleached virgin oil is then pumped to storage tanks.

The pomace remaining in the burlap filter bags contains about ten percent oil and is mixed with crushed cannery pits and culls for solvent extraction.

Wastewater generated in the hydraulic pressing process consists of occasional washing of the olives prior to pressing and centrifuge effluent.

The Solvent Extraction Process: Figure 41 illustrates the solvent extraction for olive oil production. Cannery olive pits and culls and deteriorated, bruised whole olives are manually placed into a hammer mill and pulverized into wet meal. At this point pomace from the pressing of the olive oil may be added to the meal. The meal is dried in a rotary kiln to prepare it for extraction. The dried meal is placed into the extractor where the oil is extracted by a hexane solvent. The hexane is recovered, the pomace sold for cattle feed, and the oil recovered for refining. The only source of wastewater in this process consists of water which drains out of the fruit during storage.

DRAFT

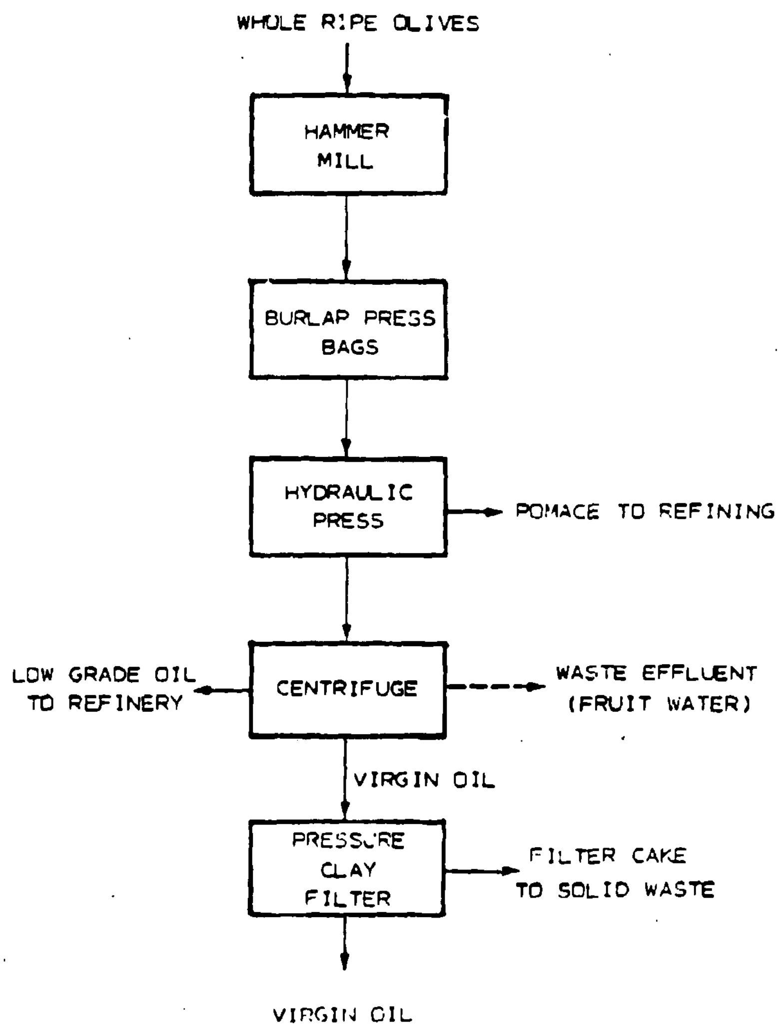


FIGURE 10

HYDRAULIC PRESSING PROCESS FOR RECOVERY OF OLIVE OIL

DRAFT

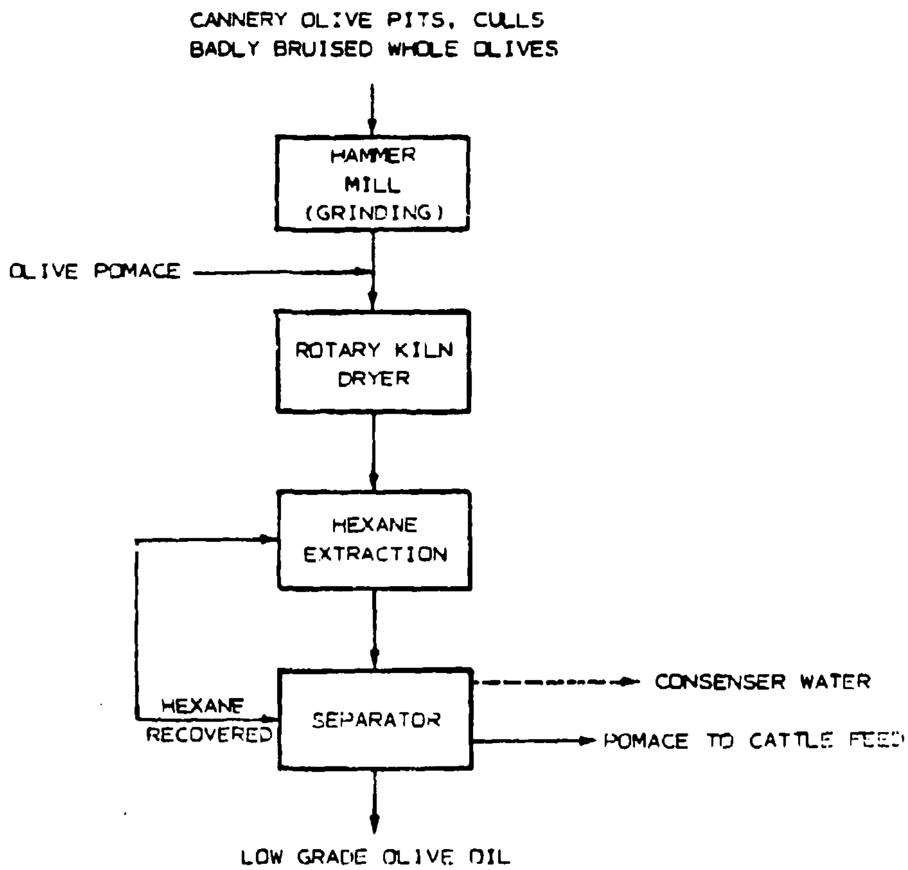


FIGURE 41

OLIVE OIL SOLVENT EXTRACTION PROCESS

SIC 2079 Shortening, Table Oils, Margarine And Other Edible Fats And Oils, Not Elsewhere Classified

The refining and production of edible oil products from both animal fats and vegetable oils derived from oilseed products constitutes a major industry in the United States. The Institute of Shortening and Edible Oils (ISEO) (27) reports that fats and oils provide about 40 percent of caloric nutritional needs for the United States. Fats and oils commonly used for table use and cooking purposes are predominately trifatty acid esters of glycerol, commonly called "triglycerides". Triglycerides make up approximately 95 percent of the constituents present in crude vegetable oil. Other principal constituents present include mono- and diglycerides, free fatty acids, phosphatides, sterols, fatty alcohols, tocopherols, carotenoids and chlorophyll (color bodies), and vitamins E and K.

The USDA Foreign Agricultural Service Statistics (28) indicate that world production of edible oils has been a growing industry for many years. Prior to World War II, cottonseed was the major oilseed crushed in the industry, but soybean oil has dominated the American market for the last thirty years due to its relatively high protein yield. Soybean oil has been largely responsible for the last decade's increase in annual world production of vegetable oil from 12.3 to 22 million metric tons. Table 9 shows the growth in demand for major vegetable oils and animal fats in the United States over the last two decades. Table 10 presents the annual production of the major crude vegetable oils produced in the United States from 1959 to 1973.

The ISEO (29) reports that there are currently 121 active edible oil refineries in the United States processing more than 8.2 million metric tons (9 million tons) of edible fats and oils annually. The largest concentration of edible oil refineries is in California which as 20 plants; Illinois is second with 15 plants, and Texas is third with 10 plants. Table 11 provides a summary table listing the geographical distribution of edible oil refining facilities throughout the United States.

The following process description covers the refining of animal fats (tallow and lards) nd crude vegetable oils such as soybean, cottonseed, peanut, palm, palm rnal, olive, safflower, and sunflower oils.

Description of Process - A typical, full scale edible oils refinery usually purchases crude vegetable oils from a variety of oilseed crushing operations and refines the oil into a number of finished products such as shortening, margarine, salad and cooking oils, salad dressings and mayonnaise. The principal steps involved in refining edible oils include (1) storage and handling, including tank car cleaning; (2) caustic refining; (3) acidulation; (4) bleaching; (5) hydrogenation;

DRAFT

TABLE 9 FOOD FATS AND OIL END PRODUCTS

U.S. DOMESTIC DISAPPEARANCE OF FATS AND OILS IN FOOD PRODUCTS, BY TYPE OF FAT OR OIL, 1950-72 1/ (MILLION METRIC TONS)

YEAR	Soybean	Cottonseed	Corn	Coconut	Peanut	Palm	Palm Kernel	Safflower	Olive	Sesame	Total
1950	0.656	0.655	0.101	0.059	0.047	-	0.012	-	0.036	0.002	1.567
1951	0.697	0.473	0.096	0.064	0.052	-	0.005	-	0.018	2/	1.405
1952	0.867	0.552	0.091	0.087	0.038	0.0005	0.005	-	0.021	2/	1.662
1953	0.965	0.521	0.107	0.083	0.021	0.0005	0.009	-	0.020	2/	1.727
1954	0.908	0.782	0.105	0.093	0.026	0.007	0.015	-	0.028		1.964
1955	1.047	0.608	0.106	0.088	0.022	-	0.016	-	0.024	0.0005	1.911
1956	0.978	0.568	0.115	0.103	0.030	-	0.019	-	0.020	2/	1.833
1957	1.041	0.555	0.123	0.106	0.030	-	0.021	-	0.022	0.0005	1.899
1958	1.281	0.466	0.122	0.115	0.028	-	0.021	-	0.024	0.0005	2.058
1959	1.431	0.483	0.140	0.081	0.037	0.001	0.022	-	0.24	2/	2.110
1960	1.366	0.556	0.141	0.078	0.028	0.0005	0.024	-	0.023	0.0005	2.216
1961	1.279	0.579	0.138	0.093	0.043	0.014	0.027	-	0.027	0.0005	2.310
1962	1.486	0.562	0.156	0.121	0.028	0.013	0.043	0.018	0.026	0.0005	2.442
1963	1.478	0.530	0.159	0.102	0.041	0.008	0.031	0.024	0.015	0.0005	2.378
1964	1.696	0.611	0.187	0.115	0.026	0.005	0.030	0.017	0.030	0.0005	2.719
1965	1.701	0.640	0.194	0.123	0.032	0.006	0.036	0.023	0.020	0.0005	2.775
1966	1.949	0.552	0.180	0.157	0.065	0.024	0.029	0.038	0.022	0.0005	3.016
1967	1.980	0.488	0.183	0.164	0.078	0.028	0.049	0.072	0.025	0.001	3.068
1968	2.147	0.445	0.183	0.167	0.091	0.035	0.044	0.031	0.029	0.0005	3.173
1969	2.488	0.435	0.177	0.182	0.067	0.058	0.042	0.056	0.026	0.001	3.533
1970	2.650	0.442	0.188	0.156	0.069	0.051	0.035	0.036	0.028	0.001	3.657
1971	2.638	0.327	0.177	0.207	0.083	0.088	0.035	0.052	0.028	0.001	3.637
1972 3/	2.811	0.319	0.210	0.222	0.078	0.150	0.031	0.015	0.030	0.001	3.867

1/ Includes disappearance into products for both civilian and military consumption. Data not adjusted for changes in finished product stocks and excludes exports.

2/ Less than 225 metric tons.

3/ Preliminary, U. S. Department of Agriculture.

TABLE 10

PRODUCTION OF MAJOR CRUDE VEGETABLE OIL IN THE UNITED STATES FROM 1959-1973*

MILLION METRIC TONS
(Million Pounds)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1969	1969	1970	1971	1972	1973
Soybean Crude Oil Production	1.97 (4343)	1.99 (4384)	2.01 (4428)	2.21 (4891)	2.29 (5057)	2.24 (4948)	2.37 (5231)	2.63 (5806)	2.80 (6171)	2.78 (6127)	3.09 (6818)	3.76 (8300)	3.74 (8265)	3.58 (7892)	3.40 (7509)
Cottonseed Crude Oil Production	0.73 (1615)	0.81 (1790)	0.86 (1765)	0.91 (2001)	0.87 (1923)	0.88 (1936)	0.92 (2028)	0.77 (1692)	0.50 (1095)	0.47 (1041)	0.67 (1480)	0.59 (1300)	0.56 (1235)	0.59 (1308)	0.71 (1566)
Peanut Crude Oil Production	0.047 (104)	0.038 (83)	0.042 (93)	0.028 (61)	0.045 (100)	0.056 (123)	0.061 (135)	0.077 (170)	0.082 (182)	0.096 (211)	0.084 (186)	0.125 (275)	0.121 (266)	0.120 (265)	0.124 (273)
Corn Crude Oil Production	0.146 (322)	0.108 (239)	0.152 (336)	0.166 (366)	0.177 (390)	0.188 (414)	0.202 (445)	0.203 (447)	0.201 (444)	0.205 (452)	0.211 (466)	0.215 (475)	0.220 (485)	0.226 (499)	0.237 (523)
Linseed Oil Production	NA	NA	NA	NA	0.179 (394)	0.209 (462)	0.185 (409)	0.206 (455)	0.164 (363)	0.138 (305)	0.133 (294)	0.127 (280)	0.179 (395)	0.202 (445)	0.173 (381)
Safflower Oil	NA	NA	0.023 (51)	0.069 (152)	0.047 (104)	0.050 (111)	0.063 (130)	0.077 (170)	0.063 (139)	0.045 (100)	0.034 (75)	0.045 (100)	NA	NA	NA

* Approximate Values

NA - Not Available

Source: Fats and Oils Situation, 1959-1973.

DRAFT

TABLE 11

A SUMMARY OF THE NUMBER OF EDIBLE OIL REFINERIES IN THE UNITED STATES LISTED BY STATE

Alabama	2	Nebraska	2
Arizona	2	New Jersey	8
Arkansas	2	New York	2
California	20	North Carolina	2
Colorado	1	Ohio	5
Georgia	4	Oklahoma	1
Illinois	15	Oregon	2
Indiana	3	Pennsylvania	1
Iowa	8	Rhode Island	1
Kansas	3	South Carolina	2
Kentucky	1	South Dakota	2
Louisiana	3	Tennessee	6
Maryland	1	Texas	10
Michigan	1	Virginia	3
Minnesota	2	Washington	3
Missouri	2	Wisconsin	1
		TOTAL	121

(6) winterization; (7) deodorization; and (8) plasticizing and packaging. Figure 42 illustrates a process flow diagram of a typical, full scale edible oils refining operation.

Storage and Handling: Crude fats and oils arrive at the refinery receiving area by tank truck or rail car and are pumped to a tank farm storage area. After use, the tank trucks and rail cars are systematically cleaned with steam or detergents. Tank car cleaning and the cleanup operations associated with the storage and handling areas constitute a major wastewater discharge from edible oil refineries.

Caustic Refining: There are in use today several edible oil plants which use the older methods of batch or "kettle" refining of crude vegetable oils. Sanders (30) reports that economics currently dictates the use of the continuous caustic refinery process which utilizes centrifuge separators for the maximum recovery of neutral oils. Figure 43 presents a simplified flow diagram of the caustic refinery process. The caustic refining process (also termed "saponification") is carried out by the chemical reactions of a triglyceride (fat) with sodium hydroxide at a temperature of 60°C (140°F) from one to five minutes. This chemical reaction is illustrated in Figure 44. Products of the reaction are alkali salts of the fatty acids whose esters formed glycerides and glycerine.

When the reaction is complete, the caustic solution is centrifuged to remove the neutral oils from the water solu[illegible] sludge or sodium soaps containing free fatty acids, proteins, c[illegible] bodies, and phospholipids. These extraneous materials are [illegible]only known as "foots" or "soapstock. The neutral, refined [illegible] are further processed by a water washing step to remove residual soa[illegible] [illegible]at could cause deterioration during later storage or processing. Wa[illegible]r usage for oil washing is about 10 to 15 percent by weight of oil.

The washed oil must be vacuum dried before storage. This operation contributes approximately two percent additional water by weight to the waste load. In addition, clean up operations such as wash-downs or tank cleaning produce periodic water waste loadings.

Soapstock Acidulation: The cc[illegible] [illegible]tely saponified foots or soapstock solution is cycled to an acidu[illegible] [illegible]n tank where excess sulfuric acid is added to yield free fatty acic[illegible] [illegible]t are recoverable for distillation purposes for the manufacture o[illegible] [illegible]tty acid derivatives. The reaction follows the general equation s[illegible]n in Figure 44.

During the processing of soapstock for fatty acid content, waste water is generated directly from the process itself. Acidulation of a basic soapstock-water mixture produces wastewater not only by neutralization but also frees water from the soapstock mixture. The end result with respect to waste load is an acid water with a pH of approximately

DRAFT

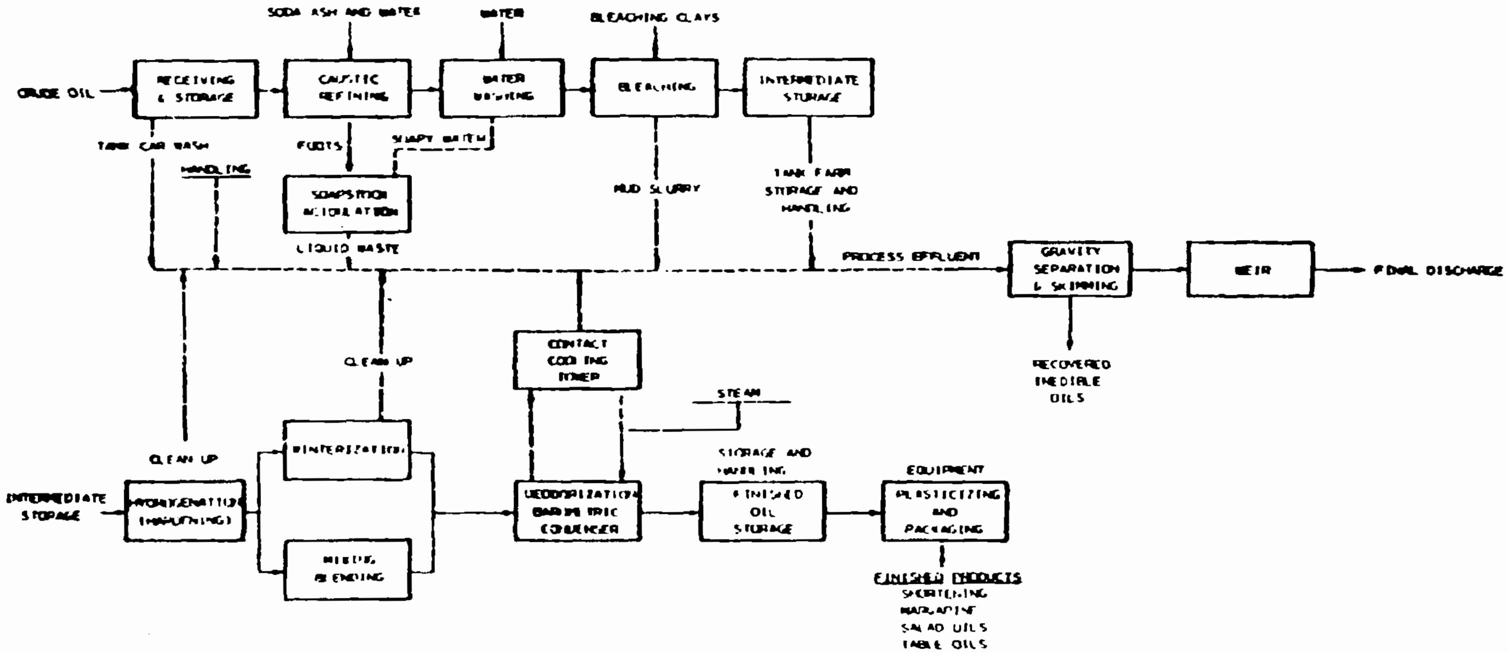


FIGURE 42

PROCESS FLOW DIAGRAM OF A TYPICAL
EDIBLE OIL REFINERY

DRAFT

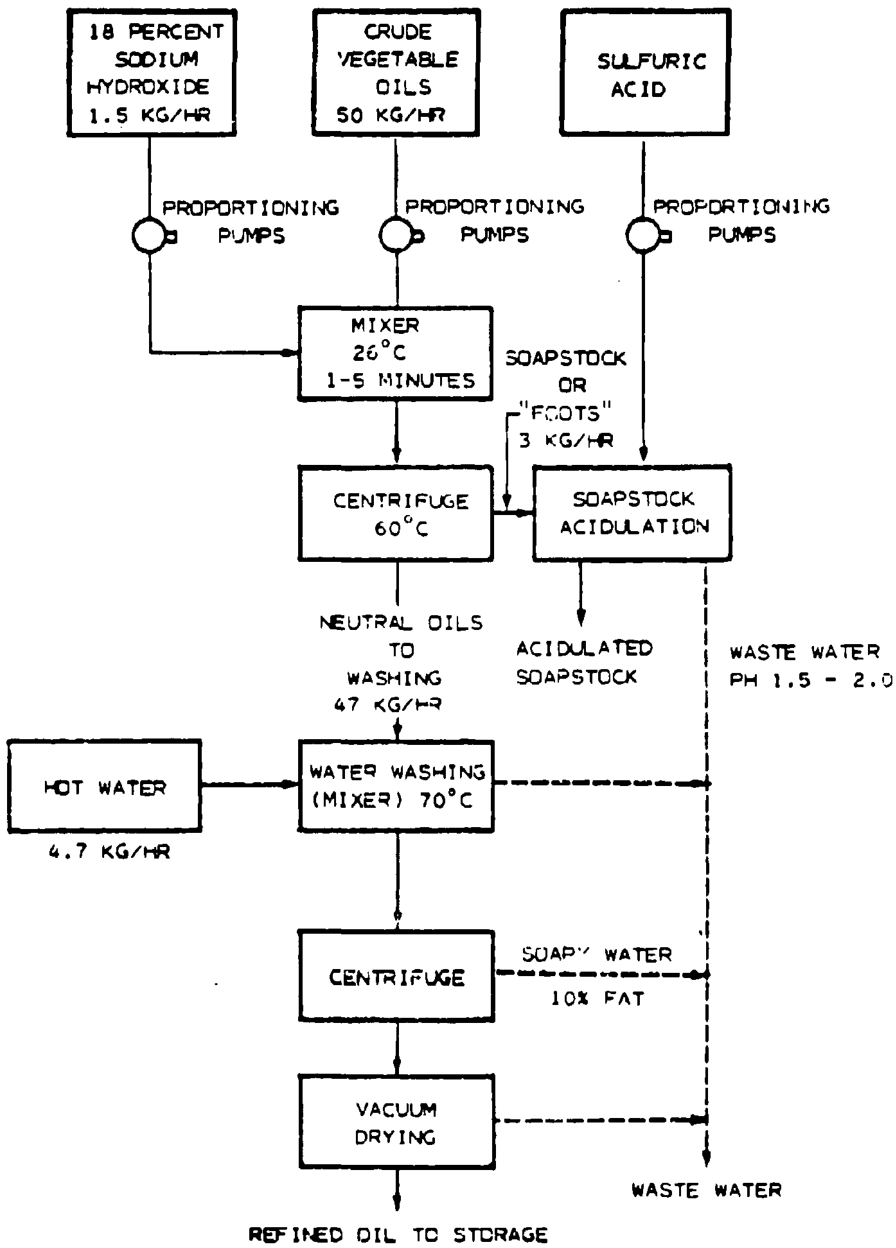
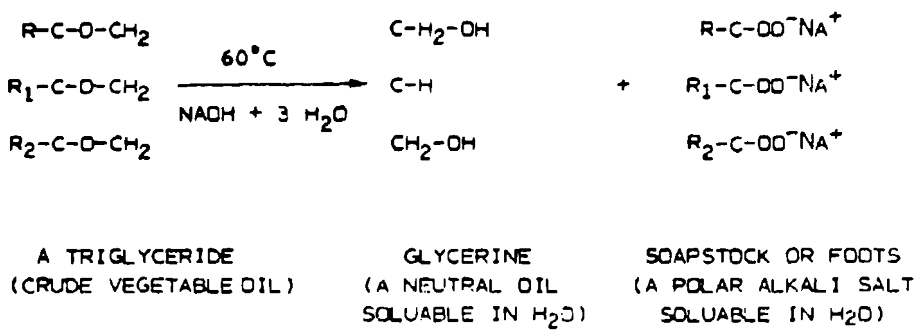


FIGURE 43

A SCHEMATIC DIAGRAM OF A CONTINUOUS PROCESS
FOR CAUSTIC REFINING AND RECOVERY OF ACIDULATION SOAPSTOCK

DRAFT

<u>CAUSTIC REFINING</u>



<u>ACIDULATION</u>

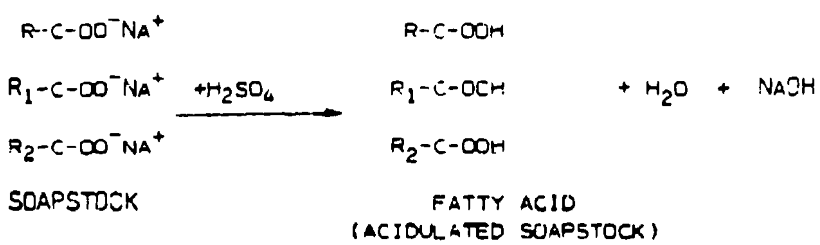


FIGURE 44

GENERAL CHEMICAL REACTIONS ASSOCIATED WITH THE CAUSTIC REFINING AND ACIDULATION PROCESSES

1.5 to 2.0. The total volume of water will amount to 65 to 75 percent, or less, of the soapstock treated. Water from cleanup produces periodic waste loading.

Bleaching: Bleaching of edible oils is usually accomplished by the adsorption process which consists primarily of the use of bleaching earth, both natural and activated. A number of refineries use activated carbon as a substitute adsorbent in place of bleaching earths.

United States refiners usually determine the colors of the lighter bleached oils and shortenings by matching a 13.3 cm (5.25 in.) column of the melted fat or oil against red and yellow Lovibond color glasses. For the darker colored oils a spectrophotometric method has been developed for the evaluation of oil colors. At the present time both methods are widely used.

The three bleaching methods commonly used are batch bleaching, continuous vacuum bleaching, and a newer development described as countercurrent vacuum bleaching. All bleaching processes are conducted under vacuum to protect the oil against oxidation. Some operators add the adsorbent, a bleaching clay such as Fuller's or diatomaceous earth, at the beginning of the heating period; others prefer to have the oil at the bleaching temperature (usually 103 to 134°C) before the adsorbent is added to facilitate dehydration. In bleaching most oils, the cost of the adsorbent is exceeded by that of the oil lost by retention in the spent adsorbent. After filtration, the oil is usually cooled to a temperature of 54 to [illegible]C (100 to 140°F) before being transferred to storage. Figure 45 [illegible]strates a simplified flow diagram of the bleaching process. After [illegible]ation, the spent filter cake material containing 25 to 40 percent [illegible] is usually discarded in either a dry or slurry form. It has not been [illegible]nomically feasible in the industry to attempt recovery of the entrained oil present in the spent filter cake. However, practices for the recovery of this oil have been developed by a few companies. The procedure calls for the spent filter cake to be subjected to a pressurized air flow for a few minutes until most of the free oil is displaced. Dry steam is then introduced into a press chamber from 30 to 45 minutes to remove the remaining oil. In some plants nitrogen is used in place of pressurized air. Acid-treated clays and activated carbon have a greater retention that neutral earth materials.

In the final analysis, the choice of an absorbent depends upon cost, activity, and oil retention. Bleaching dosages usually range from a low of 0.2 percent for lighter oils to a maximum of about 2.0 percent for darker oils.

DRAFT

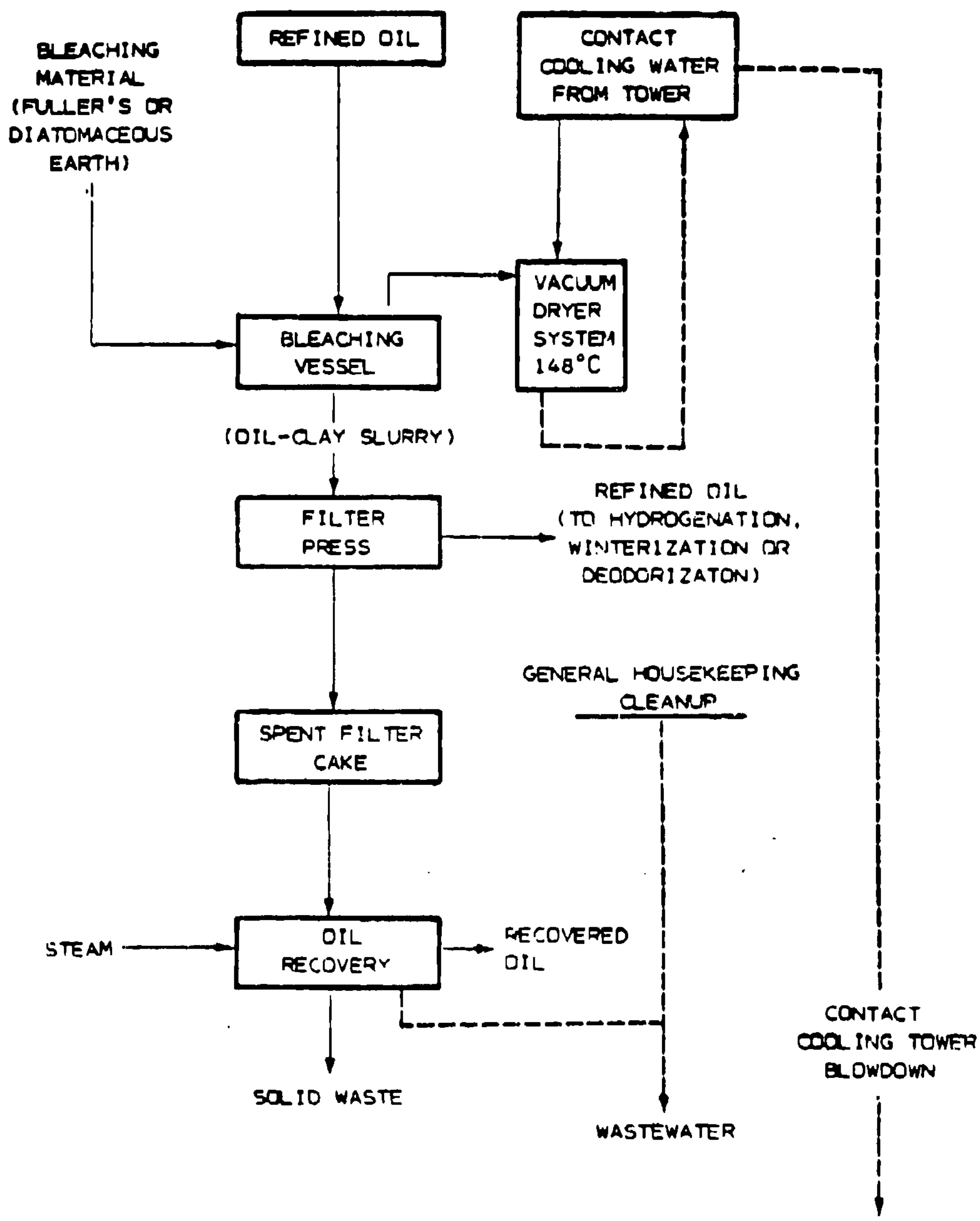


FIGURE 45

A SCHEMATIC DIAGRAM FOR BLEACHING REFINED OILS

Waste loadings from the bleaching process are identified as follows: (1) contact cooling water from barometric condenser systems; (2) liquid waste from the filter cake oil recovery operation; and (3) cleanup operations.

Hydrogenation: Hardening, or hydrogenation, of an edible fat consists of the direct addition of hydrogen to the carbon double bond of an unsaturated fatty acid chain. Primarily, hydrogenation is a means of converting liquid oils to semisolid, plastic fats suitable for shortening or margarine manufacture. It also enhances the stability as well as improving color. Figure 46 illustrates a simplified diagram of the hydrogenation process. The reaction requires a catalyst which consists of nickel in a finely divided form, prepared by special methods, and often supported on a highly porous, inert material, such as diatomaceous earth. The catalyst is suspended in the oil during hydrogenation, and at the conclusion is removed by filtration. Although catalysts decrease in activity with repeated use, a single charge may be used a number of times.

In the usual type of equipment, the hydrogenation reaction is brought about by agitating the suspension of catalyst and oil in a closed pressure vessel in an atmosphere of hydrogen. Agitation serves the double purpose of increasing the solubility of hydrogen in oil and renewing the oil at the catalyst surface. The rate of hydrogenation increases with increasing temperature and pressure. The composition and character of the hydrogenated product may vary according to the positions of the double bonds which are hydrogenated, as well as certain isomerizing influences accompanying the reaction, and are highly dependent upon the conditions of hydrogenation.

The hydrogenation process converts liquid oils to hard or "plastic" fats, it also improves the resistance of fats and oils to deterioration through oxidation or flavor reversion. The interchangeability among a wide variety of fats and oils is largely a result of the contribution of the hydrogenation process.

The only wastewater generated from hydrogenation process would be from periodic cleanup operations.

Winterization: The process called "Winterization", a term originating from the fact that initially the process was undertaken in outside storage tanks during the winter months, involves removing higher-melting glycerides from vegetable oils such as corn oil, soybean oil, and cottonseed oil. At the present time mechanical refrigeration is used to crystallize the higher-melting glycerides into a filterable mass. Oil is either batch or continuously pressed or centrifuged to remove the crystalline solids from the oil. Winterized oils are processed into a variety of finished products such as salad oils, and edible oils used in mayonnaise. Wastewater generation is primarily from general housekeeping cleanup. Figure 47 presents a flow diagram of the winterization process.

DRAFT

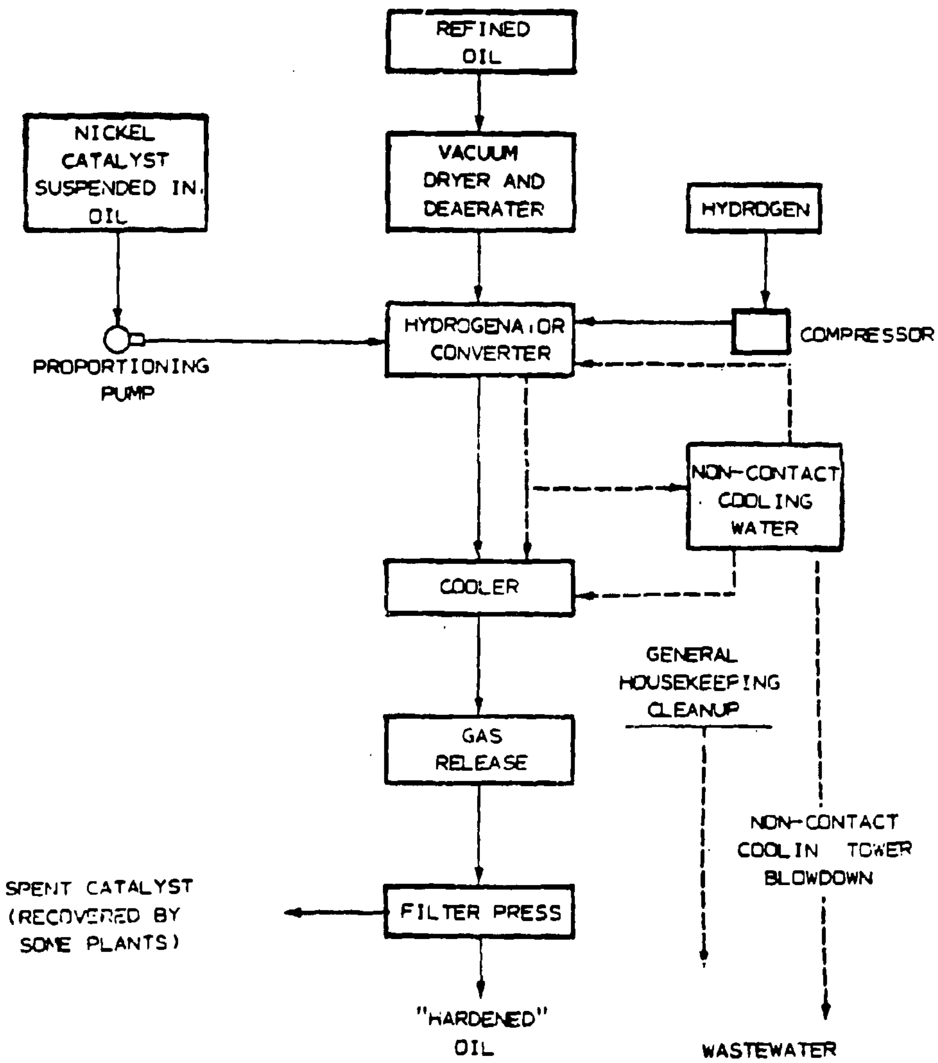


FIGURE 46

A SCHEMATIC DIAGRAM OF A CONTINUOUS HYDROGENATION PROCESS

DRAFT

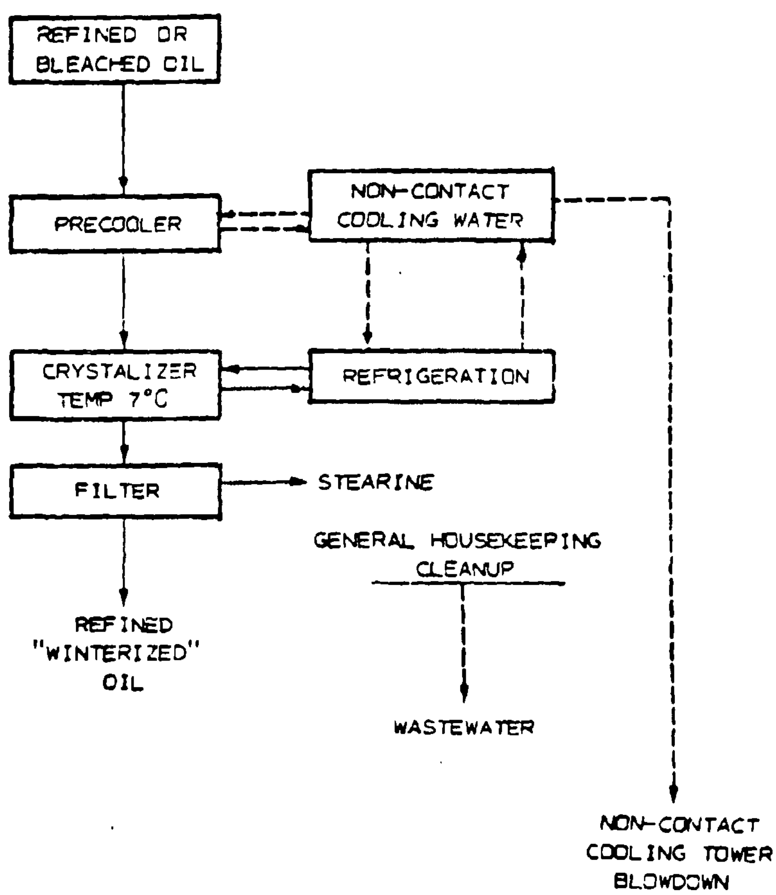


FIGURE 47

A SCHEMATIC DIAGRAM FOR A CONTINUOUS "WINTERIZATION" PROCESS

Deodorization: Edible oils are usually subjected to a steam distillation process known as deodorization. The purpose of this process is to remove odoriferous compounds and free fatty acids in order to produce an oil bland in flavor. Three types of deodorizing equipment are used: batch, semi-continuous, and continuous. In each, the principles are the same with the oil held in a vessel under vacuum using stripping steam to affect steam distillation of the volatiles. A vacuum is generally produced by condensing steam with water after the steam has been forced through a venturi. The condensing water is recirculated back to a cooling tower where heat is removed and returned to the condensing equipment for further use. Figure 48 presents a simplified flow diagram of the deodorization process. During the process, certain fatty materials are concentrated within the stripping steam and are removed by the barometric condenser water, where they are eventually deposited on the contact cooling tower grillage and in the tower basin. Therefore, the contact cooling tower presents periodic cleaning problems which are generally handled manually.

Distillate recovery systems in common use today reduce the rate of fatty material deposition at the cooling tower basin. Distillate recovery is based on a liquid oil spray condensing the fatty materials before they reach the barometric condenser. Recovery is on the order of 90 to 95 percent. The recovered distillate is collected in dry form and may be used or sold as a by-product. The reduction of distillate concentrations of organic matter to the contact cooling tower has several advanatages: (1) periods of manual cleanings are reduced; (2) cooling tower waste loadings are reduced; and (3) odor control is enhanced.

Food Emulsifier Operations: In addition to the previously described processes, several manufacturers also produce a variety of food emulsifier compounds. Production of edible food stuffs requires the use of an emulsifying agent in edible form. Items such as dressings, cakes, icings, etc. are improved by the ability of an emulsifier to hold an oil phase and a water phase in suspension. In the edible oils industry the production of food emulsifiers such as mono-and diglyceride compounds fulfills this need.

The production of mono-and diglycerides is a result of a chemical reaction in which excess free glycerine in the presence of a catalyst such as sodium hydroxide is added into a reaction vessel containing a suitable base oil (triglyceride). Under proper temperature and pressure conditions the fatty acids of the triglycerides and the hydrohyls of the glycerine exchange positions to produce a mixture of glycerine, monoglycerides, diglycerides, and triglycerides. At the end of the reaction, excess free glycerine is "stripped" off using a vacuum system employing an intercondenser to prevent contamination and loss of glycerine into the barometric condenser water. In many cases, however, some glycerine escapes into the condenser water posing a problem with waste loading at the contact water cooling tower.

DRAFT

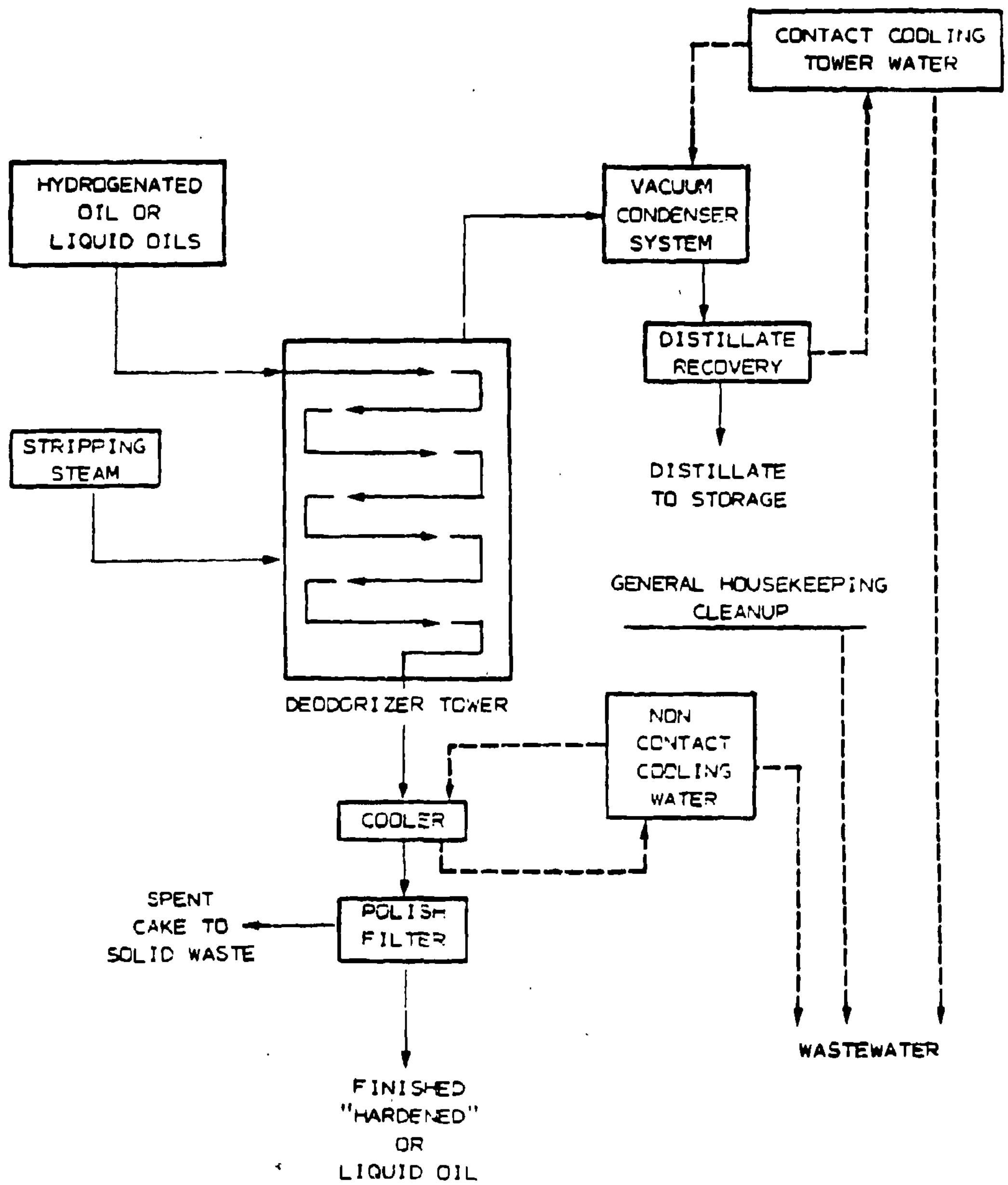


FIGURE 48

A SCHEMATIC DIAGRAM FOR EDIBLE OIL DEODORIZING

DRAFT

Plasticizing and Packaging: The plasticizing and packaging of refined, hydrogenated (hardened) edible oils into finished products such as shortening, margarine, or salad dressing are generally processed in the following manner. Sanders (30) summarizes the plasticizing process for shortening where the melted blend of refined edible oils are delivered from a feed tank through a high-pressure pump where nitrogen is added. The blend is then cooled to 18°C (64°F) in about 30 seconds and is worked gently from one to four minutes during which crystallization occurs. After crystallization is complete, the blend is allowed to undergo a sudden decrease in pressure to remove the free nitrogen. The blend (now shortening) is filled into either number 10 cans or 23 kg (50 lb) plastic lined boxes and is allowed to "set up" by storage at room temperature for 24 to 48 hours. Figure 49 illustrates a typical flow diagram for a plasticizing and packaging operation.

In general, the packaging of shortenings and other finished products employ strictly mechanical treatment of oils and their conversion from large bulk quantities into consumer or commercial sized packages. Consequently, the bearing these operations have on the waste loading of wastewater treatment facilities depends primarily on the cleanline[illegible] and efficiency of those operations. Cleaning operations, such as sal[illegible]l packaging, requires larger volumes of water and therefore, contri[illegible] more heavily to waste treatment than a more plastic product such as sh[illegible]ng.

Margarine production, because of the nature of the product and its ability to provide a growth medium for bacteria requires considerably more sanitation than does the production of shortening. Margarine is by law 80 percent oil and the remainder is water, milk solids, and salt. These ingredients are creamed and cooled for packaging. As in the packaging of shortening, general cleanliness has a direct relation to the waste load imposed. It differs, however, from shortening packaging in at least two respects: (1) the use of emulsifiers in the product may impose more severe problems with waste treatment; and (2) the volumes of water needed is increased due to the addition of margarine mixing equipment and the resulting necessity for cleaning. Figure 50 presents a typical flow diagram of margarine plasticizing and packaging operations.

The plasticizing and packaging of salad dressings and mayonnaise presents a variety of unique waste loading problems. Dressings are generally an emulsion of oils and other oil and water soluble ingredients such as certain vegetables and spices. These ingredients are blended and mechanically and chemically emulsified to produce a stable product. As in margarine, the production of salad dressings also supports the growth of certain pathogenic forms of bacteria. Consequently, CIP (Clean-in-Place) equipment is wide spread throughout the industry. The production of salad dressings and mayonnaise requires the use of food emulsifiers (mono- and diglycerides) as a basic ingredient. The high organic content of food emulsifiers coupled with their ability to exist in either an oil or a water phase creates a difficult if not unique waste loading problem for the industry.

DRAFT

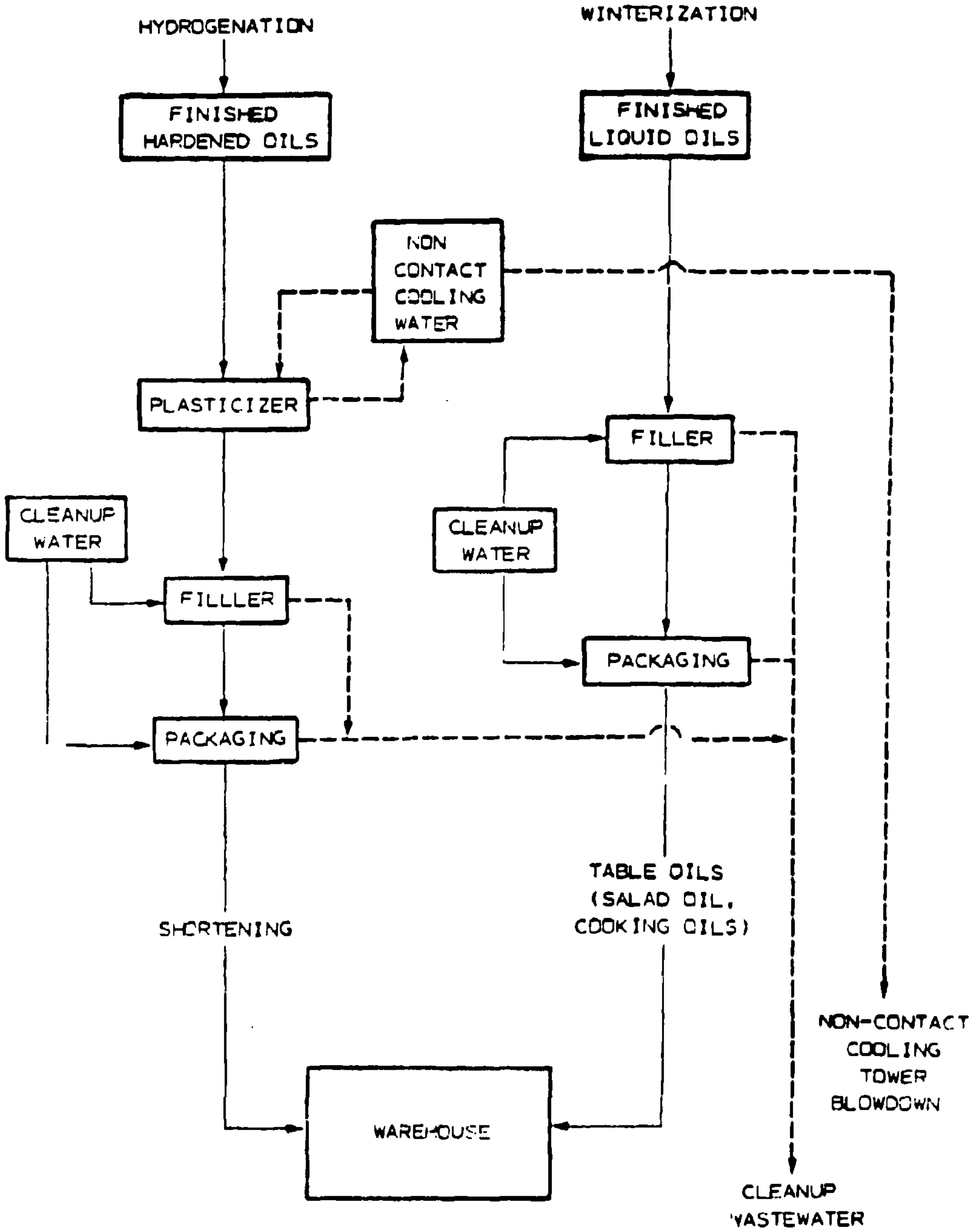


FIGURE 49

A SCHEMATIC DIAGRAM FOR EDIBLE OIL
REFINERY PLASTICIZING AND PACKAGING OPERATIONS

DRAFT

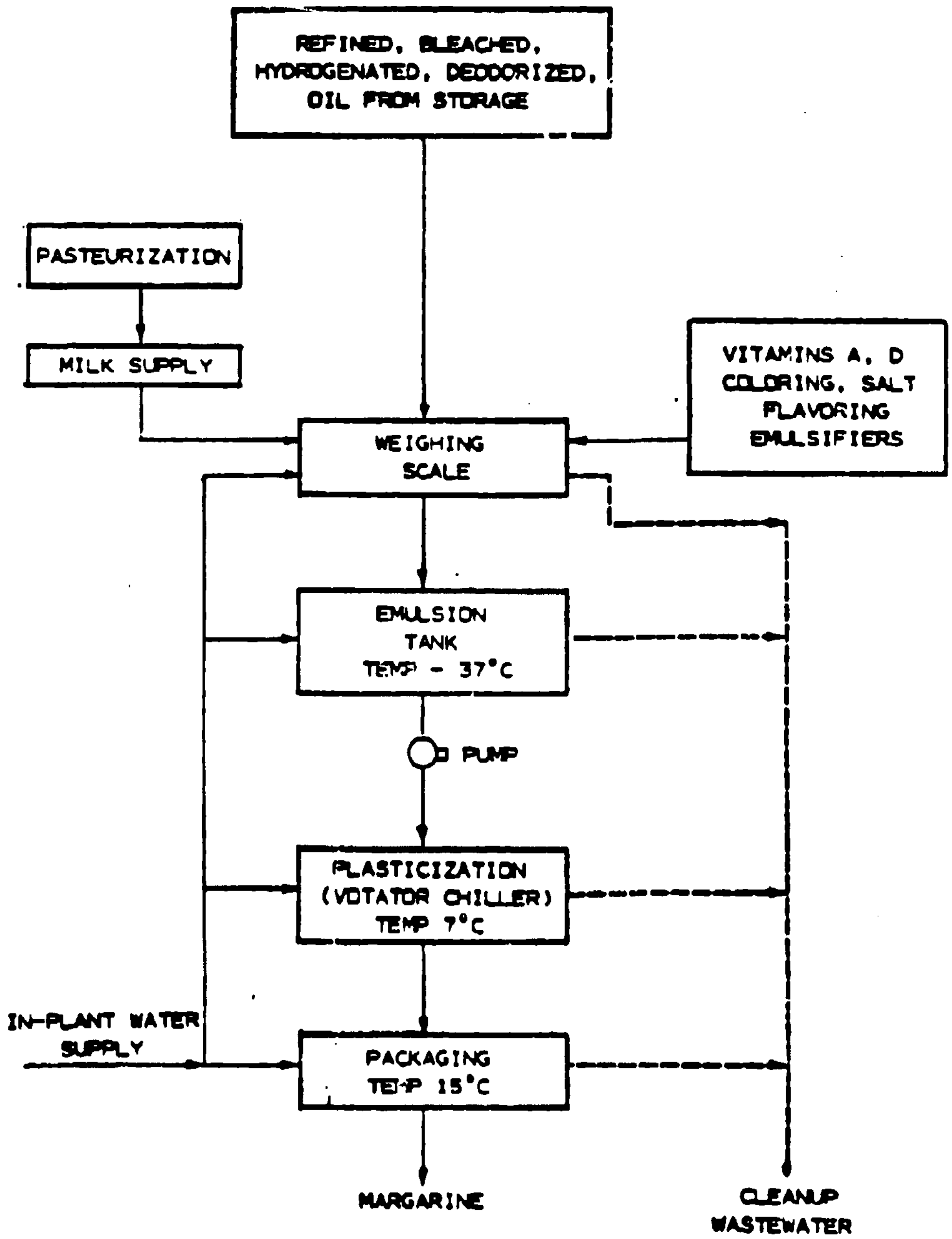


FIGURE 30

A SCHEMATIC DIAGRAM OF A CONTINUOUS MARGARINE PLASTICIZING AND PACKAGING OPERATION

DRAFT

SIC 2082 Malt Beverages

There are 104 breweries in the United States. According to the Modern Brewery Age Blue Book (31) the 1973 sales for these brewers was 16.2 billion liters (138 million barrels). The total value of shipments for 1974 was estimated by the Department of Commerce (32) at 48 billion dollars. There have been a considerable number of breweries constructed since 1950. In addition, many breweries constructed prior to 1950 have undergone major expansion. In general the past 15 years has seen the number of operating breweries decrease while the size of those operating has increased. It would appear that any breweries constructed in the future will be large and automated. As the 18 year old and over population group increases during the decade, the product shipments for the brewing industry are expected to grow accordingly.

Description of Process - The malt beverage industry produces beer, ale, and malt liquor by the fermentation of sugars converted from the starch of various grains. The basic unit processes include mashing, brewing, fermenting, aging and filtering, and packaging. In addition, some form of by-product recovery is practiced by all brewers. A simplified process flow diagram for a typical brewery is shown in Figure 51. It should be pointed out that every brewer and, in fact, every individual brewery, has features which make it unique. For the purpose of this description, only those process variables which affect wastewater generation will be discussed.

Mashing: Malt is ground and mixed with water in a mashing vessel. Rice, corn, and other grain derivatives are similarly ground and mixed, except that they are brought to a boil. The two mixtures are combined in the mash cooker, or "mash tun," where the starch from the grain is converted by enzyme action into malt sugar and the proteins are partly degraded into amino acids. Upon completion of mashing, the grains solids are separated from the extract by "lautering," by a plate and frame filter, or by a grain separator. The extract is sent to the brew kettle. Spent grains are sold wet or dried to produce marketable animal feed.

Wastes from the mashing process comprise an extremely small part of the total plant load. They are generated from intermittent clean-up of vessels and grain separators. In newer more fully automated plants vessel clean-up is accomplished by Clean-In-Place (CIP) equipment. This procedure involves an initial hot water rinse, caustic wash, and final rinse, with the initial and final rinses being sewered.

Brewing: Once the extract has reached the brew kettle it is boiled and mixed with hops or hop extract. This boiling destroys the enzymes while it extracts the resins from the hops which impart flavor and aroma to the beer. The hot extract, now called "wort," is passed through a hop separator

DRAFT

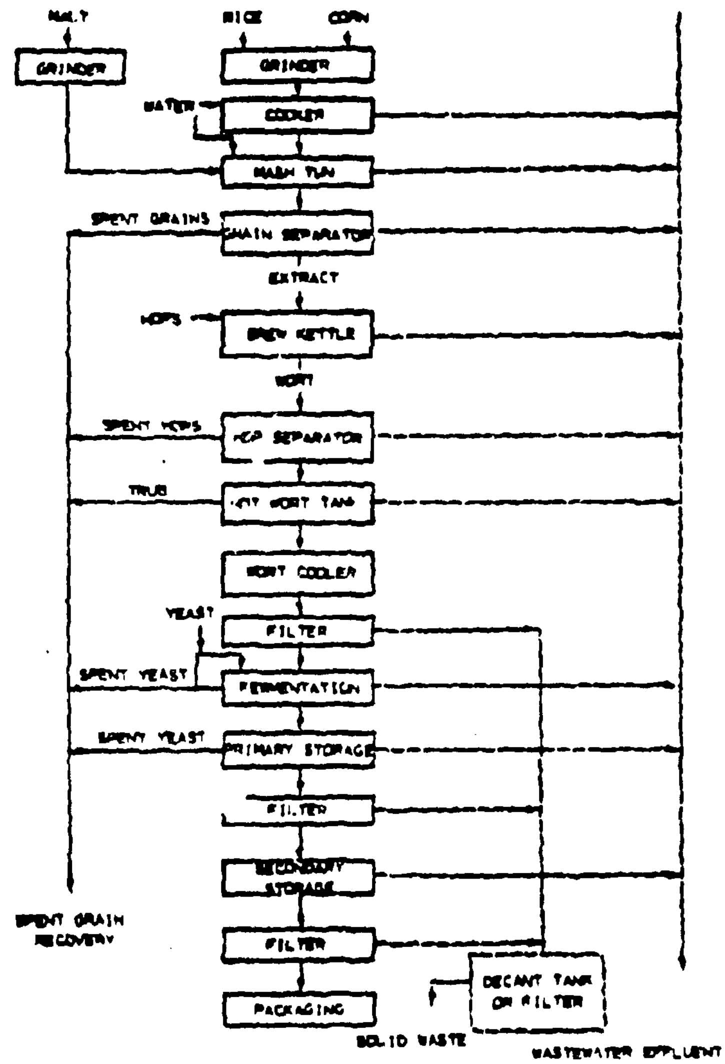


FIGURE 51

PROCESS FLOW DIAGRAM MALT BEVERAGE BREWERY

DRAFT

which screens out the spent hops. Insoluble materials which collected in the brew kettle, now known as "trub," are settled out either in the "hot wort tank" or after cooling. Normally the "wort" is then filtered with diatomaceous earth prior to fermentation.

Wastes from the brewing process are spent hops, trub, and filter residue. Spent hops and trub may be added to the spent grains or sewered. Filter wastes may be sewered or recovered separately from the spent grains. Diatomaceous earth waste is filtered to separate solids from the liquid waste. The liquid is then decanted and discharged while the solids are hauled to land disposal.

Fermenting, Aging, and Filtering: Yeast is added to the cooled wort in fermentation tanks to convert the malt sugar into alcohol and carbon dioxide. In addition, an excess of yeast is produced. About one-fourth of this yeast may be reused. The carbon dioxide gas may be vented to the atmosphere or reclaimed for other in-plant uses.

Most brewers pump the completely fermented beer into primary storage tanks. During this period additional yeasts and insoluble substances settle out. In some breweries the partially fermented beer is pumped to large tanks for a secondary fermentation and aging period. One variation of the process allows the yeast to collect in the aging tanks on a bed of beechwood chips. The chips must be cooked prior to their initial use. They are then removed and sterilized before being reused. After aging in primary storage the beer is chilled and filtered with diatomaceous earth or reusable pads before final storage. The beer is normally filtered again for clarity prior to packaging. Some brewers recarbonate at this time through the injection of carbon dioxide.

Wastes from fermentation, aging, and filtering include spent yeast and spent filter media. Yeast residue from fermentation may be sewered, added to spent grains, or in some cases evaporated. Filter cake may be [illegible]kwashed to decant tanks or to vacuum or pressure filters before discharge [illegible]r those brewers using the beechwood chip process, yeast is difficul[illegible] remove because of the large volume of wash water present. After[illegible] these brewers utilize an additional clarification step producing organic sludge which must be discharged.

Packaging: Malt Beverages are packed in cans, returnable and non-[illegible]urnable bottles, and returnable kegs. A packaging flow diagram is shown in Figure 52.

Kegs are returned containing some unused beer, which is normally discharged to the sewer. The kegs proceed to a washer with a prerinse, caustic, and final rinse spray cycle. The cleaned kegs are filled and manually corked. Since draught beer does not require pasteurization, the kegs are sent to cold storage while awaiting shipping.

DRAFT

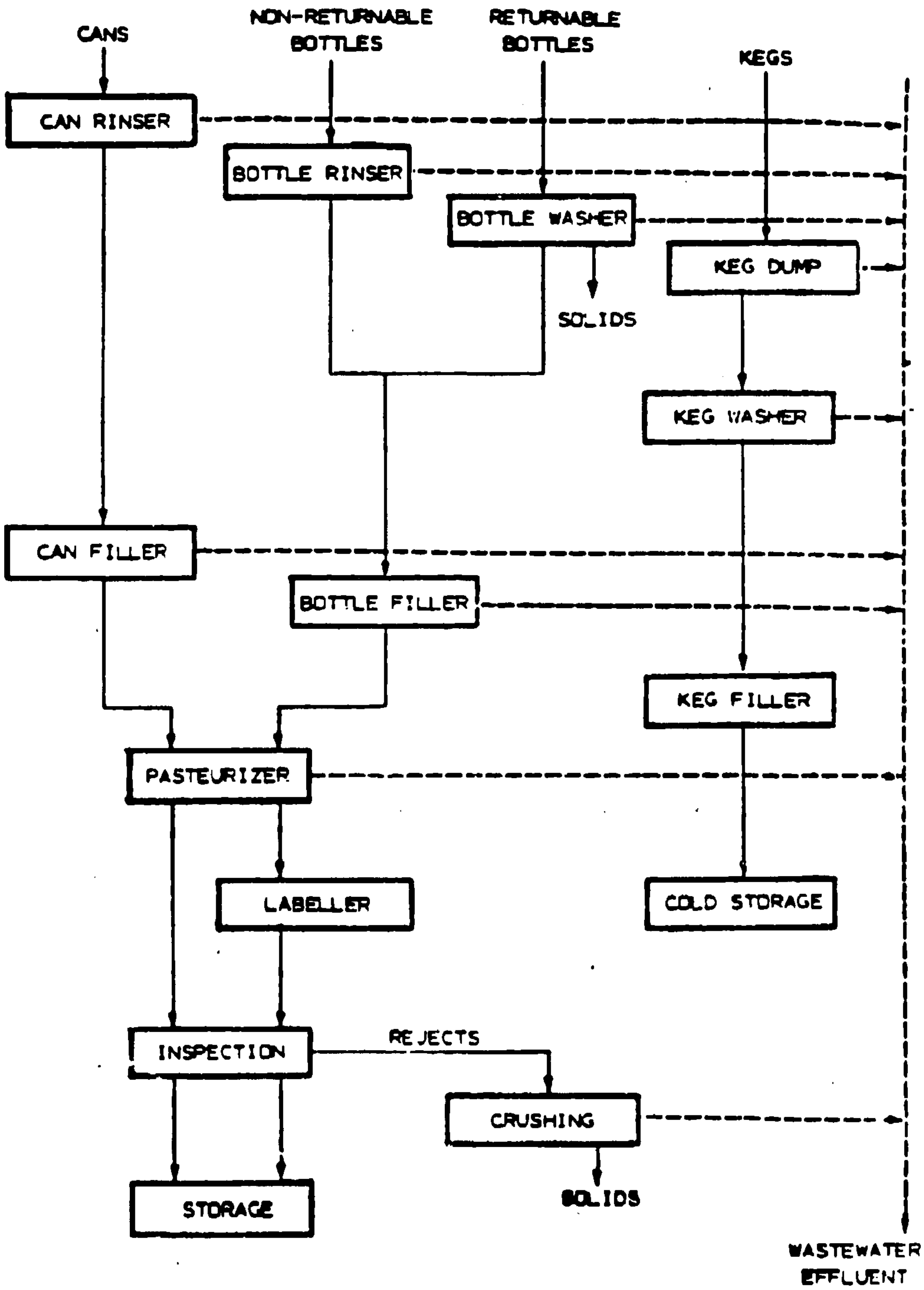


FIGURE 52

PACKAGING FLOW DIAGRAM MALT BEVERAGE BREWERY

Cans are rinsed with clean water to eliminate any dust particles which they have accumulated. During filling and seaming there is a beer loss due to the speed of the line and the configuration to the container. Canned beer is usually pasteurized, but it may instead be filtered with milipore filters or simply kept cold. The cans are inspected for proper product level and those rejected are crushed, thereby creating an additional beer loss.

Non-returnable bottles need only to be rinsed before filling. Returnable bottles, however, must be washed, cleaned, sterilized, and rinsed. Labels, unused product, and other refuse are removed from returnable bottles in a bottle washer. Basically the washers follow three steps: 1) prerinsing, in which both the inside and outside of the bottles are subjected to a hot spray; 2) soaking, in which the bottles are immersed in a hot caustic solution; and 3) final rinsing, in which caustic carry-over is removed in a fresh water rinse. The pre-rinse and final rinse are normally discharged. The bottles proceed to the bottle filler where there is some beer loss. Prior to shipment the bottles must be labelled and inspected and may be pasteurized.

Wastes from packaging are an important factor in total plant load. Beer loss is generated from keg dumps, bottle and can fillers, and compactors. These losses are normally sewered although the beer may be collected concentrated, and added to spent grains. Returnable bottle washers generate liquid and solid wastes, the solids being screened and hauled away and the liquids being sewered.

Spent Grain Recovery: Handling of spent grains from the mashing process follows one of the three following procedures: 1) spent grains may be sold wet at 80 to 90 percent moisture; 2) spent grains may be screened and pressed to remove as much moisture as possible, thereby producing spent grain liquor which must be discharged, and grains at 65 to 70 percent moisture then fed to gas fired rotary driers to produce animal feed; 3) the grains may be screened, pressed, and fed to gas fired driers while the spent grain liquor is concentrated in evaporators to a syrup (20 to 30 percent total solids) which is mixed with the dried grains. Spent hops, trub, and spent yeast may be added to the grains in any of the above procedures. In addition, a plant may have all the above capabilities and yet for economic reasons choose to sell all or some portion of these grains wet. A flow diagram for a typical spent grains recovery operation is shown in Figure 53.

Wastes from spent grain recovery form the principal part of the total plant load. If discharged, the spent grain liquor is the largest single waste source. If the spent grain liquor is recovered by concentration in evaporators, then the evaporator condensate is the major wastewater contributor. Multiple-effect, vertical tube evaporators are commonly used. Wet scrubber discharge and periodic cleaning of screens, presses, conveyors, and centrifuges will also contribute to the wasteload.

DRAFT

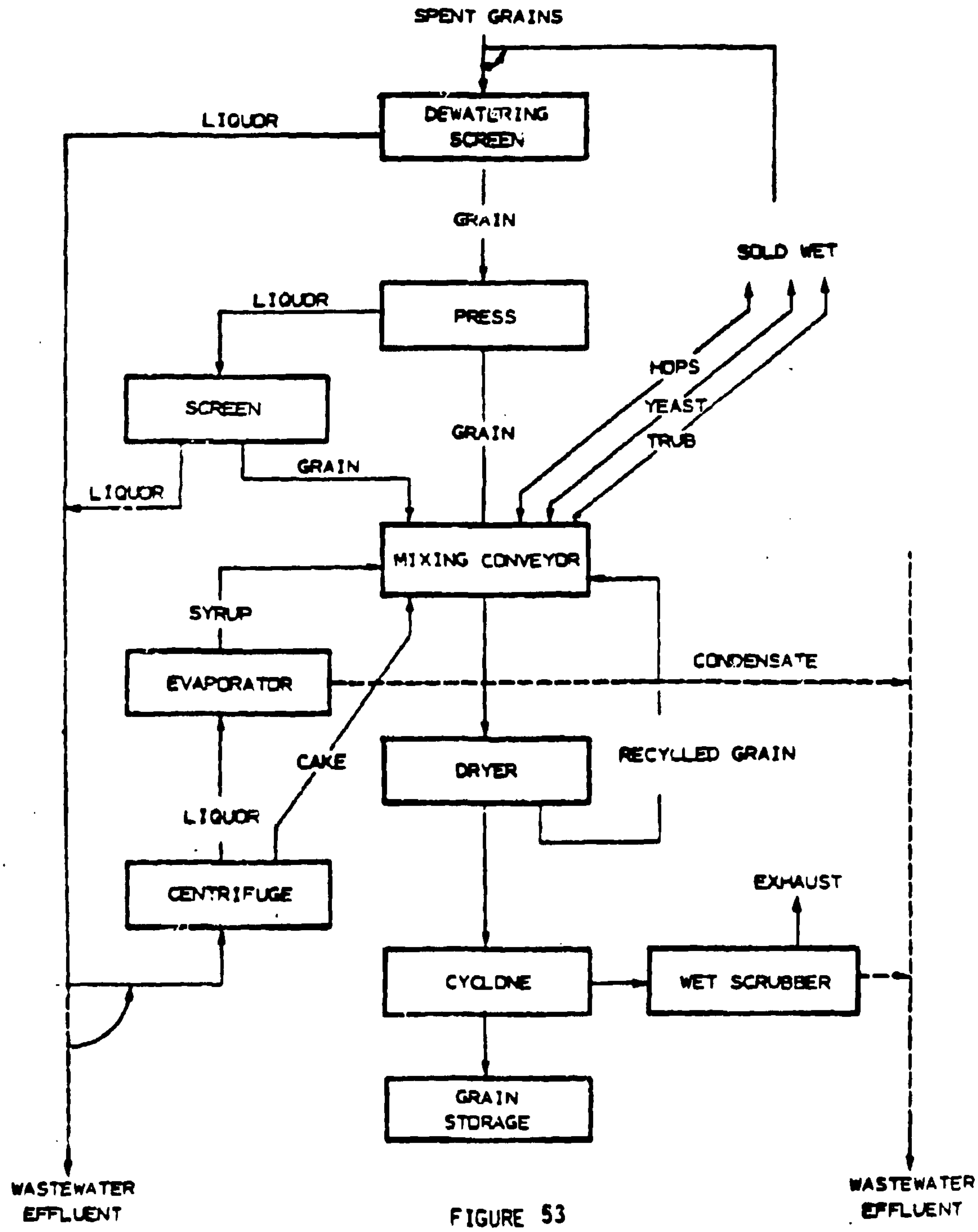


FIGURE 53

SPENT GRAINS RECOVERY MALT BEVERAGE BREWERY

SIC 2083 Malt

The malt industry consists of 29 malting companies located primarily in Wisconsin and Minnesota. Total annual production for 1973 was 128 million bushels (33). Of this total 119 million were used in the malt beverage industry, 4.14 million were used in the distilled spirits industry, and 3.5 million were exported.

Description of Process - Malt is a primary raw material for the processes of brewing and distilling. Fermentation depends upon the action of enzymes, and the purpose of malting barley is to produce those enzymes which bring about the eventual conversion of starch into fermentable sugars. Essentially the process of manufacturing malt from barley consists of steeping, germinating, and kilning. A flow diagram for the malting process is shown in Figure 54.

After preliminary cleaning and grading, barley is stored in grain bins. Differences in types of barley utilized relate primarily to kernal size, two common designations being two-row and six-row. Once the proper type of barley has been selected it is conveyed to the malt house for steeping. The barley is placed in large hopper-bottomed steep tanks where it is kept submerged in cool water for 40 to 72 hours. The purpose of this process is to impart moisture to the grain and to remove undesirable colors and tannins. This is accomplished by changing the water in the steep tanks three to four times while compressed air is bubbled through the mixture. The wastewater discharged during these changes forms the principal part of the total malt house load.

After steeping, the barley is transferred to germinating drums or compartments for a period of four to eight days. It is during this period that the formation of enzymes occurs along with the creation of heat and carbon dioxide. Temperature and humidity controlled air is forced through the malt while it is being turned. After a few days additional moisture is added to accelerate germination, usually by spraying. The portion of this water which is later drained from the germinating drums or compartments forms the second part of the total wastewater discharge.

The malt is now ready for kilning. During this procedure the malt is conveyed to drying floors where it is kept for three to four days. Furnaces under the floors provide controlled temperature conditions to dry the malt to the desired moisture content. The floors are normally situated vertically so that the malt may be dropped from level to level while the temperature is increased. Upon completion of drying the malt is stored or shipped.

The wastewater effluent from steeping and germinating is normally screened before final discharge. The solid by-product is generally sold as feed.

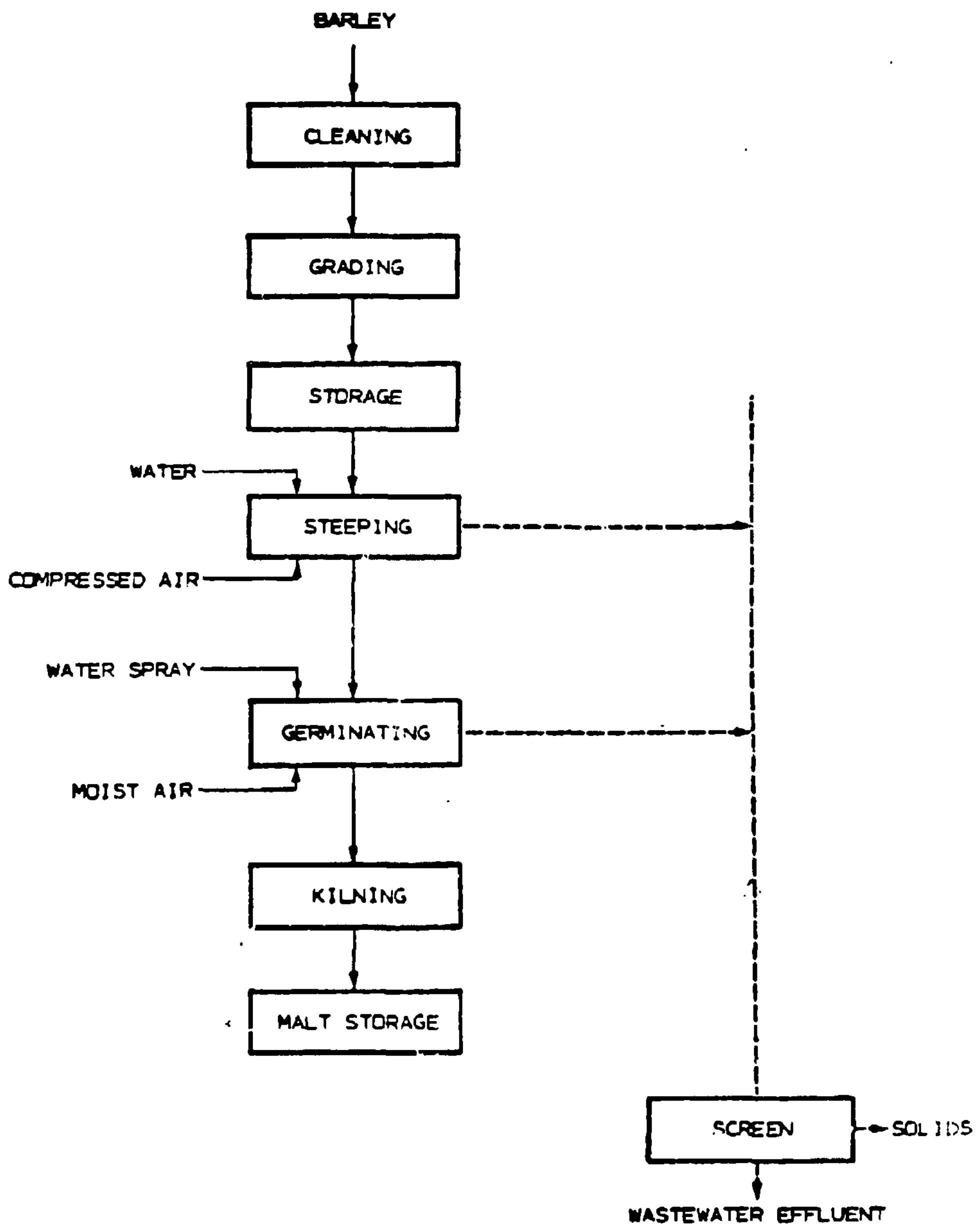


FIGURE 54

FLOW DIAGRAM MALTING PROCESS

DRAFT

SIC-2084 Wines, Brandy, and Brandy Spirits

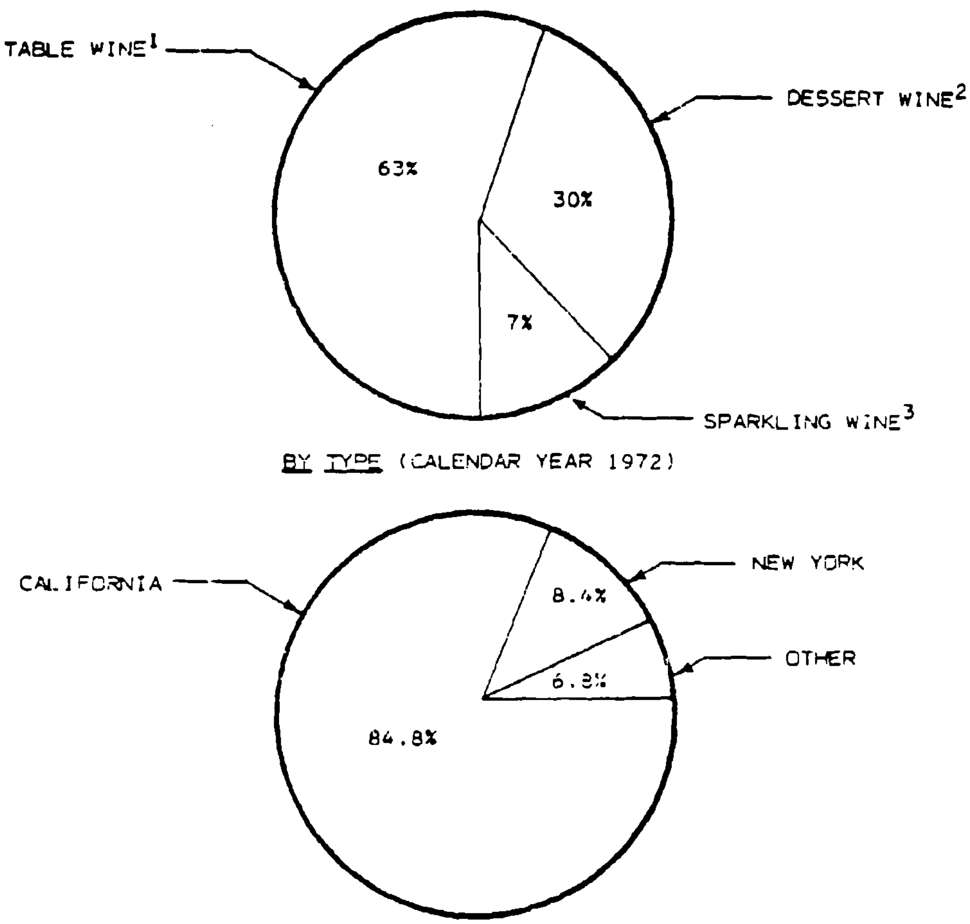
According to the Department of Commerce (32) there were 496 bonded wineries and wine cellars and 49 bottling houses in operation as of June 30, 1973. The total value of product shipments for these establishments in 1974 was estimated at $1.06 billion dollars, or about 14 percent of all alcoholic beverages. Total sales of wine in 1973 were 1.31 billion liters (347 million gallons). Of the total, California produced 69.6 percent, other states produced 14.5 percent, and 13.9 percent was imported. The distribution of U.S. produced wine by area and type, as reported by the Wine Advisory Board, (34) is shown in Figure 55.

Beverage brandy production in 1972 was 6.49 million proof gallons, almost all of which was grape brandy. Beverage brandy refers to those fruit spirits distilled under 170° proof. Neutral brandy refers to those spirits distilled between 170° and 190° proof. Wine spirits refers to those fruit spirits distilled over 170° proof. Thus, neutral brandy and wine spirits are not mutually exclusive classifications. In reporting the production, withdrawals or stocks of spirits between 170° and 190° to BATF, producers have the discretion of placing it in the classification neutral brandy or in the general classification "Alcohol and Spirits". This classification includes other than fruit spirits and since there is no breakdown of this classification in the BATF reports, the brandy component cannot be identified. Tax-free removals of spirits for addition to wines are reported. Removals under this classification would consist only of wine spirits. Removals under this classification in fiscal year 1972 totaled 24,419,000 proof gallons. Tax-free removals of "brandy" for ad tion to wine totaled 1,000,000 proof gallons. Most or all of this was produced in California.

The wine industry has maintained a growth rate which averaged 10.7 percent between 1967 and 1972. During the same period per capita consumption increased 57.1 percent to 6.12 liters (1.62 gallons). A major factor in this increase was the growth of the 21 to 44 age group--the group associated with higher levels of wine consumption--which will continue to increase during the 1970's.

Description of Process - The technology of wine making is comprehensively described by Amerine, Berg, and Creuss (35). For the purpose of this discussion emphasis will be placed only on those process variable directly affecting wastewater generation. Each and every winery has features which make it unique. The most conspicuous difference, however, in terms of wastewater effluent, is between those wineries which do not produce spirits by distillation and those which do. Table wines (including sparkling wines) are produced without the addition of wine spirits. Wineries producing these form a general classification. These wineries may also purchase wine spirits and produce dessert wines. The second classification includes wineries which produce table wines and dessert

DRAFT



BY AREA (FISCAL YEAR 1972)

[1] INCLUDES TABLE WINE AND OTHER SPECIAL NATURAL STILL WINE NOT OVER 14 PERCENT ALCOHOL BY VOLUME.

[2] INCLUDES DESSERT WINE, VERMOUTH AND OTHER SPECIAL NATURAL STILL WINE OVER 14 PERCENT ALCOHOL BY VOLUME.

[3] INCLUDES ALL NATURALLY FERMENTED AND ARTIFICALLY CARBONATED SPARKLING WINES. OTHER SPECIAL NATURAL SPARKLING WINES ARE INCLUDED.

FIGURE 55

DISTRIBUTION OF U.S. WINE PRODUCTION 1972 wines, but which also produce wine spirits for addition to dessert wines and/or brandy. It should be noted that wineries in the eastern part of the U.S. produce only table wines or if they produce dessert wines, purchase wine spirits for the addition to dessert wines. In either case they do not maintain stills. Those wineries producing wine spirits are located solely in California, and, for the most part, in the San Joaquin Valley. For this reason the process description will be divided into two sections: wineries without stills, and wineries with stills.

Wineries Without Stills: Products from these wineries are red and white wines, sparkling wines and dessert wines using wine spirits purchased elsewhere. The basic unit processes common to these wineries are: crushing and destemming, pressing (procedure varies), fermenting, clarification, aging, and bottling. In addition, all wineries are faced with distinct seasonal variations, as are most agricultural food industries. During the grape crushing season, which lasts approximately six to eight weeks in September and October, all the fermentable material must be fermented. Finishing operations, however, are carried on throughout the year, thereby creating differing problems in wastewater disposal.

A process flow diagram for the production of red table wine without recovery of distilling material is shown in Figure 56. After picking, the grapes are placed in containers and transported to the winery where they are weighed and dumped into a crusher/stemmer. There are three types in use: the roller, disintegrator, or Garolla. The Garolla is the only type from which the stems and leaves are removed. The juice, skins, and seed, now known as "must," are pumped to fermentation vats. Wastes from crushing and destemming consist of periodic wash downs of the crusher/stemmer, which are sewered, and stems, which are normally spread on vineyard property.

Fermentation is preceeded by the addition of a small amount of sulfur dioxide to the must, thereby inhibiting the growth of wild yeast or bacteria. With the addition of a pure yeast "starter" the fermentation process is initiated and the grape sugars are converted into nearly equal parts of alcohol and carbon dioxide. Considerable heat is generated and the vats must be cooled to maintain optimum fermenting conditions. When the fermenting must has attained the desired amount of color and tannin, then it is drawn off the pomace as "free-run" juice and pumped to a finishing tank where fermentation may be processed to completion. The pomace is pressed to extract any remaining liquid. The resulting press-run may be used for the production of less expensive wines or it may be recombined with the "free-run". The pomace is hauled and spread in the vineyards or dried and sold as feed for poultry. Usually within six weeks after crushing the fermentation is complete. The liquid, now called wine, is decanted or "racked" off the sediment of yeast pulp and tartarates known as "lees". This procedure may take place three or four times. Additional wine may be recovered by passing the lees through a centrifuge or filter. The sulfur dioxide content is normally

DRAFT

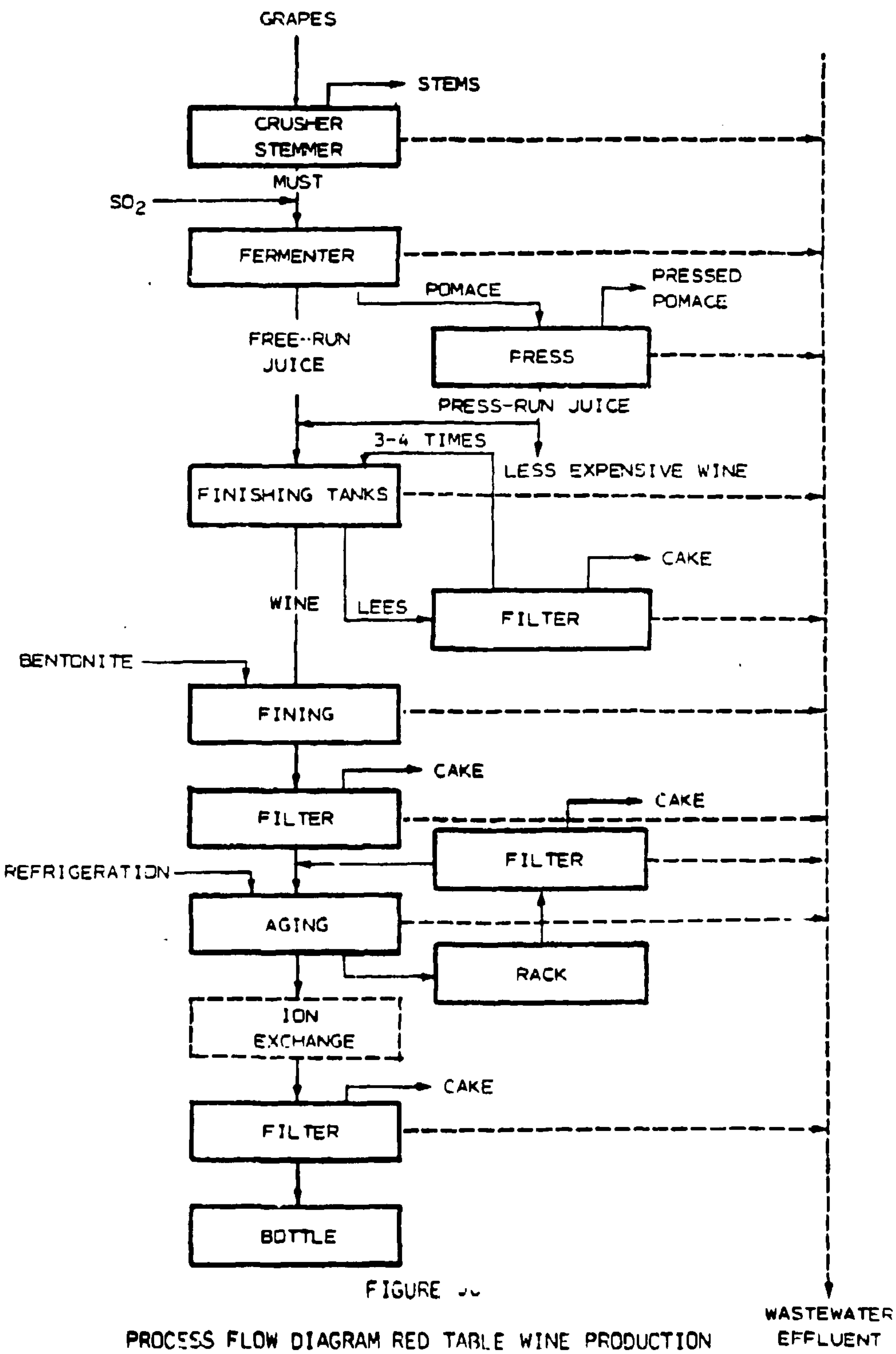


FIGURE ..

PROCESS FLOW DIAGRAM RED TABLE WINE PRODUCTION WITHOUT RECOVERY OF DISTILLING MATERIAL adjusted at this time. Wastewater from fermentation is generated from wash downs of fermenters, finishing tanks, pomace presses, and lees filters . Pressed pomace and lees filter cake are normally hauled and spread in the vineyards.

The wine may now undergo a series of "finishing" operations which vary from winery to winery. After the first racking a fining agent such as bentonite clay may be mixed with the wine to encourage the settling of suspended and colloidal materials. This step would normally be followed by filtration with filters or plant and frame presses. The wine must now be aged. This may be done in wooden, stainless steel, or concrete containers of various sizes. During aging wine is normally refrigerated to hasten the precipitation of tartarates which might be desposited after bottling. Since refrigeration is expensive the use of ion exchange resins as an alternative has come into limited practice. In this process potassium and calcium ions are replaced with sodium or hydrogen ions. Additional racking, filtration, fining, and centrifugation may be utilized to further clarify the wine. Uniformity of quality and character are maintained by analyzing and blending the wine. In every case a polishing filtration is customary shortly before bottling to insure that the wine is perfectly clear. Wastes from finishing operations consist of lees from fining vats, centrifuges, and aging containers. Cake from filters is hauled and spread in the vineyards.

Bottling, labeling, and casing are the final operations. Most wineries find it more practical to bottle their own wines, although wine may be shipped in tank cars to plants where the only operation is bottling. The bottles are filled and corked under sterile conditions. There is little spillage involved except in the case of breakage. The wine is inspected for clarity prior to labeling and casing, and this operation for the most part, is entirely automated.

Figure 57 shows a process flow diagram for the production of white table wine without the recovery of distilling material. Both white and red table wine production normally occur in any one winery but the processing operations are different. The white wines are not fermented in the presence of the skins as are the red wines. As a result the tannin and extract content are lower. It should be noted that either white or red grapes can be used for the crush. The must from the crusher is allowed to separate so that the free-run juice may be obtained. It is then sent to a press, which is most often of cylindrical design, and the remaining juice is collected. The pressed pomace, which still contains some sugar, is hauled and spread in the vineyards. The press-run is normally utilized for the production of less expensive wine. The free-run is sent to fermentation and innoculated with pure yeast. From this point on the wastewater discharge is similar to that of red wine production.

DRAFT

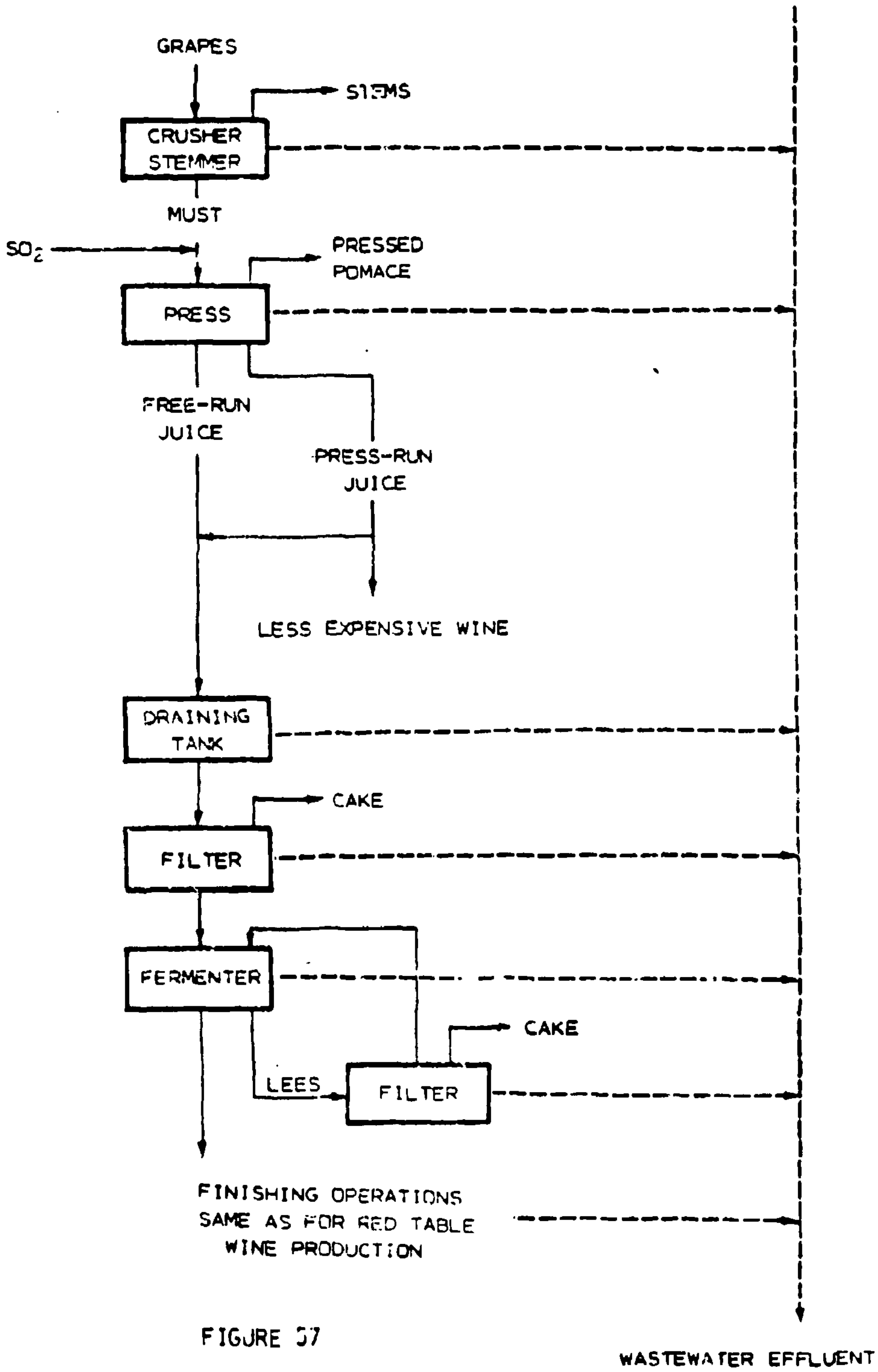


FIGURE 37

PROCESS FLOW DIAGRAM WHITE TABLE WINE PRODUCTION WITHOUT RECOVERY OF DISTILLING MATERIAL

Figure 58 shows a process flow diagram for the production of sparkling wine. These may be defined as wines which have more than 1.5 atmosphere pressure at 10°C (50°F). Although there are several methods for the production of sparkling wines the most common involves the addition of sugar and yeast to cause a "secondary fermentation" of wine in a closed container. A common example of one type of sparkling wine is what is known as champagne. To a properly selected and blended wine or "cuvee", sugar and yeast are added. The moisture is placed in bottles or tanks for fermentation and storage. After an appropriate time interval the bottles are "disgorged" or the liquid "transferred" temporarily from bottle to storage. This procedure allows the removal of yeast which has accumulated in the bottle. The transferred wine is filtered, placed back in the bottle, and cased for storage. If the "bulk" or tank process is used then two tanks are employed with interconnecting filtration. Upon transfer of the fermented wine to the second tank the wine is bottled. Wastes from sparkling wine production consist of mixing tank cleanup and yeast from filtration of fermented wine.

Figure 59 shows a process flow diagram for the production of dessert wine. These wines contain more than 14 percent alcohol due to the addition of fortified spirits. Common examples of this process are white dessert wine, port or other red dessert wine, and sherry. Fermentation is allowed to proceed to a specified sugar level. The wine is pumped to fortifying tanks for the addition of wine spirits. Fortified wine for sherry production may be baked or aged shermat blended with submerged culture of flor sherry. Fining, filtering, and aging procedures follow as previously discussed. Wastes from the production of dessert wine are substantially the same as those from the production of table wines. Since the two operations normally take place on the same premises, the load represents and addition in terms of vessels required for fortifying, baking, and storage, and in terms of the associated filtration and wash downs necessary.

Figure 60 shows a process flow diagram for an eastern winery producing table, dessert, and sparkling wines. Several basic differences in eastern and western wineries are apparent. The grapes from the east are the V. labrusca which are lower in sugar content and higher in acidity than the V. vinifera grown in California. Preparation for fermentation generally involves pressing. Grapes for white wines are cold pressed as they come from the stemmer/crusher. For this pressing many continuous and bladder models are being used. Grapes for red wines are "hot pressed", i.e. the pulp is heated prior to the loading the press. Amelioration of up to 35 percent by the addition of dextrose may be required prior to the fermentation due to the high acidity and low sugar content of the juice. In addition, if hot pressing was used, the juice must be cooled before fermentation starts. After fermentation it is common practice to blend in up to 25 percent of California wines. Eastern sherry wines are made by fortifying finished wines and then baking by the Tressler method. This consists of heating while oxygen is released slowly in the wine. Another method involves allowing the sherry to age in oak barrels.

DRAFT

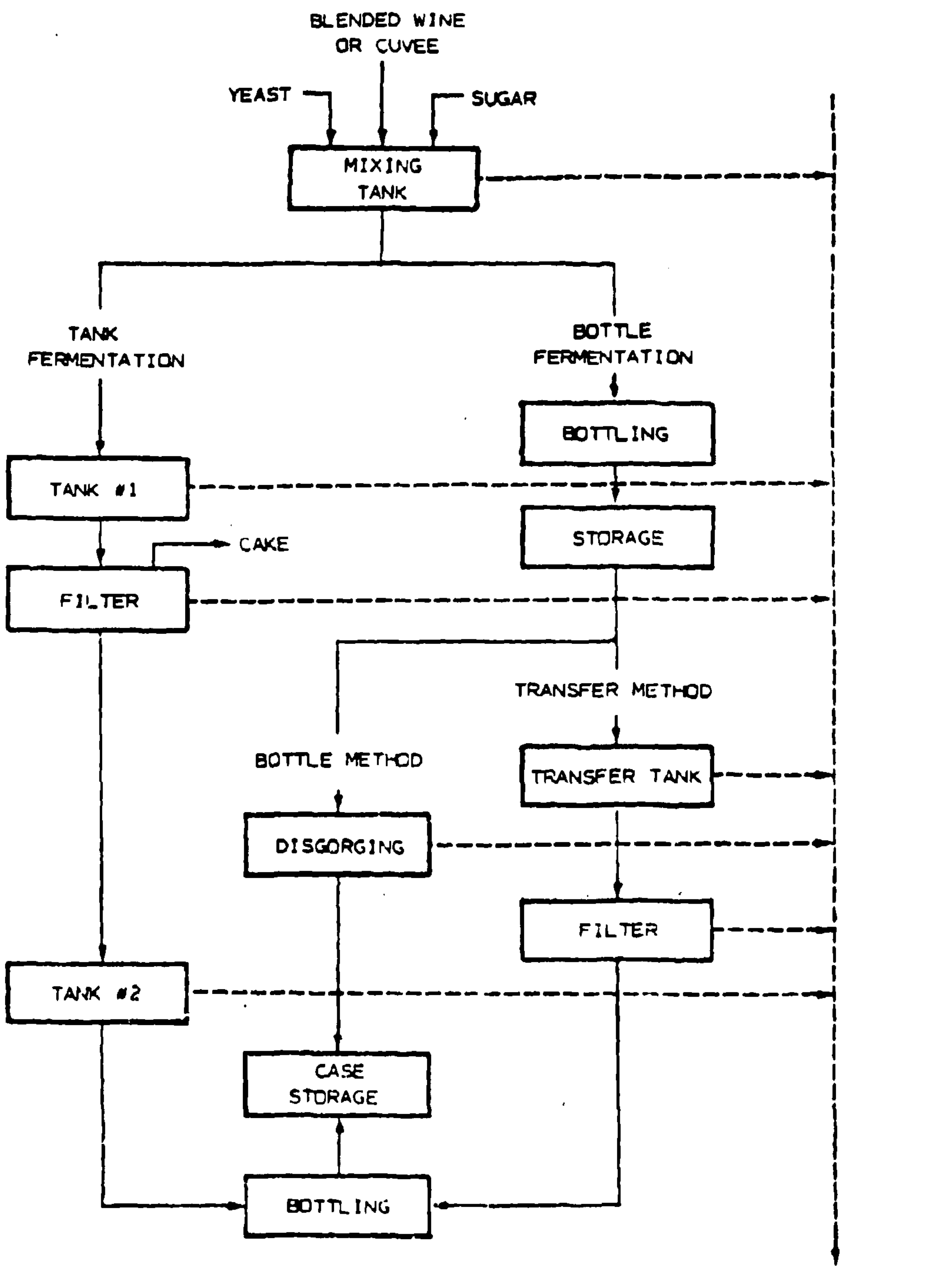


FIGURE 38

PROCESS FLOW DIAGRAM SPARKLING WINE PRODUCTION

DRAFT

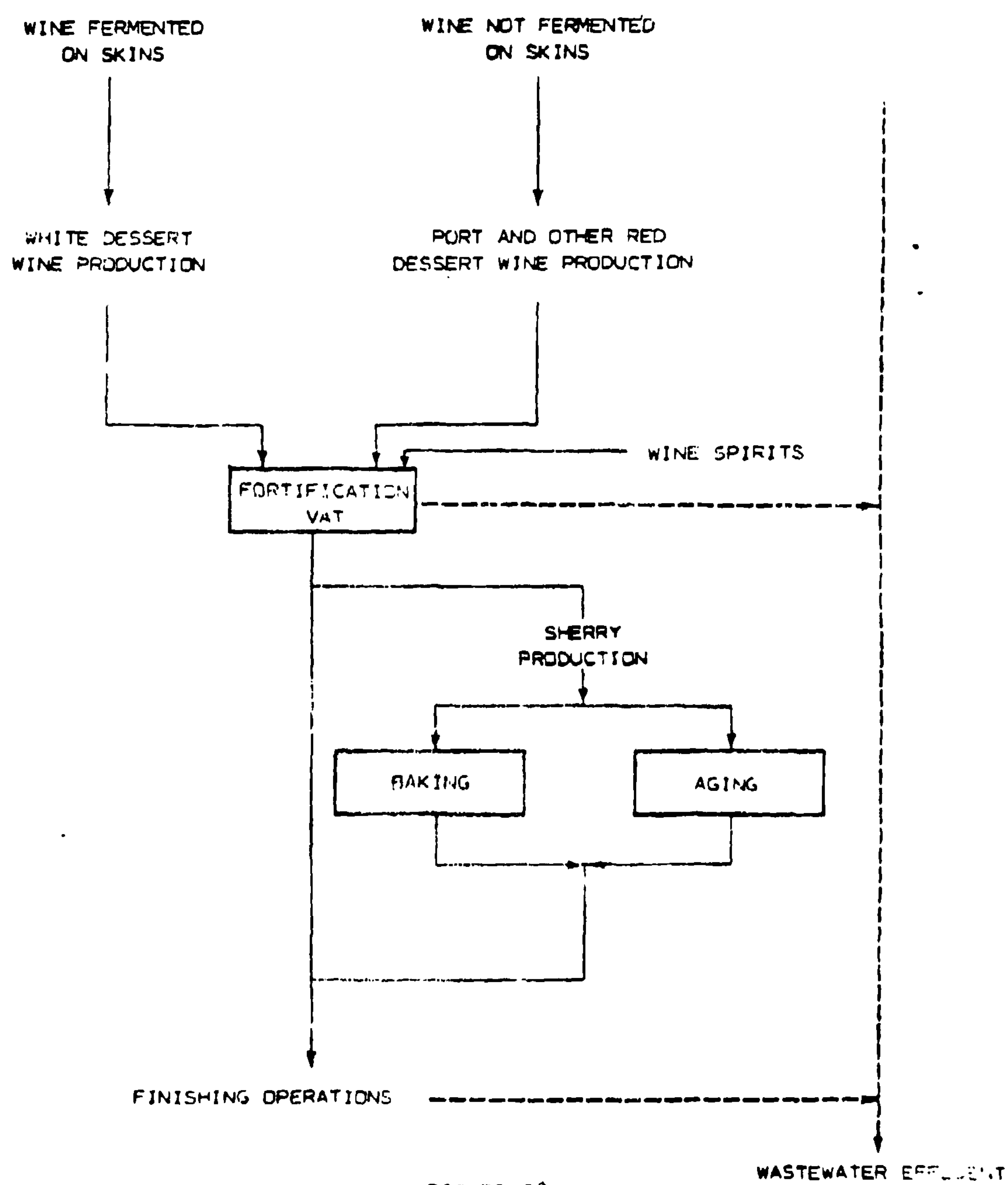


FIGURE 5?

PROCESS FLOW DIAGRAM DESSERT WINE PRODUCTION

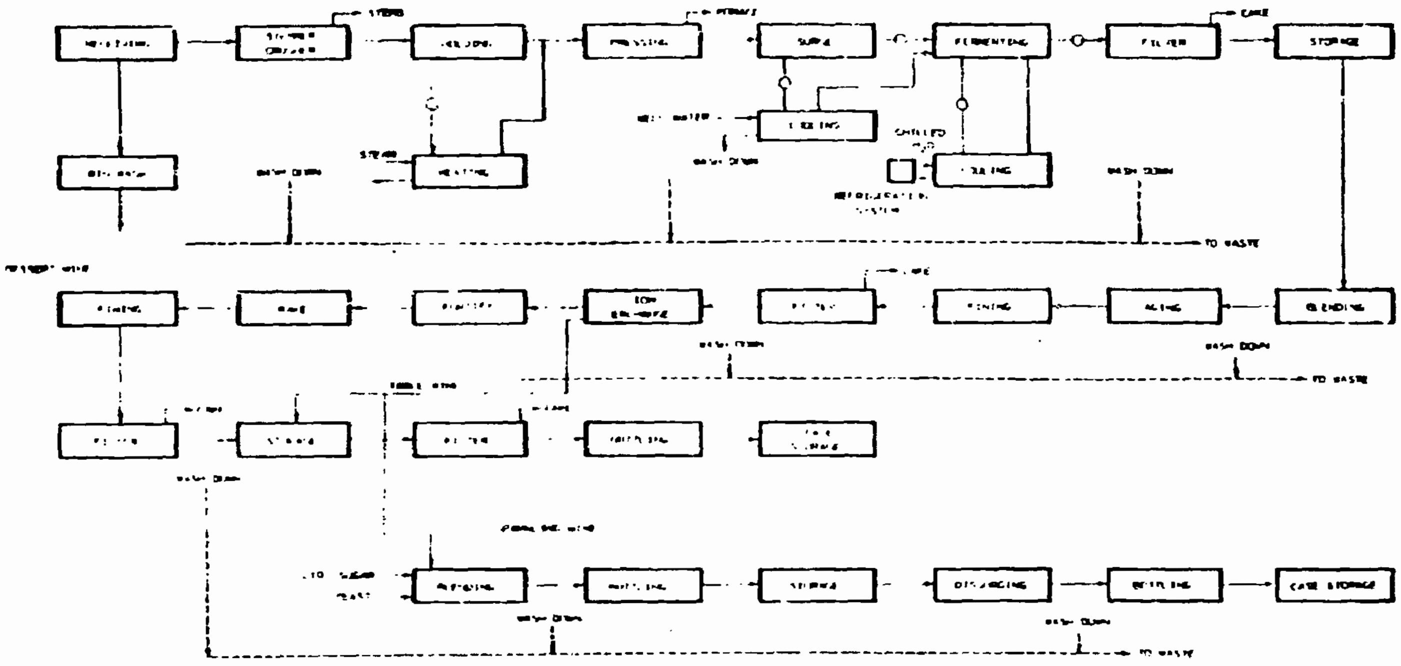


FIGURE 60

PROCESS FLOW DIAGRAM
EASTERN U.S. WINERY OPERATIONS

Sparkling wine production is bottle rather than tank fermented and normally employs the transfer system to clear the bottle of yeast deposits. Wastewater from eastern wineries is generated in a manner similar to that in western wineries without stills. (For further discussion of wastewater per unit of production see Wastewater Characteristics, Section V).

Wineries With Stills: Wineries with stills may produce all of the aforementioned wines in addition to beverage brandy and wine spirits. A process flow diagram for such a winery with complete recovery of distilling material is shown in Figure 61 . Only the best wine is used for the production of beverage brandy, whereas wine spirits or fortifying brandy is made from recovered distilling material.

Beverage brandy is produced from the distillation of wine and normally takes place in a continuous column still. Indirect heat or steam introduced at the bottom of stripper evaporates the alcohol from the wine which is introduced near the top of the column in the counter current. The vapor leaving the top of the still is condensed to form the spirit. The de-alcoholized residue, known as "stillage", is discharged from the base of the column. The beverage brandy as it leaves the still is at 170° proof or less. Additional columns may be added at this time to remove the higher alcohols (principally amyl alcohol) which comprise the fusel oil content of brandy. Removal of aldehydes is also practiced by the addition of an aldehyde column. Since the aldehydes (chiefly acetaldehyde) have a low boiling point they are taken off the top of the column and the product off the bottom of the aldehyde column. The brandy is then reduced in proof, aged in wood, and bottled.

Fortifying brandy is made by a similar process but by the use of distilling material such as lees, filter wash, pomace wash, unmarketable standard wine, and other wine residues. The final product, either wine spirits or neutral brandy, is distilled from 140° to 190° proof and sold as such.

A major part of the wastewater from wineries with stills is derived from stillage. Since the distillation process depends upon grape crushing for its raw mate ial (i.e., either newly fermented wine or distilling material) the distilling season and stillage generation roughly parallel the crushing season. During this time period those California wineries with stills use a land disposal system for stillage wastes. This entails pumping the stillage into shallow "checks" or ponds of not more than 0.10m (four inches) depth for evaporation and percolation. Enough land is required for separate checks to accomodate at least 7 to 10 days of stillage volume, at which time the original check may be reused after having dried and being desced.

DRAFT

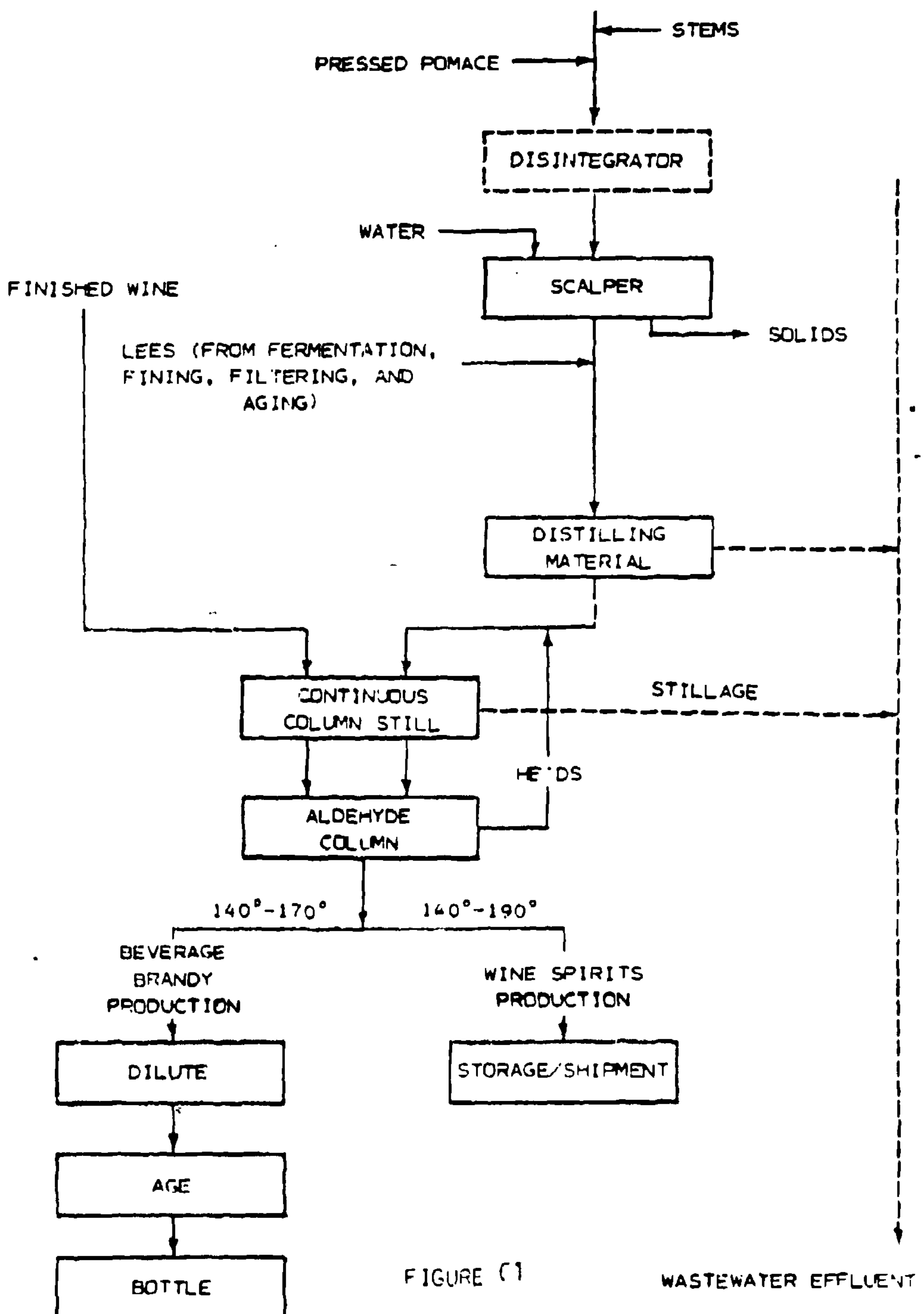


FIGURE C1

PROCESS FLOW DIAGRAM
BEVERAGE BRANDY AND WINE SPIRITS PRODUCTION WITH
COMPLETE RECOVERY OF DISTILLING MATERIAL

DRAFT

SIC 2085 Distilled, Rectified, and Blended Liquors

The distilled spirits industry is comprised of those establishments manufacturing alcoholic liquors by distillation and rectification, and those manufacturing cordials and liqueurs by blending liquors with other ingredients. The major products associated with this industry are whiskey, vodka, gin, rum, cordials, and liqueurs. As reported by the Distilled Spirits Council of the United States, the relative proportions of domestic distilled spirits bottled in 1973 are shown in Figure 62.

The production of distilled liquor was estimated by the Department of Commerce (2) at $1.9 billion in 1973, with per capita consumption amounting to 2.85 gal (10.6 l) annually. The major producing areas are Kentucky, Illinois, Indiana, Maryland, Pennsylvania, and Tennessee, which contain the majority of the 220 licensed U.S. grain distillers. The production of rum by molasses distillers occurs principally in Puerto Rico, with some plants located in the Virgin Islands, Florida, and Massachusetts.

Description of Process - Grain Distillers - Wide variations in distilled beverage products can be caused by one or more of the following factors: (1) types of materials and their proportions; (2) methods of material preparation; (3) selection of yeast types; (4) fermenter conditions; (5) distillation processes; (6) maturation techniques; and (7) blending experience. This description, however, will only discuss those variations germane to a basic understanding of the process and, more specifically, those variations directly affecting wastewater generation. Figure (63) is a simplified flow diagram for the basic process common to all grain distillers. The principal steps involved are mashing, fermenting, distilling, aging, rectifying-bottling, and feed recovery.

After preliminary grading and cleaning the grain is milled to form a meal. Milling breaks the outer cellulose wall around each kernel to expose more starch surface to the action of cooking and conversion. Water is added to the meal and the suspension is fed into a cooker. Cooking may be carried on under pressurized or atmospheric conditions in either batch or continuous processes. After partial cooling, the addition of ground barley malt converts the solubilized starches by enzyme action into grain sugar. This conversion may take place in a separate vessel called a "converter" in order to free the cooker for the next cook. The slurry, at this point called "mash," is further cooled by vacuum or by tubular heat exchangers and pumped to the fermenters.

Wastes from the mashing process consist of condensate from pressure cookers and vacuum coolers in addition to vessel cleanup. For plants operating in this mode the load comprises about 12 percent of the

DRAFT

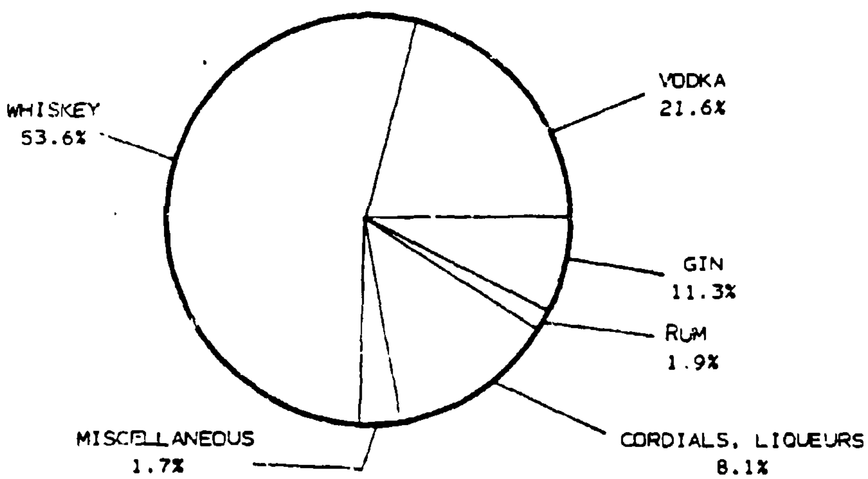


FIGURE 62

DOMESTIC DISTILLED SPIRITS BOTTLED OUTPUT

DRAFT

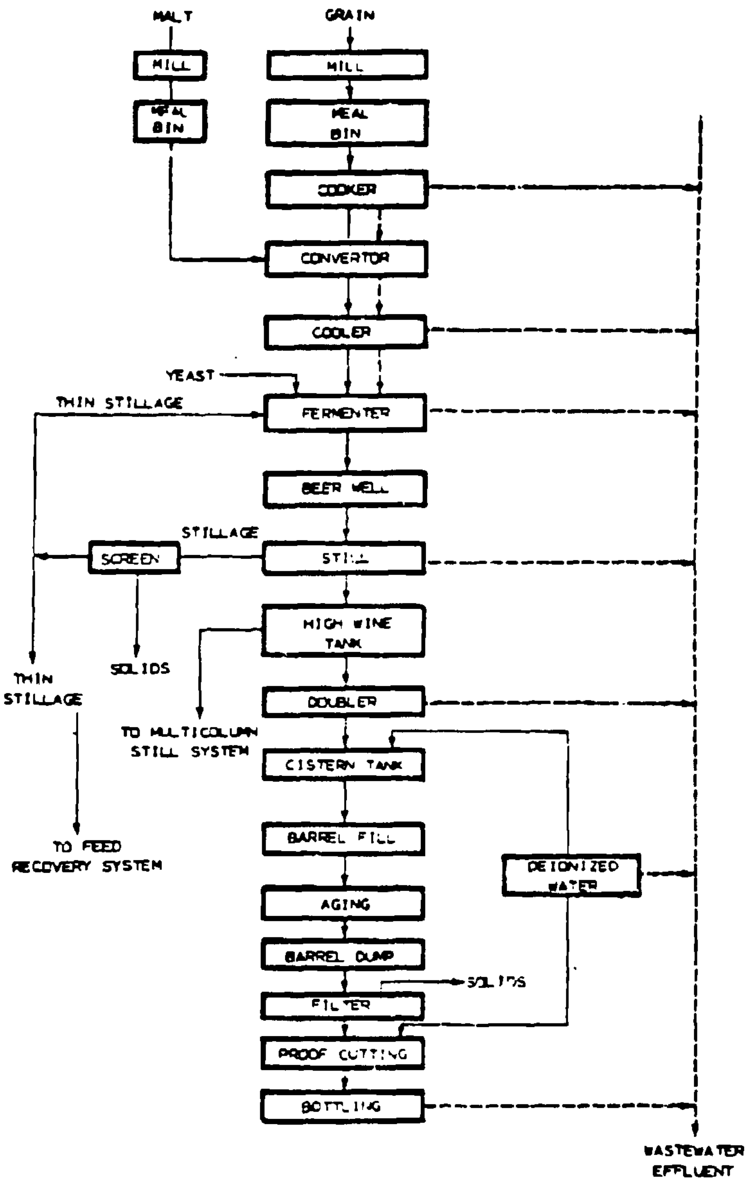


FIGURE 63

PROCESS FLOW DIAGRAM WHISKEY DISTILLERY

total plant waste. For plants with atmospheric cookers and shell and tube mash coolers the load would be lower.

The fermentation process commences with the introduction of pure cultured yeast, thus converting the grain sugars into nearly equal parts of ethyl alcohol and carbon dioxide. Fermenter mash concentration, agitation, and temperature cause the rate of fermentation to vary between two and five days. The mash concentration is set between 28 and 40 gallons per bushel of grain, depending on the amount of "thin stillage" or "back-set" that is returned from the base of the whiskey separating column and the amount of water added. In the production of "sour mash" whiskey this concentration, by law, would be greater than 25 percent of the fermenting mash volume. The fermented slurry, now known as "beer," is dropped into a beer well in route to the still.

Wastes from fermentation are small, consisting of fermenter and yeast tub cleanup. In most cases the first rinse, which contains considerable mash and alcohol, is discharged to the beer well. Sterilization by steam thus becomes the only discharge and contributes about one percent of the total plant wasteload.

Distillation involves the separation of alcohol from the de-alcoholized residue known as "stillage". Although numerous varieties of distillation exist, for whiskey this is normally accomplished in a continuous whiskey separating column. Indirect heat or steam introduced at the base of the column strips the alcohol from the fermented mash introduced near the top of the still. The vapor leaving the top of the still is condensed and forms the product. The discharge from the base of the column contains the soluble and suspended substances carried through the process and from which several useful by-products are derived. The alcohol, at approximately 115° proof, is stored in a high wine tank, and possibly run through a doubler which raises the alcoholic content to approximately 130° proof. The product is then ready for shipment to the cistern tank.

Beer still cleanup and doubler discharge, if not pumped back to the beer well, constitute the wastes from distilling. These comprise only one to two percent of the total plant load.

In whiskey production, deionized water is added to the product in the cistern tank and the mixture is aged in new, white oak barrels with charred staves and heading. The total years of storage depends on the time it takes to attain the desirable ripeness or maturity. The three reactions occuring simultaneously in the barrel during aging are extraction of complex wood constituents by the liquid oxidation of the original components in the liquid and other material extracted from the wood, and reaction between the various organic substances present in the liquid resulting in the formation of new congeners. Wastes from maturation are negligible.

If the production of grain neutral spirits is desired, then the product is pumped from the high wine tank at approximately 105° to 135° proof and sent through a continuous multi-column still system, thereby by-passing maturation. Figure (64) illustrates this system, which normally consists of aldehyde concentrating, rectifying, and fusel oil columns. The product is first fed to the aldehyde column. The product is then split into three paths. The main stream (20° to 40° proof) is pumped to the rectifying column; the heads (aldehydes and esters) are pumped to the heads concentrating column; and the fusel oil is pumped to the fusel oil concentrating column. The grain neutral spirits are withdrawn from the rectifying column at 191° proof.

Wastes from the multi-column process comprise two to four percent of the total plant wasteload. Concentrated heads may be discharged, burnt as fuel, or returned to fermenters. Fusel oil tails are discharged to the sewer while fusel oil is sold. Rectifying column tails maybe sewered or demineralized and used as dilution water. Most complete distilleries alternate between whiskey or grain neutral spirits production, and there is little difference apparent in the resultant wasteload.

Blending and bottling may take place at a separate facility or as part of a complete distillery. (A discussion of bottlers is included under SIC 5182). At a complete distillery the aged product is dumped from barrels and filtered, with filter media and charcoal residue being treated as a solid waste. After gauging, the product is final filtered and the residue sieuced to sewers. The addition of deionized water fixes the proof, and the product is ready for bottling. Some breakage will inevitably occur and this also would be sewered. The waste associated with bottling is probably less than one percent of total distillery waste.

Several variations exist in the method of recovering whole spent stillage. Basically distilleries fall into two categories: 1) those with no recovery and 2) those utilizing evaporators and dryers for complete recovery. Only the smallest distilleries practice no stillage recovery. It is more economical for these plants to dispose of wet stillage to nearby farmers for cattle feed than to install a feed recovery system. These small distilleries have a substantially different wasteload, since feed recovery is the major contributor to total distillery waste.

Figure 65 illustrates the process flow for a feed recovery system. Since whole spent stillage is approximately five to seven percent solids, feed recovery is essentially a dewatering process. The first step consists of passing the whole stillage over a screen. The coarse solids are retained and sent to a press for further removal of soluable solids. The press cake, if dried separately on driers, becomes "distillers light grain." The thin stillage liquid is normally centrifuged to remove suspended solids then piped to multiple-effect evaporators where it is concentrated to a syrup containing about 25 to 35 percent solids. These

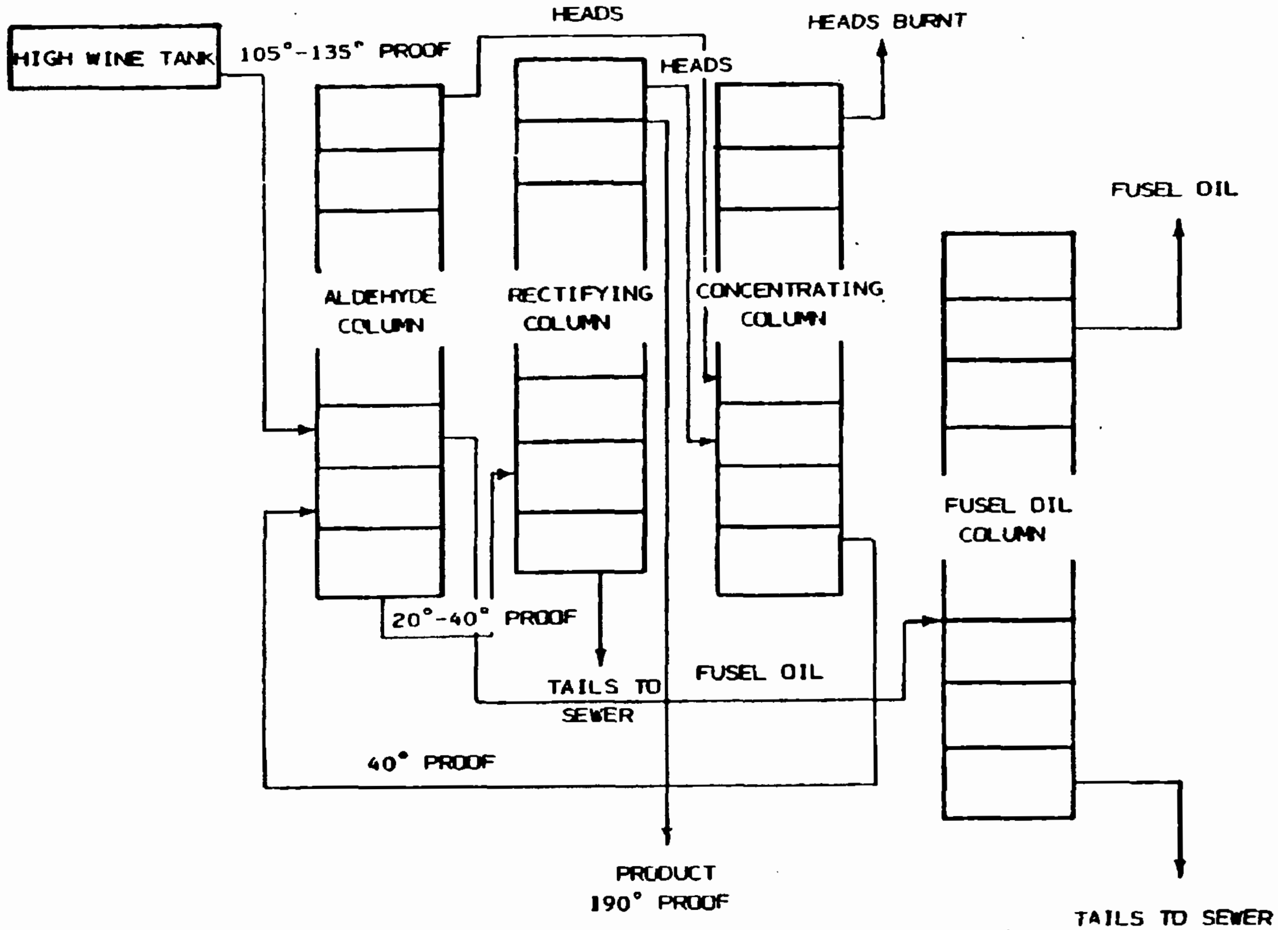


FIGURE 64

PROCESS FLOW DIAGRAM HIGH PROOF SPIRITS PRODUCTION

DRAFT

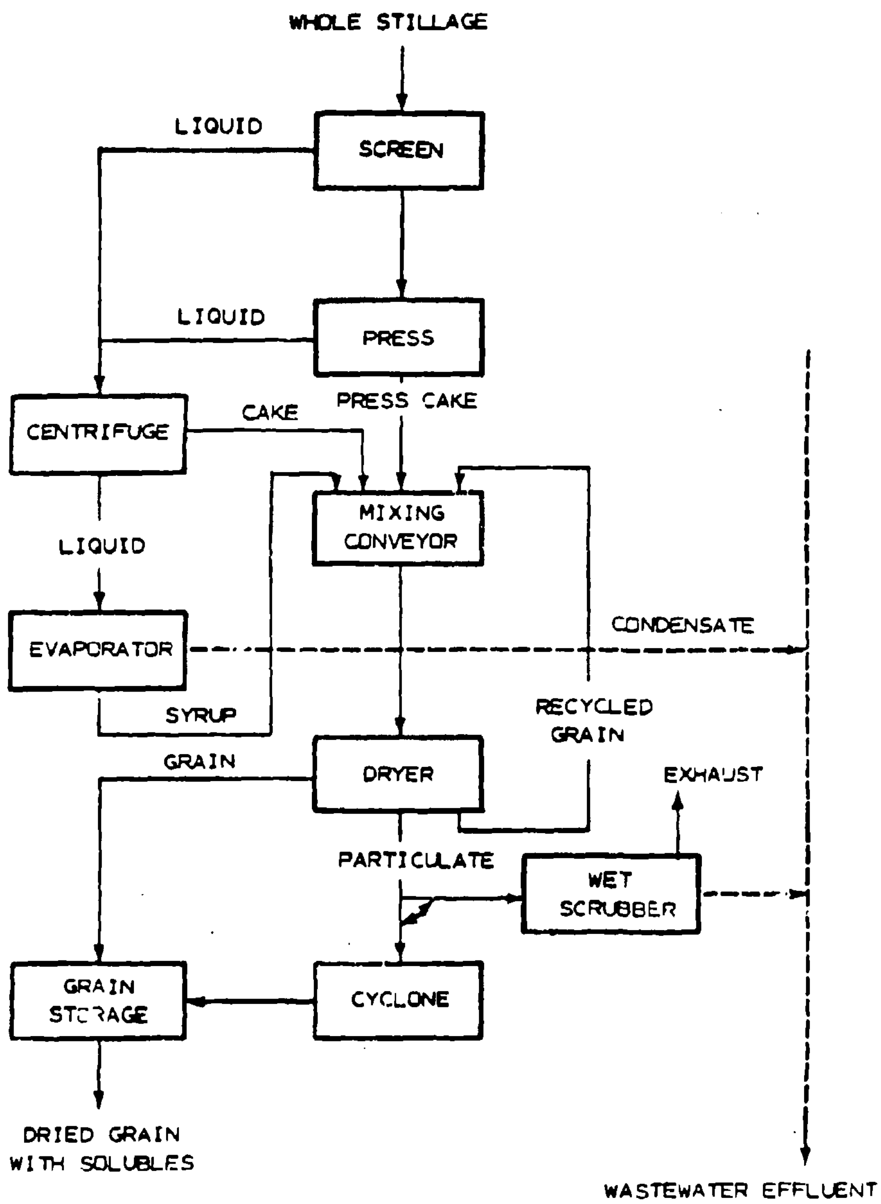


FIGURE 65

PROCESS FLOW DIAGRAM
FEED RECOVERY SYSTEM

evaporated solubles may be drum dried to produce "distillers dried solubles," or more commonly dried with press cake in rotary driers to produce "distillers dark grains."

The major contribution to distillery wasteload is from the feed recovery system. It can, according to Boruff and Blaine (36), account for as much as 83 percent of the total distillery waste. The most significant source of wastewater within the feed recovery system is the condensate from evaporators. Dust emanating from grain dryers may constitute a secondary source if wet scrubbers are used, or it may be eliminated through the use of cyclones.

Description of Process - Molasses Distillers - While the basic process of molasses distillers is similar to that used by grain distillers, there exist some variations which warrant discussion. Figure 66 shows a process flow diagram for a molasses distillery.

Molasses syrup (either case molasses or citrus molasses) is received as by-products from the case and citrus industries and stored in large holding tanks. The molasses is then pumped to tanks where phosphorus and ammonia nutrients are added to satisfy the nutritional requirements of yeast fermentation. The amounts of nutrients added depend upon the grade and purity of the raw molasses. Hiatt (37) cites instances of pasteurization of the raw molasses prior to nutrient addition, but existence of this practice is not evident in the industry at this time. Some pre-heating of the yeast seed cultures does take place though. To eliminate undesirable bacterial contamination the pH is adjusted to between 4.0 and 5.0 through the addition of sulfuric acid. Some distillers also include the use of antifoamers prior to fermentation.

The molasses mixture is seeded with the desired yeast cultures to initiate fermentation. While cooling of the molasses to aid fermentation has been reported, some distillers use a "wild fermentation" process where the mash is inoculated by the yeast that is present in the air and in the raw material. This takes place in lieu of cooling.

Following fermentation the "mash" (8 to 12 percent alcohol) is sent through a multi-column distillation process. Some experimentation has been performed attempting to remove the spent yeast cells by centrifugation prior to distillation. Currently, this is not a common practice in the industry. One possible arrangement of the multi-column system is shown in Figure 66. A separating column removes the alcohol from the de-alcoholized residue known as "slops" or "stillage." The vapor leaving the top of the column is condensed and sent to an aldehyde column. Here the "heads" (aldehydes and esters) are removed. The product is drawn off the bottom and sent to the rectifying column where fusel and amyl oils are separated. The final product is now ready for flavoring, aging, and

DRAFT

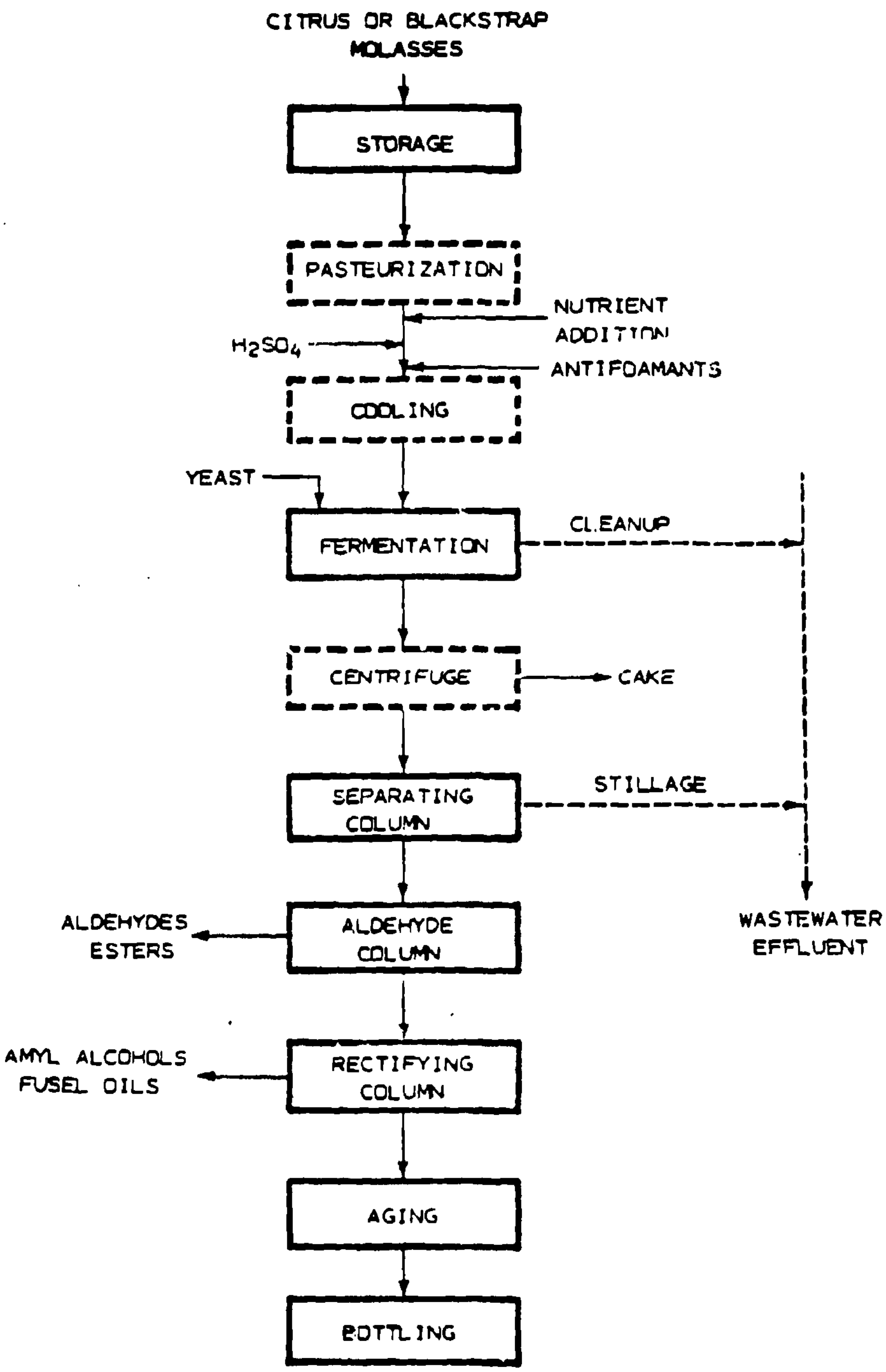


FIGURE 66

PROCESS FLOW DIAGRAM MOLASSES DISTILLERY bottling. By-product fusel oils may be marketed. Aldehydes and esters may be used for fuel in the distillery.

Stillage from distillation comprises the major part of molasses distillery waste. Present methods of stillage disposal vary according to locale. Puerto Rican distillers discharge their untreated effluents directly to the ocean. Two of the continental United States molasses distillers practice periodic evaporation of their slops streams. In these two instances, the amount of evaporation depends upon the available market for concentrated molasses slops as feed supplements.

SIC 5182 Bottlers and Blenders of Wines and Distilled Liquors

According to the Bureau of Alcohol, Tobacco, and Firearms (BATF) there are 90 plants in this category authorized to operate. These plants are distributed throughout 25 states with the heaviest concentration in California. The BATF reports only total bottled output, therefore no breakdown is available between separate bottlers and bottlers combined with distilleries or wineries. Production may range up to 13 million proof gallons per year for the larger plants in this category.

Description of Process - Typical operations in plants from this subcategory are redistilling, rectifying and bottl[illegible]. As defined in the industry, rectifying includes mixing, blending, [illegible] chilling processes. The principal products of such plants may be wines, [illegible]ies, whiskies, white goods, cocktails, and cordials. Wastewater f[illegible] these plants is negligible, as documented in Section V.

SIC 2086 Bottled and Canned Soft Drinks

The soft drink bottling and canning industry consists of franchised and independent companies who purchase concentrate or syrup and package soft drinks. According to the U.S. Department of Commerce, (32) soft drink bottlers and canners operate approximately 2470 facilities with the largest concentration of plants in the southern states.

The National Soft Drink Association (38) reported a total wholesale value of 6.2 billion dollars for product shipped in 1973. Per capita consumption amounted to 26.9 gallons which was divided as follows: 91 percent regular and nine percent diet drink. Cola flavored drinks represented 65 percent of the regular market, with lemon-lime drinks ranked second at 11 percent. The percentage distribution of package types is shown in Figure 67 . It should be pointed out that this distribution varies widely by local market.

Total sales were marketed as 80 percent packaged and 20 percent bulk. Packaged product includes all glass containers and cans whereas bulk product reaches the consumer via stainless steel pressurized cannisters of differing sizes classified as "post-mix" or "pre-mix". The designation "post-mix" indicates fountain syrup prepared at the point of consumption, and "pre-mix" indicates a finished beverage ready to be dispensed. In 1973 "post-mix" accounted for 81 percent and "pre-mix" 19 percent of total bulk volume.

DRAFT

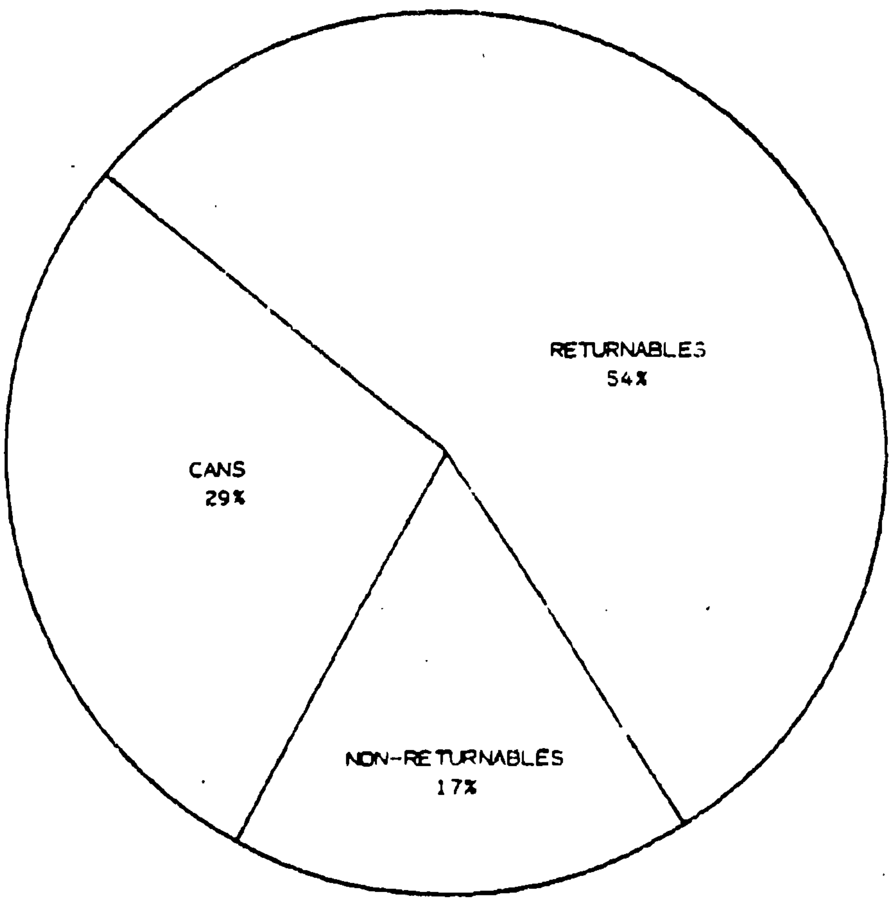


FIGURE 67

CONTAINER MIX IN THE SOFT DRINK INDUSTRY

In addition to geographical differences in sales volumes and package type, there are definite seasonal variations. During the summer months of July through September, sales can peak as much as 50 percent above sales during the winter months of January through March. Peaks in sales are preceded several months by corresponding peaks in production. The value of shipments for the soft drink industry is expected to maintain a future annual growth rate of 9 to 11 percent as it has over the past six years.

Description of Process - Soft Drink Bottling and Canning - The term "soft-drink" refers to those non-alcoholic beverages which are normally flavored, acidified, colored, sweetened, and carbonated. A similar but non-carbonated product is also packaged but in comparatively small quantities. Figure 68 is a simplified process flow diagram illustrating operations in a soft drink bottling and canning plant.

Raw Materials: Soft drink manufacturers must ultimately combine treated water with finished syrup to form a final product. Finished syrup received in bulk will already have been flavored, colored, acidified, and sweetened. This syrup, which is prepared from a proprietary formula at a corporate bulk syrup plant, is delivered by tank truck to the bottler. In some cases a flavored, colored, and acidified concentrate is received and the finished syrup is produced by adding sugar (liquid or dry) and water to the concentrate. The concentrate may be received in powder and/or liquid form depending on the type of product. In other cases all raw materials may be purchased directly from members of the flavor and extract industry and mixed at the bottling or canning plant. Under normal conditions, there are no wastes associated with the receipt of raw materials.

Water Treatment: Soft drink plants routinely treat incoming city water. Two degrees of treatment are normally required: water utilized for bottle washing must be low in hardness; water to be mixed with syrup must be completely free of any substances which might affect the flavor, color, and appearance of the final product. A typical water treatment plant might submit incoming city water to chemical coagulation and sedimentation in a large reaction tank through the addition of ferrous sulfate and lime. Water filtration and purification by means of sand, gravel, and carbon media in addition to chlorination might follow. Dearation and ion exchange units are sometimes utilized. Whatever the means or degree of treatment, the primary goal is to eliminate any contaminants destined for product usage. Some plants soften incoming city water to be used in bottle washing. This provides for better wetting and sheeting characteristics, thereby increasing the ease of caustic removal in the rinse cycles.

Wastewater associated with water treatment will vary widely depending on incoming water quality and plant operating procedures. As a general rule, however, these wastes are a small part of the total plant load.

DRAFT

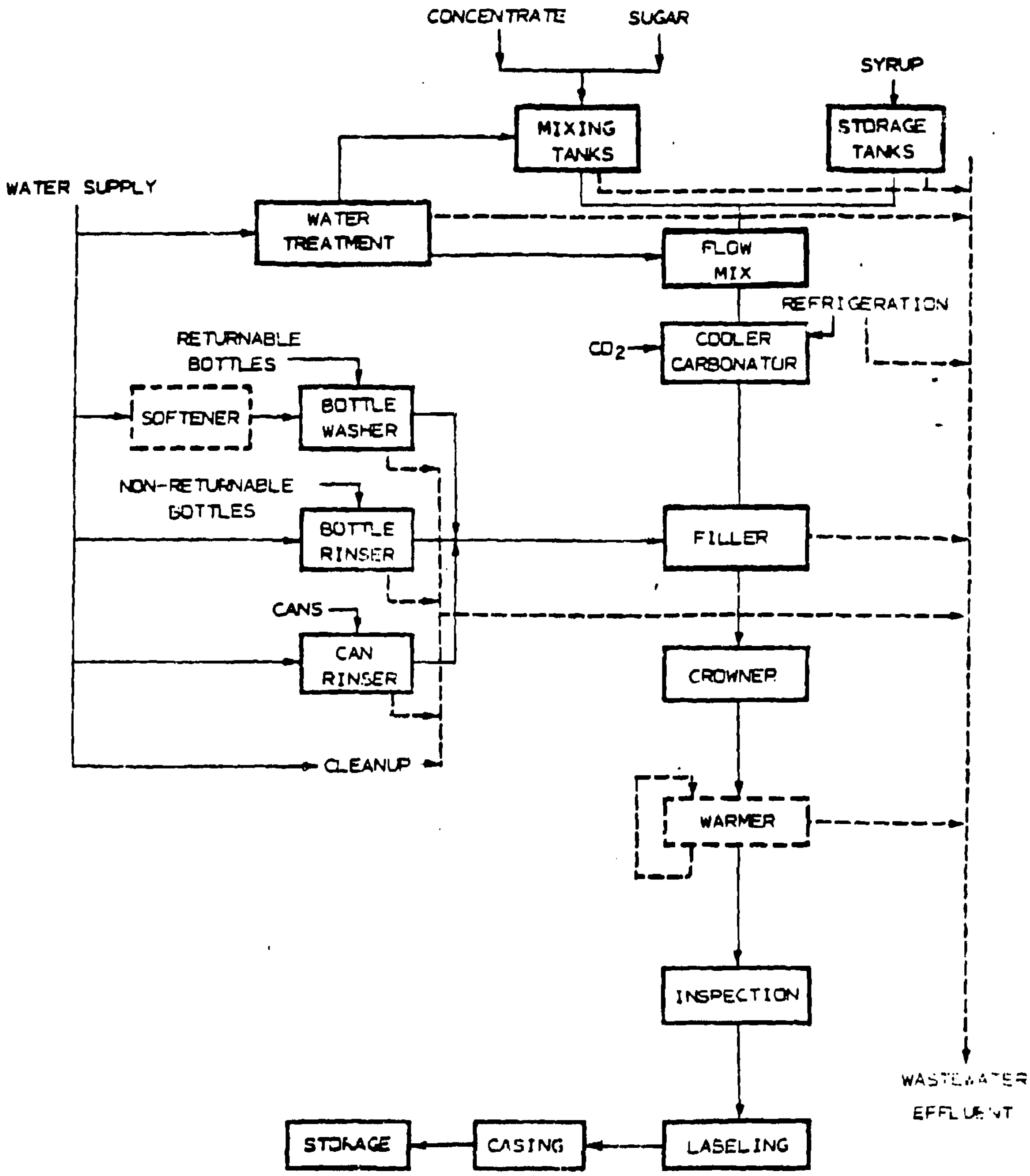


FIGURE 68

PROCESS FLOW DIAGRAM
SOFT DRINK BOTTLING AND CANNING PLANT

Syrup Preparation and Storage: Syrup received in bulk requires no preparation. It is typically stored in tanks of approximately 20,000 l (5,000 gal) until it is ready for use. Separate mixing tanks, however, are involved in the preparation of syrup from concentrate. These mixing tanks, which are smaller than the storage tanks, are normally used to prepare only the amount of syrup to be used in the final product for that day. This means that, if four different products utilizing concentrates are to be packaged that day, the equivalent of four mixing tanks is required.

In order to minimize wastes, and to provide ease in handling and sanitation, stainless steel mixing tanks with cone/dished heads are used in the preparation and storage of syrup. Each "flavor change" however, necessitates the removal of residual syrup from the tank walls. This clean-up constitutes the wasteload from the mixing operation. Syrup storage tank clean-up also contributes to the total wasteload, but it is on a less frequent basis.

Container Preparation: The three types of containers associated with packaged production are cans, non-returnable bottles, and returnable bottles. The cans and non-returnable bottles are normally only rinsed with city water to eliminate particles that may have accumulated during storage. The returnable bottles may contain leftover materials such as unused product, cigarette butts, mold, and other refuse which are removed automatically in a bottle washer. These machines must wash, clean, sterilize, and rinse all bottles. Figure 69 provides an internal view of one type of washer currently in use.

All bottle washers follow the same basic steps of prerinsing, soaking, and final rinsing. During prerinsing both the inside and the outside of the bottles are subjected to a hot spray. Solids removed at this point pass first through a coarse, then through a fine mesh screen before the rinsewater is sewered. Recirculated final rinse water is often used in the pre-rinse section. Soaking involves immersing the bottles for not less than five minutes in at least a three percent alkaline solution containing 60 percent caustic soda. This occurs in a single or multi-compartment tank at a minimum of 66°C (150°F). The liquid level and strength of the solution are checked regularly to maintain specified standards. The entire solution is dumped intermittently, at periods ranging from six weeks to six months. After intermediate caustic removal sprays, the bottles undergo a final fresh water rinse. This water, which contains some carry-over caustic cleansing solution, is sewered if not reused for pre-rinsing.

Inspection of soft drink bottling plants confirms that bottle washer wastes represent the major portion of the total plant load. The residual drink left in the bottle is the major source of BOD. Suspended solids from the pre-rinse are inevitably sewered. High alkalinity and pH result from carry-over detergent in both pre-rinse and final rinse.

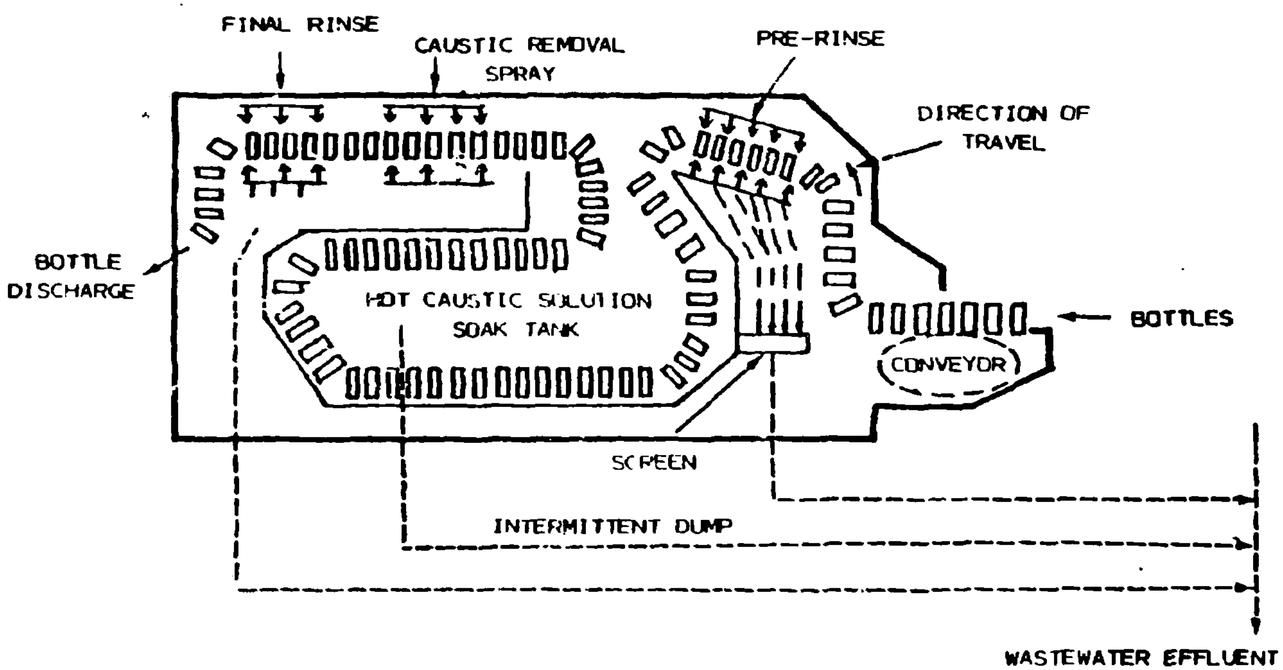


FIGURE 69

FLOW DIAGRAM
SOFT DRINK BOTTLE WASHING MACHINE

DRAFT

Container Filling: Finished syrup from storage or mixing tanks is combined in specified proportions with treated water in the "flow-mix". This mixture is fed to a cooling-carbonating vessel where it is chilled and infused with gaseous carbon dioxide. The mixture then passes to the "filler" where it is introduced into the container. In some bottling plants an alternate method is used whereby syrup is first placed in bottles which are then filled with carbonated water. In either case the container is immediately crowned or capped. The filled and sealed bottles are passed through a warm water rinse before inspection, possible labeling, casing, and shipment or storage.

Wastes from container filling result from filler spillage, lost product associated with flavor changes, and the corresponding clean-up. A flavor change necessitates flushing the lines from syrup through the flow-mix, cooling-carbonating vessel, and filler. Chlorine and treated water, plus any product left in the lines, are then sewered. The percent of the total plant wasteload contributed by flavor changes varies according to the number of changes made daily and the efficiency with which each plant eliminates product loss. Filler spillage varies considerably between bottling and canning plants. In a bottling plant there is little or no spillage while the filler is operating. In a canning plant, however, there is considerably more product loss in filling due to the speed or the line and nature of the container. In a plant which only cans, this loss would be the major source of BOD wasteload.

Bulk Filling: As part of some plants' total production both pre-mix and post-mix cannisters are utilized. This operation requires only that separate syrup and water lines be provided to an area where the cannisters are filled under pressure. Figure 70 demonstrates this procedure.

Wastes from bulk filling result from a small amount of residual product left in the cans by the consumer. Hot water, caustic, and final water rinse procedures are used to clean the cans.

SIC 2087 Non-Synthetic Flavoring Extracts and Syrups

When used for food purposes a flavoring extract may be generally defined (39) as a solution in ethyl alcohol of proper strength of the sapid and odorous principles derived from an aromatic plant, parts of the plant, or essential oil from the plant, with or without coloring matter, conforming in name to the plant used in its preparation.

Flavorings derived from parts of aromatic plants are termed natural flavorings whereas those prepared from synthetic chemicals, such as esters, aldehydes, ketones, and others, are considered artificial, imitation, or synthetic flavors.

DRAFT

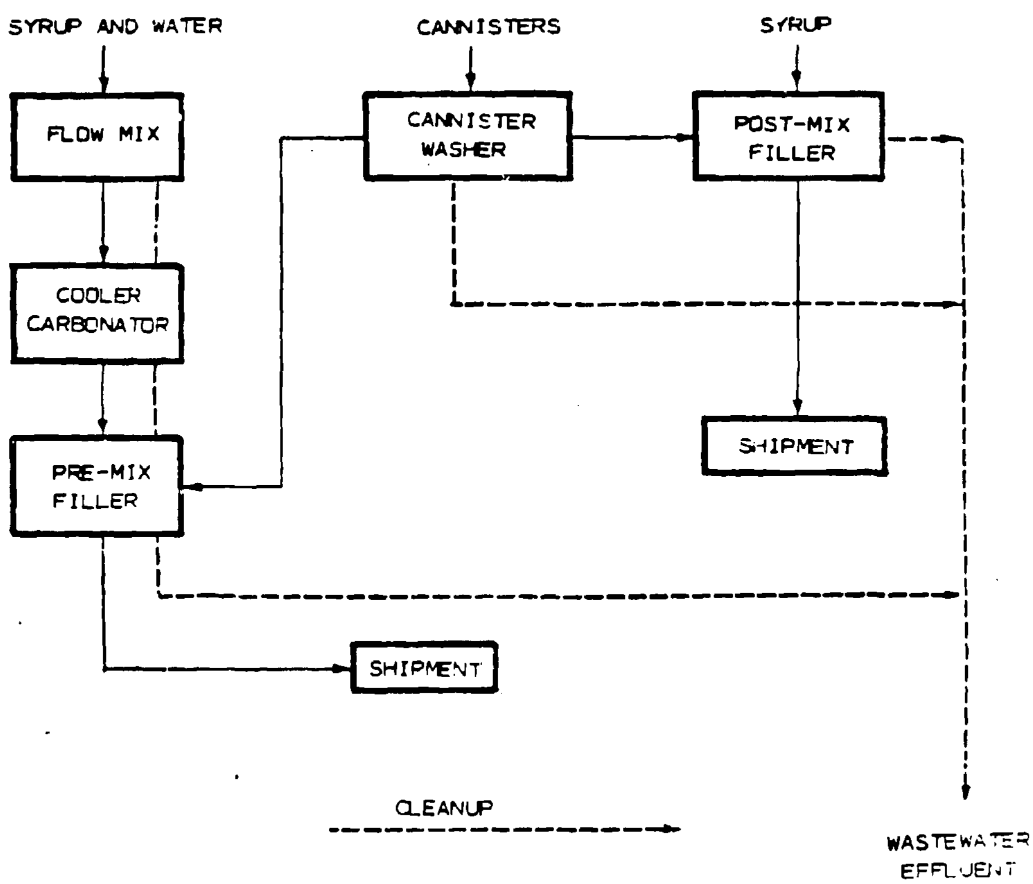


FIGURE 70

PROCESS FLOW DIAGRAM BULK FILLING SOFT DRINK PLANT

Common flavoring extracts include vanilla, lemon, clove, cinnamon, orange, nutmeg, peppermint, and wintergreen. The most common methods for the preparation of flavoring extracts are steam or water vapor distillation (with or without vacuum), solvent extraction, and expression.

Flavoring extracts are produced in a wide variety of concentrations and forms -- extracts, concentrates, powders, emulsions, tablets, and essences -- with the strength and form depending on the intended use of the product. Natural flavoring extracts are then blended with other substances, such as sugar, synthetic flavoring extracts, alcohol, and food colors, in numerous combinations and proportions to produce finished specific flavors. The finished flavors are also produced in the same variety of concentrations and forms as the flavoring extracts. Finished flavors are utilized in a number of other food related areas, principally the beverage, baking, confectionery, and frozen desserts industries.

There are approximately 60 companies operating flavor producing plants in the United States. While little information is available from the industry, it would appear that a typical plant produces flavoring extracts as well as finished specific flavors and possibly spices.

A separate entity of the flavoring extract and syrup industry is the manufacturing of beverage bases (concentrates and syrups). These bases are almost exclusively produced by the major soft drink companies which utilize them in their soft drink products. There are approximately 22 beverage base plants operating in the United States.

The demand for flavoring extracts and flavors fluctuates in direct relation to fluctuations in the beverage, baking, confectionery, and frozen desserts industries. However, the need for flavoring products probably maintains a near balance since beverage and frozen dessert demand is high when baking demand is low and vice versa (40). In 1973 the value of product shipments of flavorings accounted for an estimated 1.6 billion dollars and was expected to rise to 1.7 billion in 1974.

Process Description-Standard, Terpeneless and Concentrated Flavoring Extracts from Essential Oils - Essential oils may be defined as liquids which occur naturally in many types of plants or which may be reproduced by a combination of substances in the plant upon reaction with one another in the presence of water. The preparation of the most common forms of flavoring extracts from essential oils is illustrated in Figure 71.

Essential oils are generally purchased and stored in fiber drums, while alcohol and other solvents are stored in storage tanks. A standard formula exists for every type of flavoring extract which can be manufactured. The preparation of a standard flavoring extract (Figure 71) involves a blending process in which a specified percentage by volume of the essential oil, alcohol, and water are mixed in tanks.

DRAFT

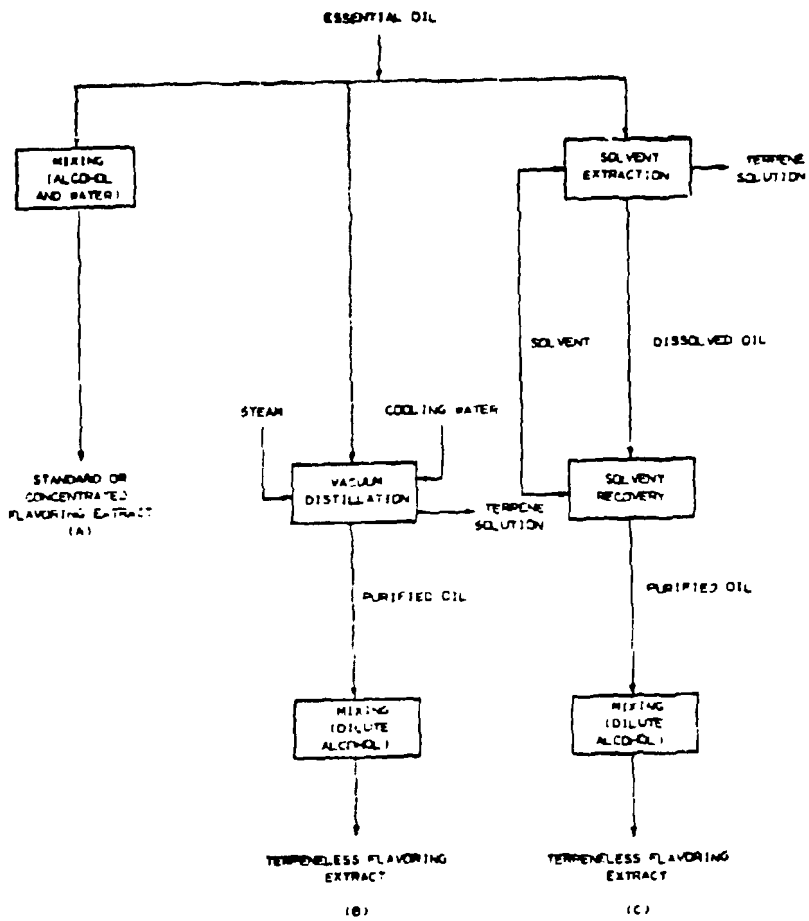


FIGURE 71

STANDARD, TERPENELESS AND CONCENTRATED NATURAL FLAVORING EXTRACT PROCESS

DRAFT

For certain applications, such as in ices and fountain syrups, it is desirous to produce a more water soluble flavor. Consequently, the more insoluble components (terpenes) of the oil must be removed. This can be accomplished by vacuum distillation (Figure 71) or solvent extraction (Figure 71) of the essential oil.

In the vacuum distillation process, steam is used to strip the more volatile plant oil from the terpenes. The purified oil is then mixed with dilute ethyl alcohol of proper strength to form the terpeneless extract.

In the solvent extraction process the solvent dissolves the plant oil from the essential oil and is drawn off. The solvent is then recovered from the purified oil which is subsequently mixed with dilute ethyl alcohol of proper strength to form the terpeneless extract.

Concentrated extracts are produced in the same manner as standard extracts except the percent by volume of plant oil is considerably increased.

Wastewater generated from the production of these products consists primarily of internal equipment cleanup when a flavoring change is made.

Process Description-Flavoring Extracts from Direct Solvent Extraction of Aromatic Plant Tissues - There are few flavoring extracts prepared from the direct solvent extraction of plant tissue. By far the most common example is the manufacturing of vanilla extract as illustrated in Figure 72.

Vanilla beans are received and stored in boxes. The vanilla beans taken from storage are first chopped before being steeped in an alcohol-water solution. In order to exhaust the desired material from the bean, solutions ranging from 35 to 60 percent by volume of ethyl alcohol are used. The vanilla extract, composed of alcohol, water and dissolved vanilla flavor, is drawn off through a filter, adjusted to a desired water, alcohol, and sugar content in storage tanks, and subsequently bottled.

The alcohol remaining in the chopped beans from the steeping process is extracted and reused. The beans are discarded as solid waste.

The major wastewater generation is attributable to filter backwash and to the cleaning of vanilla extract storage tanks when sediment accumulates in the tanks.

Process Description - Natural Flavoring Concentrates and Powders - Flavoring concentrates and powders are derived from plant liquor or essential oils. Fruit liquor is usually used in the case of fruit concentrates and powders while essential oils are used for spice concentrates and powders.

The typical process flow diagram for the manufacturing of these products is illustrated in Figure 73 .

DRAFT

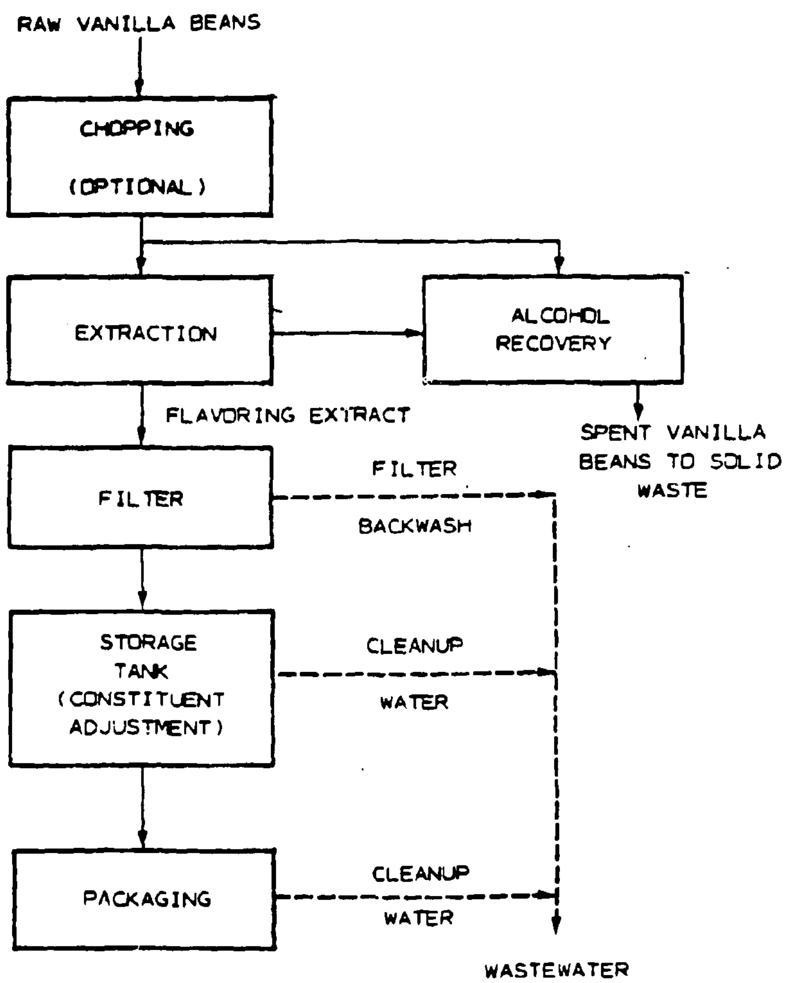


FIGURE 72

NATURAL VANILLA EXTRACT MANUFACTURING PROCESS

DRAFT

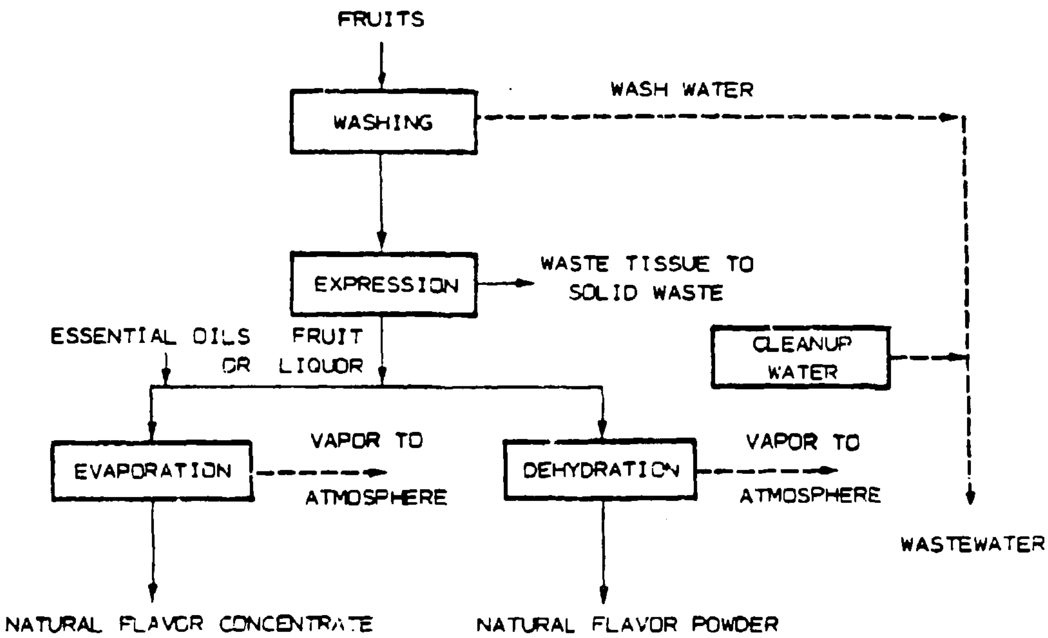


FIGURE 73

NATURAL FLAVORING CONCENTRATES AND POWDERS
MANUFACTURING PROCESS

DRAFT

In order to produce fruit concentrates or powders, fruits are washed and chopped and the fruit liquor containing water, oil, and fruit particles is expressed from the chopped fruit. To prepare the fruit concentrate the liquor is evaporated under vacuum. If powdered flavor is to be produced, the liquor together with vitamins, sugar, and acid is completely dehydrated.

The production of spice concentrates involves the evaporation of essential spice oils. The oils are dehydrated for the production of powder.

Wastewater generated from the manufacturing of concentrates and powders includes fruit wash water, evaporator effluent, and dehydrator effluent.

Process Description - Finished Specific Flavors and Cordials - The manufacturing of finished specific flavors and cordials is a blending process in which natural and/or synthetic flavoring extracts are blended in numerous proportions and combinations with other ingredients such as alcohol, sugar, coloring agents, and water.

If not produced at the plant, flavoring extracts and colors are usually received and stored in fiber drums. After proper mixing they are packaged in bulk containers. The finished flavors may be produced in all of the various forms discussed above.

Cordials are a blend of flavoring extracts, sugar, water, and alcohol. Cordials are a special case of flavor production in which alcohol comprises a considerable portion of the total product volume.

Wastewater attributable to the preparation of finished flavors and cordials consists entirely of cleanup of mixing tanks prior to flavor changes.

Process Description - Beverage Bases - By far the majority of beverage bases, both concentrates and syrups, are manufactured by major soft drink companies in plants which produce concentrates and/or syrups exclusively. The manufacturing of flavoring concentrates and syrups is illustrated in Figure 74 .

The flavoring extracts, acids, treated water, colors, and sugar (except in concentrate production) are proportioned from storage tanks into large, stainless steel mixing tanks and blended. The product is then strained through a wire mesh screen and packaged or shipped in bulk by tank cars or trucks.

The manufacturing of beverage concentrates and syrups in flavoring extract plants is done on a much smaller scale and excludes water treatment and container washing. There is also no need for flavoring material storage as these materials are produced in-house.

The primary sources of wastewater in the soft drink concentrate and syrup plants are cleanup of mixing tanks prior to flavor changes at the end of each day; and washing of containers, drums, and tank cars. The production of beverage bases in flavoring extracts plants would generate wastewater from cleanup of mixing tanks only.

DRAFT

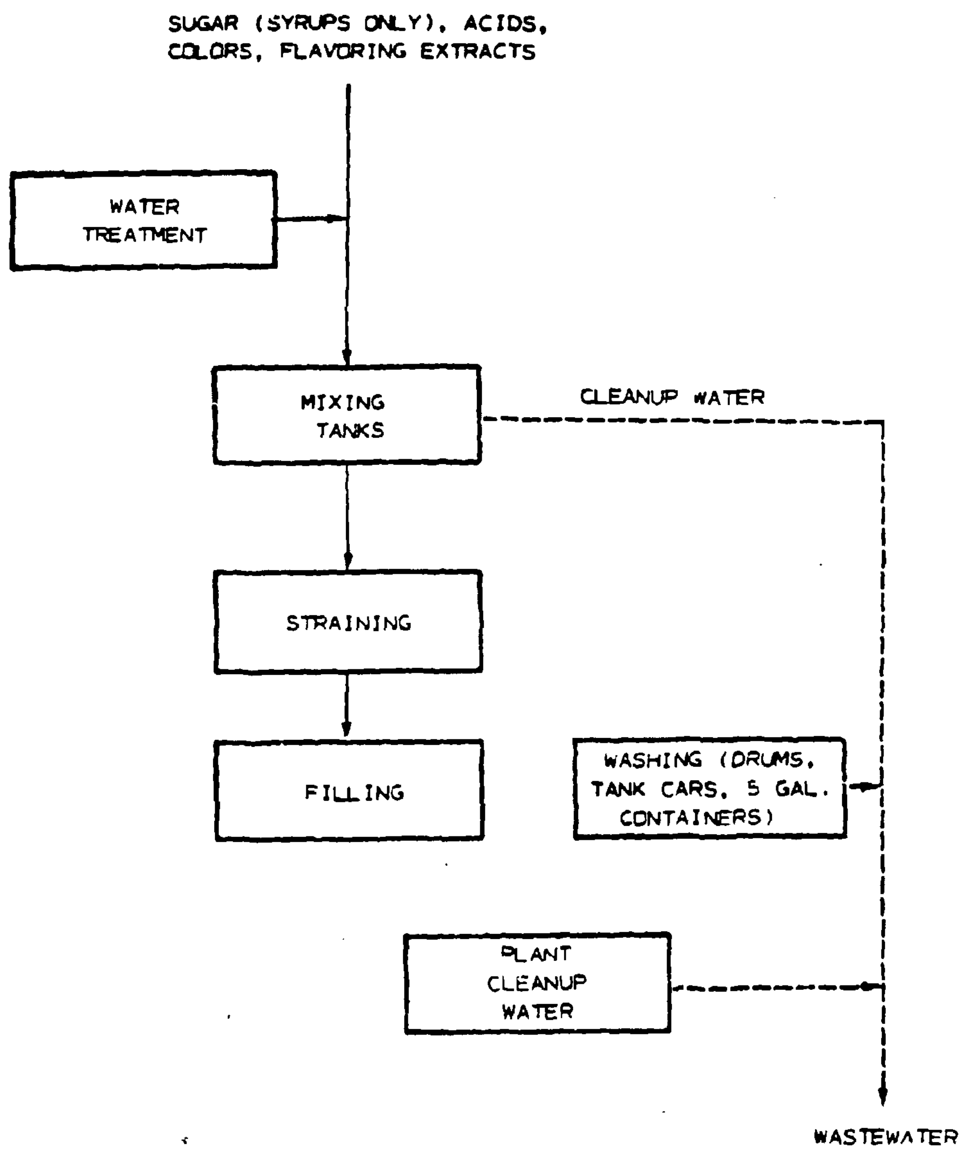


FIGURE 74

BEVERAGE CONCENTRATE AND SYRUP MANUFACTURING PROCESS

DRAFT

SIC 2095 - Roasted and Soluble Coffee Processing

General - Coffee roasting and the production of soluble coffee extracts occurs in 203 plants distributed throughout the country. According to the Pan American Coffee Bureau (41), in 1972 843,696 kkg (930,000 tons) of roasted coffee and 81,048 kkg (89,300 tons) of soluble coffee were produced with a total value of $2.32 billion. The greatest density of plants is found along the Atlantic seaboard and in California. According to the National Coffee Association (42), of the 21 million bags (60 kg each) of coffee that are imported each year, 10 percent has already been processed, usually into soluble coffee.

The National Coffee Association further reports that seven large corporations account for 70 percent of the total production in this country. In the soluble coffee segment of the industry, two corporations produce 81 percent of total production.

Coffee is normally sold in a roasted and ground or soluble form. Both are available as either regular or decaffeinated types, and soluble coffee is produced by spray drying or freeze drying. Some coffee plants produce all possible combinations of the above forms and types. The Pan American Coffee Bureau (43) indicates that decaffeinated coffee accounts for only 12 percent of all coffee sold; however, 28 percent of all soluble coffee is made from decaffeinated beans.

Since 1962, the per capita coffee consumption in this country has been declining. However, the National Coffee Association (42) indicates that the soluble coffee industry continues to expand and account for a larger share of the total coffee market each year.

All coffee processing begins with the green coffee bean. Further processing will include roasting, possibly preceded by decaffeination and followed by extraction and then spray or freeze drying. These processes are described in the following subsections. Figure 75 illustrates the basic processes used in producing roasted coffee.

Description of the Decaffeination Process - Green coffee beans usually arrive at the plant in 60 kg (132 lb) burlap sacks from which they are transferred to a storage hopper. The beans are then cleaned by air levitation to remove foreign material and chaff which are lighter than the beans. The beans are then either decaffeinated by individual type or the various types of beans are mixed to obtain the desired blend and then decaffeinated. If decaffeinated roasted or soluble coffee is desired, the caffeine is removed from green coffee beans using the direct solvent method or the water extraction (liquid/liquid) method.

In the direct solvent method (see Figure 76), caffeine is removed by contacting the beans with organic solvent, most commonly methylene chloride. The beans are prewetted by various methods before extraction, a necessary step to allow high decaffeination levels. The solvent is drained off and fresh solvent added until the residual caffeine is at the level desired

DRAFT

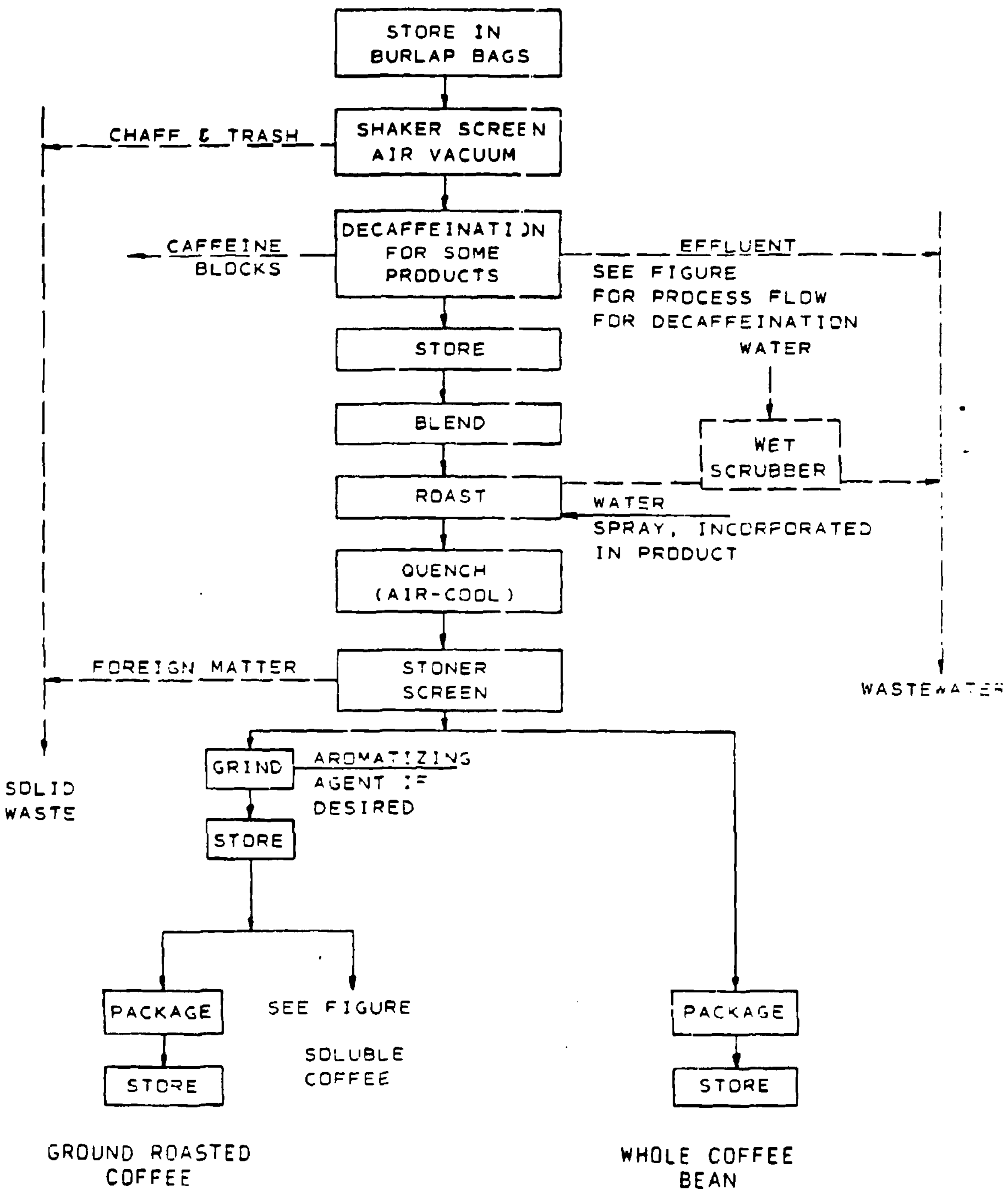


FIGURE 75

COFFEE ROASTING PROCESS FLOW DIAGRAM

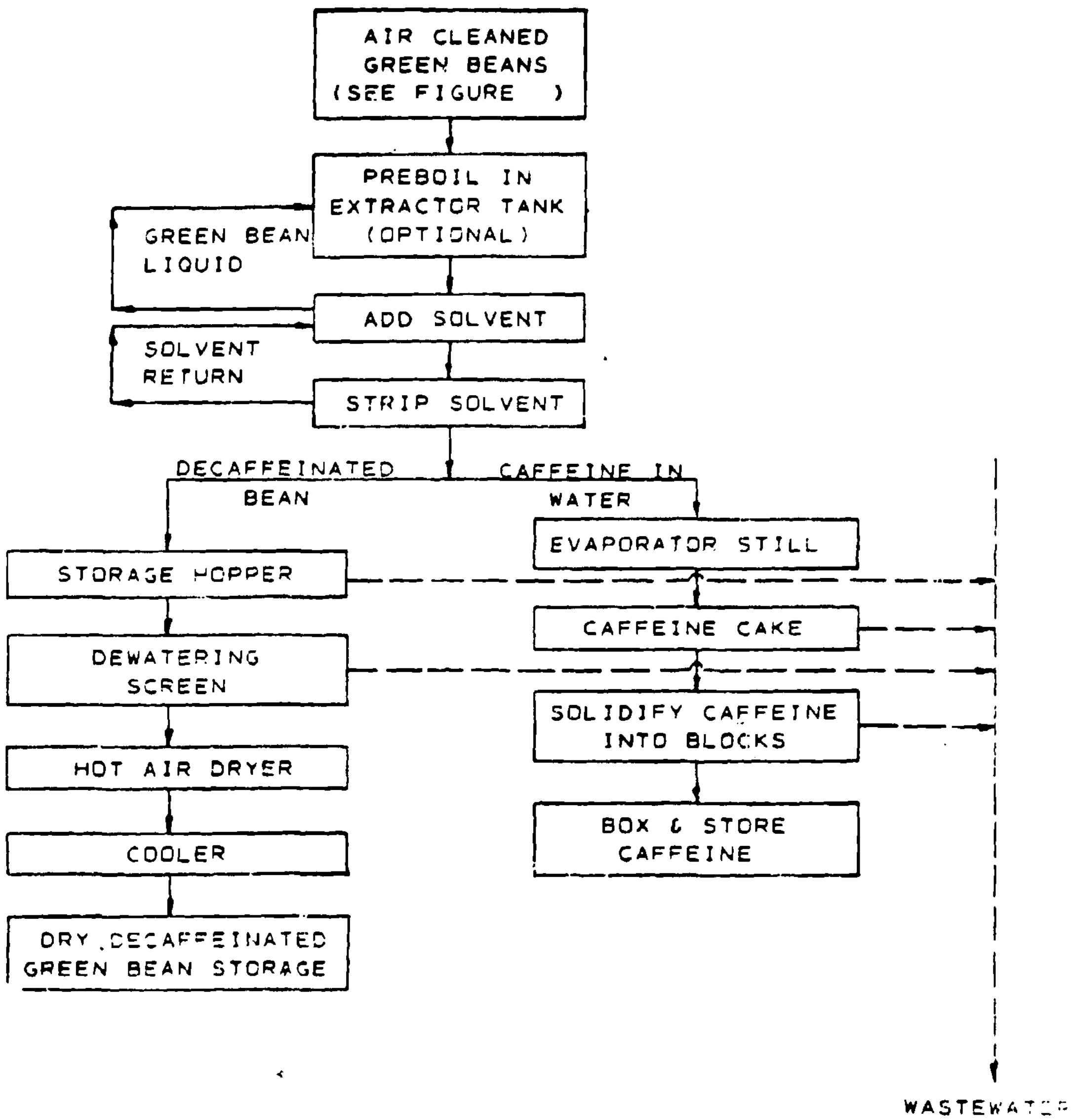


FIGURE 76

ORGANIC SOLVENT CONTACT
DECAFFEINATING PROCESS FLOW DIAGRAM

DRAFT

(usually 97 percent of the caffeine is removed). The used solvent is distilled to recover clean solvent and a crude caffeine residue.

The method of extraction most commonly used in this country by the large producers of decaffeinated products is called the water extraction or liquid/liquid extraction method (see Figure 77). In this process, the caffeine is extracted from the green beans in extractor columns with 93°C (200°F) water. Next the extract may be centrifuged to remove solids. The caffeine is then selectively transferred from the aqueous green coffee solution stage to the trichlorethylene solvent by countercurrent or rotating disk contactor liquid/liquid extractors. The water extract is then stripped of its solvent residue and returned to the process to extract further caffeine. The caffeine contained in the trichlorethylene can be recoverd by distillation of the solvent, or by liquid/liquid extraction with water. The solvent is purified by distillation and returned to the process. Caffeine may be packed and shipped in its crude form or it may be further purified to meet food and drug standards. The extraction of green beans with recycled water extract continues until the caffeine level in the green is reduced to the required degree (usually 97 percent removal), and the beans are then drained, washed and dried.

In the extraction processes discussed, the decaffeinated beans are rinsed and dewatered with an auger screw or screen. The beans are then hot air dried, cooled, and stored in preparation for roasting.

Wastewater is generated in the decaffeinating process primarily from the washing of the decaffeinated beans, the flushing of the extract centrifuge and the solvent and caffeine separation process. Smaller amounts of wastewater come from the caffeine solidifying process, storage of the wet beans and condensate overflow.

Description of the Roasted Coffee Process - Coffee beans are roasted in order to develop their flavor. There are eight commonly used shades or degrees of roasting. Selection of a particular shade depends on the type of beans and the flavor desired

Green coffee beans are normally roasted in revolving metal cylinders, directly or indirectly heated by gas or #1 fuel oil. Batch roasting in lots of 230 to 635 kg (500 to 1400 lbs) is the more common method, with end temperatures in the 200° to 220°C (390° to 428°F) range at the end of the cycle in 8 to 13 minutes. If a continuous roasting method is used, the temperature is 260°C (500°F) and the contact time is approximately 5 minutes.

The roasted beans are cooled by either wet or dry methods. The roasting process is termed "wet" if it is checked by the spraying of water over the hot beans (while still in the roaster). This water is partially evaporated and partially absorbed into the bean. None is discharged as wastewater. In dry roasting, the process is arrested only by air cooling and by contact with the cooling apparatus.

DRAFT

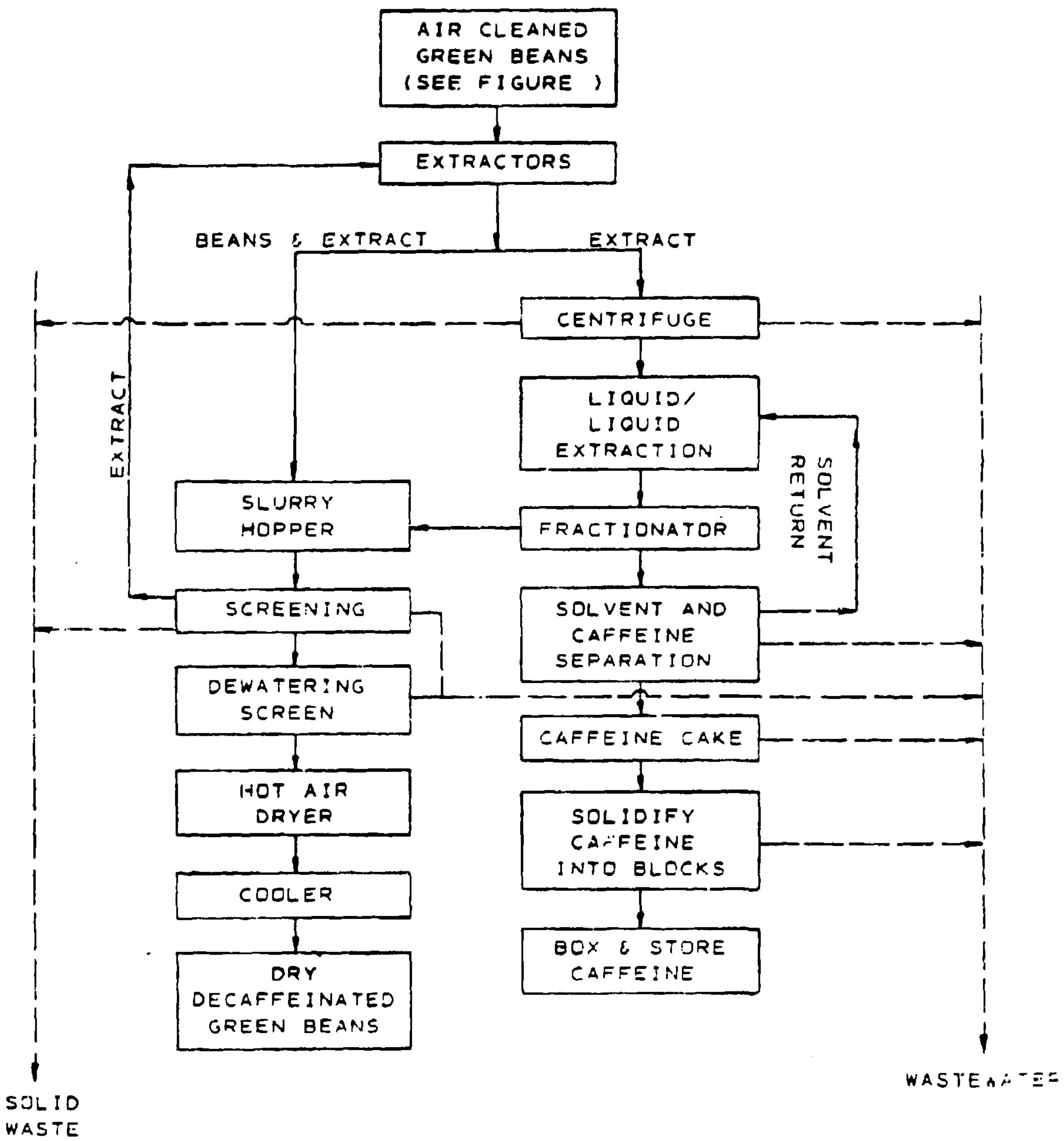


FIGURE 77

LIQUID/LIQUID EXTRACTION
DECAFFEINATION PROCESS FLOW DIAGRAM

Stoning, removal of metal and other foreign material heavier than the coffee beans, is then performed. Next the beans are stored until packaged as whole roasted beans or ground. A "granulator" composed of a series of rollers and often capable of 10 size adjustments, is commonly used to grind the beans at rates up to 1.8 kkg per hour (2 tons per hour). The ground roasted coffee is packaged for sale or further processed into a soluble coffee product.

There is normally no wastewater generated in the production of roasted coffee unless the plant utilizes a wet scrubber for the stack gasses, and few coffee roasting plants have wet scrubbers. General plant clean-up is dry -- usually portable vacuum cleaners and/or brooms.

Description of the Soluble Coffee Process - The fresh grounds are added to one end of a series of six to eight extractor chambers (see Figure 78), through which hot water is passed countercurrent to the grounds. This countercurrent flow permits the fresh hot water to extract the remaining soluble materials from the most spent grounds. The conditions of this flow are carefully controlled for maximum removal of soluble constituents and good flavor and quality.

The extract is cooled if it is to be stored before further processing, and centrifuged or filtered. The liquid extract at this stage is 20 to 30 percent solids. For freeze drying, the solids concentration must be increased to 40 percent. For spray drying, it is economically advantageous to increase the solids content to the same 40 percent. Concentration of the extract to the desired 40 percent solids level is accomplished by evaporation or freeze concentration.

Spent grounds are carried from the extractor by steam ejection to a storage tank. In some plants, the grounds are then deposited in a landfill. In other plants, the grounds are rotary dried or pressed and used as fuel for the boilers. The waste from the pressing of the grounds is a significant source of wastewater as is the intermittent (every 5 to 10 minutes) cleaning of the centrifuge or filter. Other wastewater sources include the general washdown of the extractors, sludge from the centrifuge or filter, the scaling tank, the heat exchanger, and the holding tank.

Spray Drying and Agglomeration: After concentration (if used), the extract is delivered to the atomizing nozzle and spray dried. The dried product is stored in bulk until it is packaged by automatic or semi-automatic machinery. The powdered coffee produced by spray drying is usually agglomerated by a second pass through part of the drying tower to yield the relatively large "coffee crystals" which are now popular in this country.

Wastewater is generated in this process step when the equipment is cleaned. Cleaning is done at the end of a run which may be as infrequent as monthly.

Freeze Drying: Another method of producing soluble coffee is freeze drying (see Figure 79). In this process, the liquid coffee extract is cooled and concentrated by centrifugation. Following this, it is frozen, ground, and more water is withdrawn through sublimation. The product is then packaged and stored prior to shipment.

DRAFT

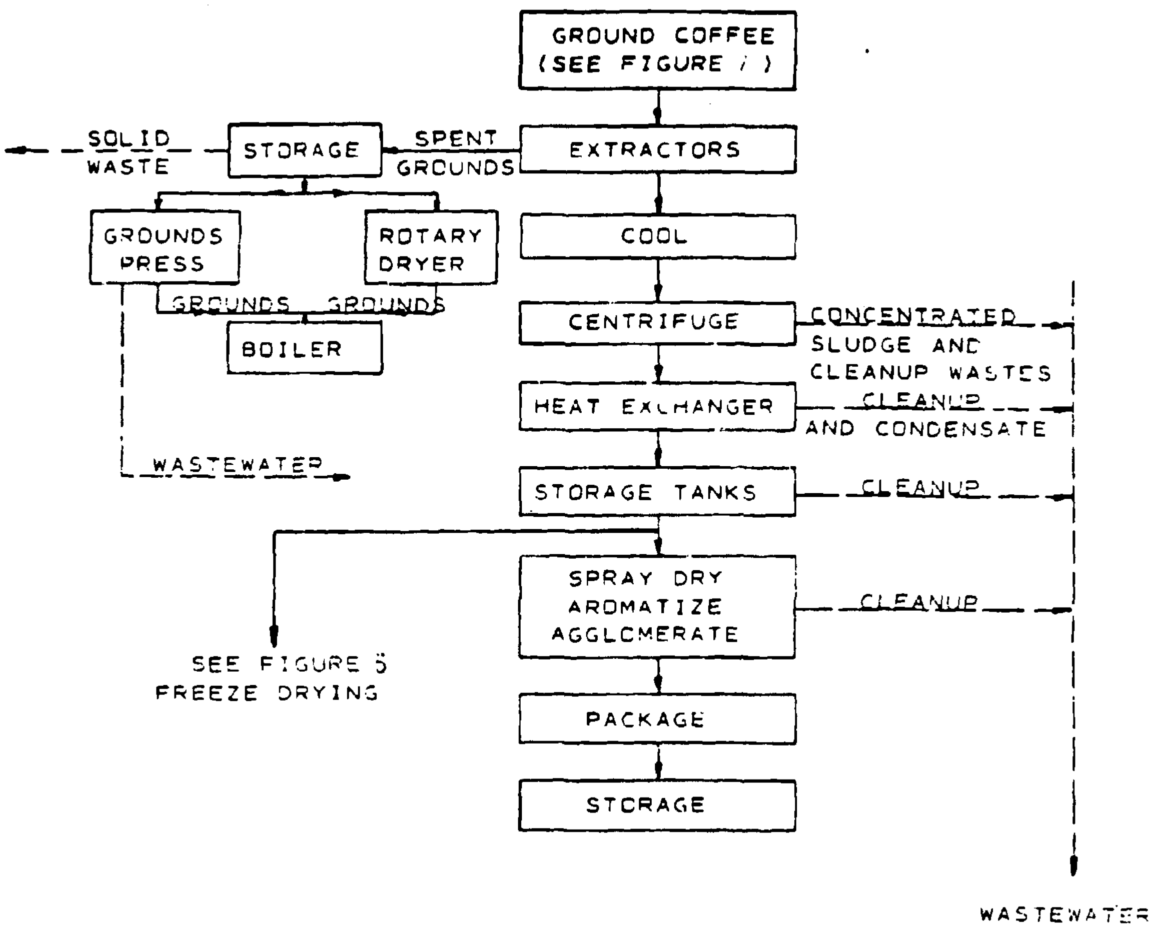


FIGURE 78

SOLUBLE COFFEE PROCESS FLOW DIAGRAM

DRAFT

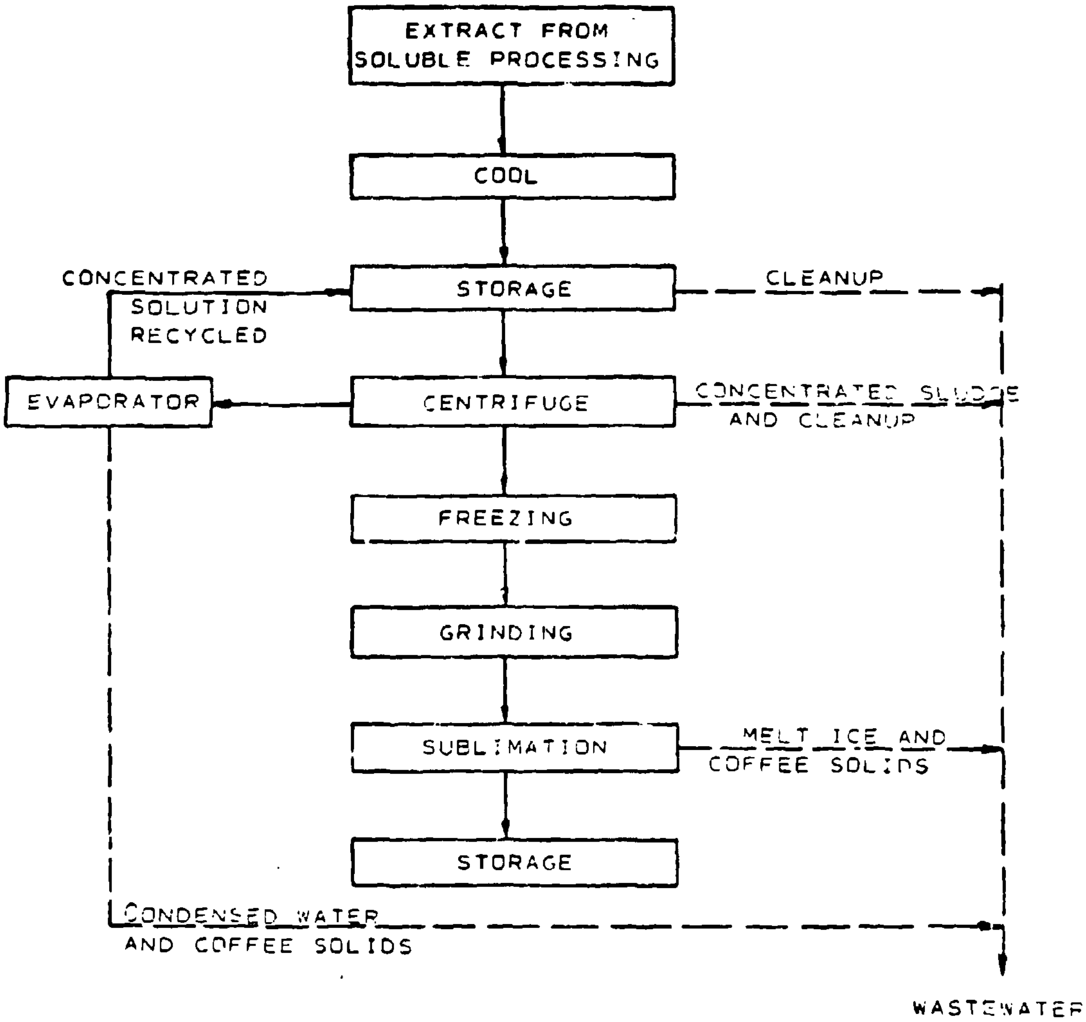


FIGURE 79

FREEZE DRYING PROCESS FLOW DIAGRAM

DRAFT

SIC 2097 - Manufactured Ice

General - Commercial ice producing plants fall within two distinct product categories - block and fragmentary ice. Block ice is produced in 136 kg (300 lb) or 132 kg (400 lb) blocks which are frozen in rectangular cans partially submerged in refrigerated brine tanks. Block ice is sold whole, divided into 10 to 200 blocks, cut into cubes and bagged, or crushed and sold as bagged sized ice. Cube ice machines are sometimes found in ice manufacturing plants, but their low volume capacity hardly justify their use. Cube and crushed ice finds its greatest usage in the preserving and serving of foods and beverages, or distribution to vending machines. Fragmentary ice is produced as small pieces such as disks, cylinders, and random shapes similar to crushed ice and normally is bagged at the plant. It is often produced on large capacity units for industrial users sucn as poultry plants, dairies, chemical plants, ready-mix concrete suppliers, and fish and seafood transportion.

According to the Bureau of the Census (2), in 1972 approximately 4.1 million kkg (4.5 million tons) of ice were commercially manufactured at some 2,000 plants located throughout the country, with the heaviest concentration of manufacturers in the Atlanta, Georgia area. Production at individual plants ranges from 0.45 to 363 kkg (0.5 to 400 tons) per day; however, typical daily production is in the 45 to 136 kkg (50 to 150 ton) range.

Demand for ice fluctuates seasonally, with the highest demand in the summer and lowest demand in the winter. Some plants close in the winter months; others continue to operate with a skeleton crew; and still others with large storage facilities, sell their product year-round but cease processing during the winter.

According to the National Ice Association (44), approximately 60 percent of ice manufacturing plants produce both fragmentary and block ice; 25 percent manufacture block ice only; and 15 percent manufacture fragmentary ice only. Block ice is still the large volume product of most ice manufacturers. However, increased efficiency of fragmentary ice making machines and decreased demand for block ice has led to decreased production of block ice and a corresponding increase in fragmentary ice. According to the Bureau of the Census (2), the quantity of block ice produced dropped from 4.4 million kkg (4.9 million tons) in 1967 to 2.2 million kkg (2.4 million tons) in 1972. This trend is expected to continue, resulting in no construction of new block ice plants. The last known block ice manufacturing plant was built around 1966. The demand for fragmentary ice has been and is expected to continue to increase substantially, possibly spectacularly. Many manufacturers have installed fragmentary ice making machines to supplement and/or to replace block ice making facilities.

Generally, the water used to make ice must be potable. It may be supplied by the local water purveyor or a well. Depending on its quality, the water may be treated by the ice manufacturer.

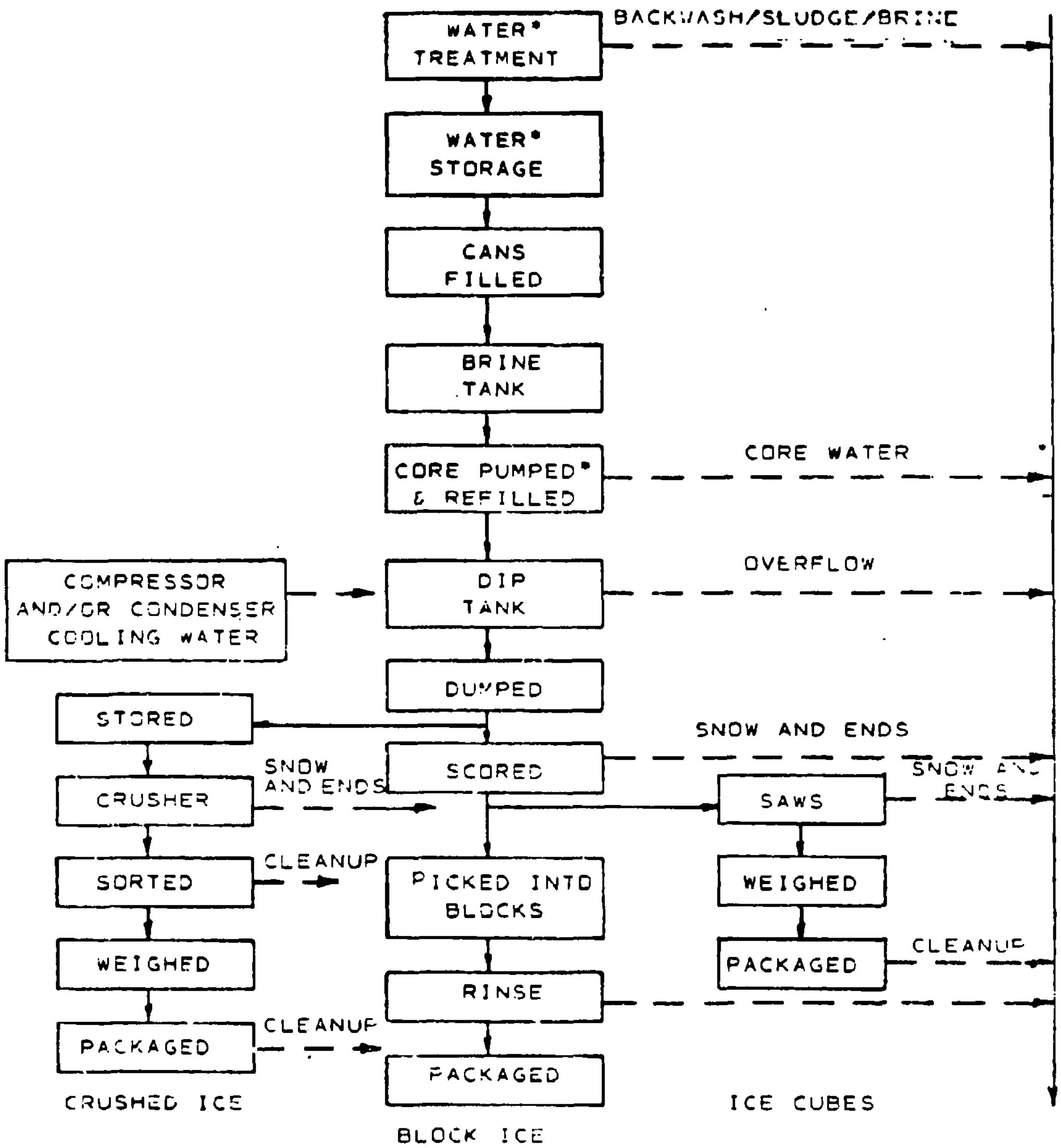
<u>Description of Process - Block Ice</u> - Municipal water is sometimes not satisfactory for the production of quality ice. Undesirable water qualities can result in poor color, residues, and tendencies to shatter or crack. To obtain clear block ice, it is sometimes necessary to treat fresh water with lime, sand filters, carbon filters, or reverse osmosis to remove suspended and/or dissolved solids. According to the National Ice Association (44), about 60 to 70 percent of the block ice manufacturers treat their water supply. Sources of wastewater at this stage of processing include backwash water, precipitate, and brine from treatment facilities.

Figure 80 illustrates the processing of block ice. The cans in which block ice is to be frozen are filled from an elevated can filler. Once filled, the cans are placed in agitated brine tanks either singularly or in groups. Groups of cans are held together by grids made of flat steel with the weight of the grids assisting to keep the cans submerged and prevent tipping. The grids also hold the cans apart (seldom over 3 cm) to allow the brine to flow between the cans. Wooden can covers rest directly over the grids and provide additional weight to hold the cans in the brine. There is virtually no make-up or blowdown from brine tanks. Water is kept in the tanks for years, and salt is added once or twice a year. Brine tanks are seldom, if ever, dumped.

During freezing, air may be used to agitate the fresh water in the cans. The purpose of this aeration is to aid in forming clear, pure water crystals by assisting in the rejection of most of the impurities into the core of the ice block. The unfrozen core, consisting of about 10 to 22 l (3 to 6 gal), is usually pumped out and replaced with fresh water preferably cooled. According to ASHRAE (45), the block of ice will require up to an additional hour to freeze the core water. A 136 to 182 kkg (300 to 400 lb) block of ice requires 1 to 2 days to freeze, depending upon the temperature of the brine.

When the blocks are frozen, the cans are removed from the brine. The frozen cans are then transported to the dumping area where they are submerged in a dip tank (filled with water) until the ice block loosens and floates up in the can. The dip tank water should be below 21°C (70°F) to avoid ice stressing and cracking or undue melting. After the ice thaws from the can, the cans are raised and moved to the dumping area where the cans are tipped, the ice blocks sliding free. Once the ice is dumped, it is rinsed with fresh water. It may then pass through a scoring machine (circular saws) to score the ice for 11 kg (25 lb) blocks and then is moved to storage. Alternatively, the 136 to 182 kg (300 to 400 lb) block may be stored until sold, at which time the block is scored and picked into smaller blocks, rinsed, and distributed to retailers or sold at the plant. Ice cans, once emptied, are refilled with water to freeze the next batch of ice.

DRAFT



* MAY BE OMITTED

NO SOLID WASTE

FIGURE 80

PROCESS FLOW DIAGRAM
BLOCK ICE

Wastewater from the freezing of block ice comes from core pumping, water used to cool the refrigeration compressors, dip tank overflow, and snow from scoring. In some ice plants, compressor cooling water is routed to the dip tank where it is used to thaw the ice blocks from the cans. In the dip tank, some chlorides and solids are added to the wastewater. They are transferred from the brine tank as the cans are being dipped.

Whole ice blocks are stored in freezer rooms with the bottom layer held off the floor about 15 cm. A space between the ice blocks and the side walls of the storage room is also maintained to promote cold air circulation around all ice blocks.

Cubes: Cubes prepared from block ice are sawed out of the whole by a variety of automatic and semi-automatic machines which handle blocks of 11 to 182 kg (25 to 400 lb). The machines consist of one or two sets of power operated circular saws operating in two plants successively - and a third large power saw for cutting the indented cubes free of the block. Ice losses from this type of processing are 30 to 50 percent in the form of snow and end pieces. These waste pieces are sometimes used to precool water which is to be frozen, but most often are discharged as wastewater.

Some ice manufacturing plants have small, 225 or 450 kg (500 or 1000 lb) per day, cube machines like the cube machines found in hotels and other commercial establishments. Cube machines are a very small percentage of most ice manufacturing plants' capacities, and are intended primarily for retail sales.

Crushed ice: Sizing machines, which have come into increasing use, consist of an ice crusher into which blocks of ice are fed. The crushed ice is delivered into an overhead rotating screen, which separates the broken pieces into bins containing the desired size(s). These pieces are then weighed and placed in plastic bags for sale or distribution to retailers, vending machines, or other larger customers.

Up to 50 or 60 percent of the block ice may be lost in crushing. Particles less than a specified size cannot be used, and must either be recycled to manufacturing or melted and discharged as wastewater. A machine has recently been introduced for use in compressing undersized crushed ice or snow into blocks. Widespread use of this type of machine could significantly increase the yield from block ice manufacturing, instead of wasting the water or recycling the snow and end pieces back to the product water.

<u>Description of Process - Fragmentary Ice</u> - Fragmentary ice differs from sized ice in that sized ice is made from crushed block ice, whereas fragmentary ice is produced when water flows over a freezing surface. One of five general methods is employed in removing ice from surfaces to which it has been frozen. These are as follows:

DRAFT

1. Separation from a flexible surface

2. Scraping the ice crystals from a wet direct expansion chilled surface and pressing the sludge into briquettes

3. Hot vapor heating the surface to release ice frozen by direct expansion to the inside or outside of tubes.

4. Mechanically separating the ice from a direct expansion refrigeration drum

5. Water defrost of sheets frozen to refrigerated plates (45).

These processing steps are done in commercial fragmentary ice making machines. As indicated in Figure 81 , following removal from the fragmentary ice machine, the ice is sized by screw conveyors if necessary, sorted by size, stored in hoppers or a surge bin, and then packaged in plastic bags. Unlike crushed ice, little, if any, ice is less than the minimum size; accordingly it can all be packaged for sale.

Fragmentary ice varies from crystal clear to opaque depending upon the water quality, and is irregular in form. Potable water (municipally supplied or from wells) seldom requires pretreatment for the manufacture of fragmentary ice. Wastewater sources peculiar to the production of fragmentary ice include the following:

1. Excess water not frozen on the freezing surface

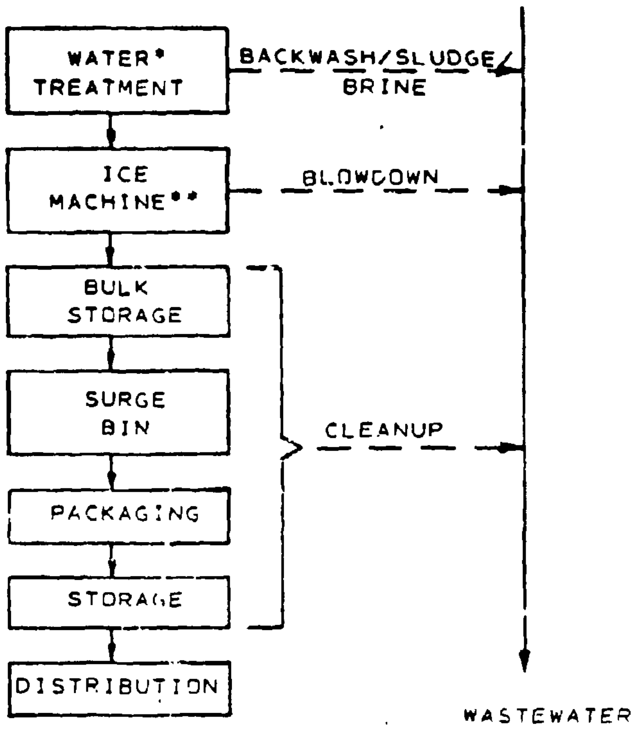
2. Water used for defrost

3. Blowdown from fragmentary machines

Manufactured ice is stored on both short and long term bases. Facilities for short term (day) storage are normally large enough to accommodate at least 3 days of production. Ice is stored for longer periods because of fluctuations in demand; e.g., production decreases during the fall and stored ice is used to fill the smaller winter demands. According to ASHRAE (45), the increasing demand for manufactured ice and subsequent production of all types of sized ice has prompted the expansion of day storage facilities by 100 to 200 percent.

General cleanup (dry sweeping with subsequent melting and/or hose down) 1 to 4 times each day, and the periodic defrosting of storage facilities add to the waste stream.

DRAFT



*NORMALLY NOT USED

**THE ICE MACHINE CAN BE ONE OF FIVE TYPES OF FRAGMENTARY ICE MAKERS; WITH OR WITHOUT WATER STORAGE BUILT INTO IT.

NO SOLID WASTE GENERATED.

FIGURE 81

PROCESS FLOW DIAGRAM
FRAGMENTARY ICE

DRAFT

SIC Code 2098 - Macaroni, Spaghetti, and Noodles

Spaghetti, macaroni, and other related products, known as alimentary pastes, are made by forming unleavened dough into a variety of shapes, which are subsequently dried to less than 13 percent moisture. Typically, these products are made by mixing semolina with water and kneading the resulting dough until homogeneous. The dough is then extruded or rolled before being cut into the familiar shapes of macaroni products: spaghetti, macaroni, noodles, shells, elbows, etc. Egg noodles contain added egg or egg yolk.

According to the Department of Commerce, Census of Manufactures (2) there are approximately 191 manufacturers spread throughout the nation which produce macaroni products. The West leads with 64 plants, followed closely by the Northeast with 63 plants. The North Central U.S. has 43 macaroni and spaghetti plants, and the South only 21. The plants range in size from large corporations to very small, family owned businesses. Total sales volume is about 400 million dollars, and production about 910 million kilograms annually.

The above figures for number of plants are believed to be misleading, however, because they include many Italian eating establishments which manufacture pasta only for their own use. Standard and Poor lists only 24 companies in this category which manufacture on a commercial scale. Since some of these companies have several plants, it is estimated that the total number of significant commercial plants in the United States is between 30 and 40. All plants contacted discharged to municipal systems.

Process Description. Figure 82 shows a process flow diagram for a typical macaroni and noodle processor. The basic raw materials are semolina, durum flour, farina flour, or a combination of these, and water. Semolina is milled from hard wheat such as amber durum. Size of particles is less important than uniformity. Coarse semolina is easier to handle, but requires longer mixing times.

Egg products are normally used in certain noodle formulations. In some cases, frozen pasteurized egg yolks are used. Alternatively, freshly separated egg yolks or dehydrated egg yolk solids may be incorporated into the various egg containing products.

The other major ingredient common to all pastas is water. Quality and temperature of incoming water are of special

DRAFT

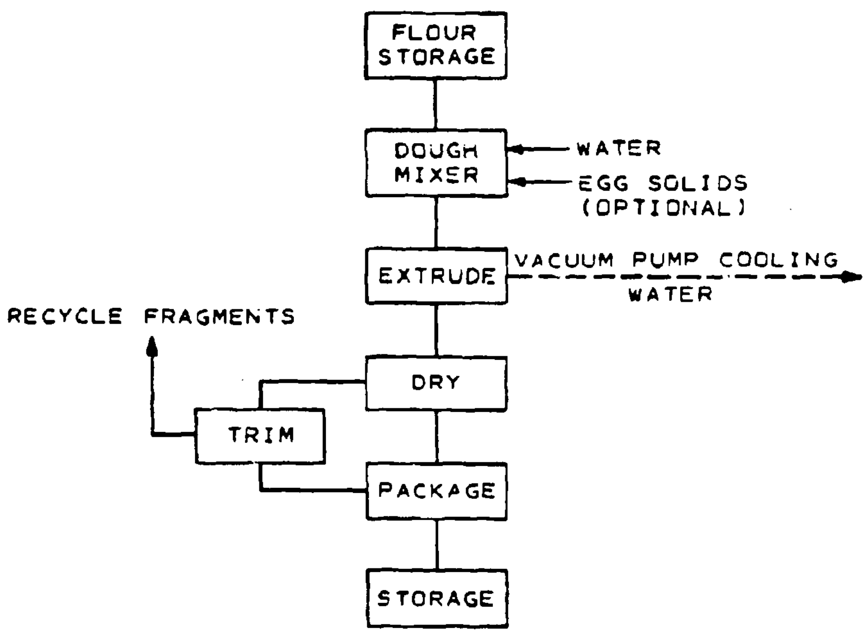


FIGURE 82
PROCESS FLOW DIAGRAM FOR
MACARONI, SPAGHETTI, AND NOODLES

consideration to obtain consistent quality products. Other ingredients may include egg-white solids, onion, garlic, celery, bay leaf, salt or other seasonings, and disodium phosphate.

Solid and liquid raw materials are mixed together in desired proportions. On the average, about 30 parts of water by weight are added to 100 parts of solid raw material. The moisture content of the original semolina varies between 12 and 16 percent.

Mixing methods vary with the type of dough mixer used. The larger and more modern facilities utilize continuous dough mixing techniques, whereas the smaller processors employ batch methods for blending and mixing. Either process results in a homogeneously kneaded dough of approximately 30 to 32 percent moisture. After mixing, the dough is pushed through various shaped dies under high pressures.

In almost all cases, a vacuum is applied to deaerate the dough as it enters the extruder. This requires extensive cooling water for proper maintenance and operation of the pumps. This water, while being non-contact water, is usually combined with remaining plant effluent, and represents, in many instances, virtually the entire effluent flow, exclusive of sanitary wastes.

If short macaroni products are to be made, a cutter placed directly under the die cuts strands into the desired length. The "shorts" are conveyed directly to the drier. Long spaghetti, macaroni, or noodle strands are spread manually or mechanically on drying sticks. After they are cut to an even length, the loaded sticks pass through a predrier in which approximately six to eight percent moisture is extracted in an hour or less time. The goods come out of the predrier with a moisture content of 22 to 24 percent.

At the discharge from the predrier, there is a recovery zone to insure equal moisture distribution throughout the product and to prevent the goods from checking or cracking during the final drying.

The final drier can be batch or continuous. Batch driers are typically used when production figures are under 4,545.45 kg (10,000 lb) per day. Batch driers in which products circulate in a closed circuit through different climate zones have proven to be efficient and reliable.

Special equipment is needed to manufacture twisted or stamped goods. "Pasta Bolognese" is made from a calibrated dough sheet which is extruded from the press. Since twists and stamped goods are usually made in small quantities, production costs are relatively high. They are typically dried in stationary batch driers containing a number of trays, through which air, heated by coils containing hot water or low pressure steam, is blown.

Both long and short cut macaroni products are generally dried to about 12 or 13 percent moisture content. Once dried, the products have excellent preservation qualities.

Short products such as soup pastas, elbows, sea shells, etc., can either be dried stationary on trays or continuously in drum or belt driers. Trays are typical for small operations, but continuous systems were observed for high production levels.

Furthermore, microwave ovens have been recently introduced for the drying of "shorts." Microwaves selectively heat water with little direct heating of most solids. Drying is uniform throughout; the shorts' pre-existing moisture gradients are evened out. This unique application results in very rapid drying, but requires specialized equipment and safety devices. Normal 24 hour drying cycles were observed to be reduced to 30 minutes.

In small factories, products are packaged by hand. In larger factories, long, short, and twisted goods are weighed and filled by semi-automatic or completely automatic machines into cellophane or plastic bags, or paper cartons. Cut corners or "breaks" inherent in the packaging of "long" items are typically recycled back through the process by being finely ground and then used as a raw ingredient.

Those plants that utilize frozen egg solids were observed to do in-place cleaning. The resultant waste flows were low (typically less than 11,340 liters/day (3,000 gal/day)). Similarly, several plants indicated the use of dried egg solids with all cleanup being performed with conventional "dry" methods (i.e., sweeping, scraping, rubbing, etc.).

It is obvious that pasta production is essentially a dry process with manufacturers avoiding the use of water during processing and cleanup. The only significant waste volume observed is non-contact cooling water. The only strong waste from an organic pollutant point of view is generated by periodic cleaning in special washers of the extrusion dies, and cleanup of egg product blending equipment in noodle manufacturing operations. In both cases, waste volume is very low.

SIC 2099 Almond Paste Manufacturing

Results of this study indicate there are currently only four active almond paste manufacturers in the United States. These operations distributed in the states of New York, New Jersey, Illinois, and California, represent a relatively minor industry in terms of food production. Several plants manufacture almond paste in combination with a variety of other nut products such as nut toppings, pastry fillings, icings, glace bases, baker's specialty items, and other nut pastes. In addition, some facilities manufacture almond paste less than 30 days per year. The following process description was obtained through a plant visitation to one almond paste manufacturer.

Description of Process - Figure 83 presents a generalized flow diagram of almond paste processing. Raw almonds (and similar nuts such as pecans, walnuts, hazel nuts, cashews, and apricot kernels) arrive at the plant by truck in boxes and are stored in coolers. The raw almonds are roasted and placed in a series of initial soak tanks at a temperature of 81 to 92°C (180 to 200°F) for about 20 minutes. Durst (46) reports that from the soak tanks, the almonds are blanched to separate the testce (red skins), germ (small hearts), and cotyledons (almond halves or split almonds). The testce and germ are aspirated and separated by screen from the cotyledons. The cotyledons are inspected and are placed in pregrinding soak tanks at 59 to 72°C (140 to 165°F) for 15 to 20 minutes. After the almond cotyledons have soaked they are conveyed to a blending hopper where the almonds are water cooled. At this point ingredients such as sugar and flavorings are added. The blend is then placed into a grinder which ruptures the fat cells causing the mixture to have a pasty consistency. The almond paste is then transferred into a number of soaking units where it is cooked to a moisture content of 10 to 15 percent. After cooking, the paste is hand packaged into 227 to 286 gm (8.0 to 10.0 oz) vacuum packed cans or 22.6 kg (50.0 lb) plastic lined bakes for institutional use. Substantial packing care is required to contain the product and prevent oxidation and subsequent rancidity of the fat content.

The major sources of wastewater generation in the manufacturing process are (1) the initial and pregrind soak tank; (2) daily plant housekeeping including equipment cleanup and floor washings; and (3) water used to cool the nuts before grinding.

SIC 2099 Baking Powder

Background of the Industry - Baking powder is produced in at least 28 plants in the United States, most of which are located in the Chicago and New York metropolitan areas. Ten manufacturers account for a major portion of the production of the industry.

Baking powder is produced for use by commercial bakeries as well as by the individual consumer. Packaging requirements thus range from small tins to barrels.

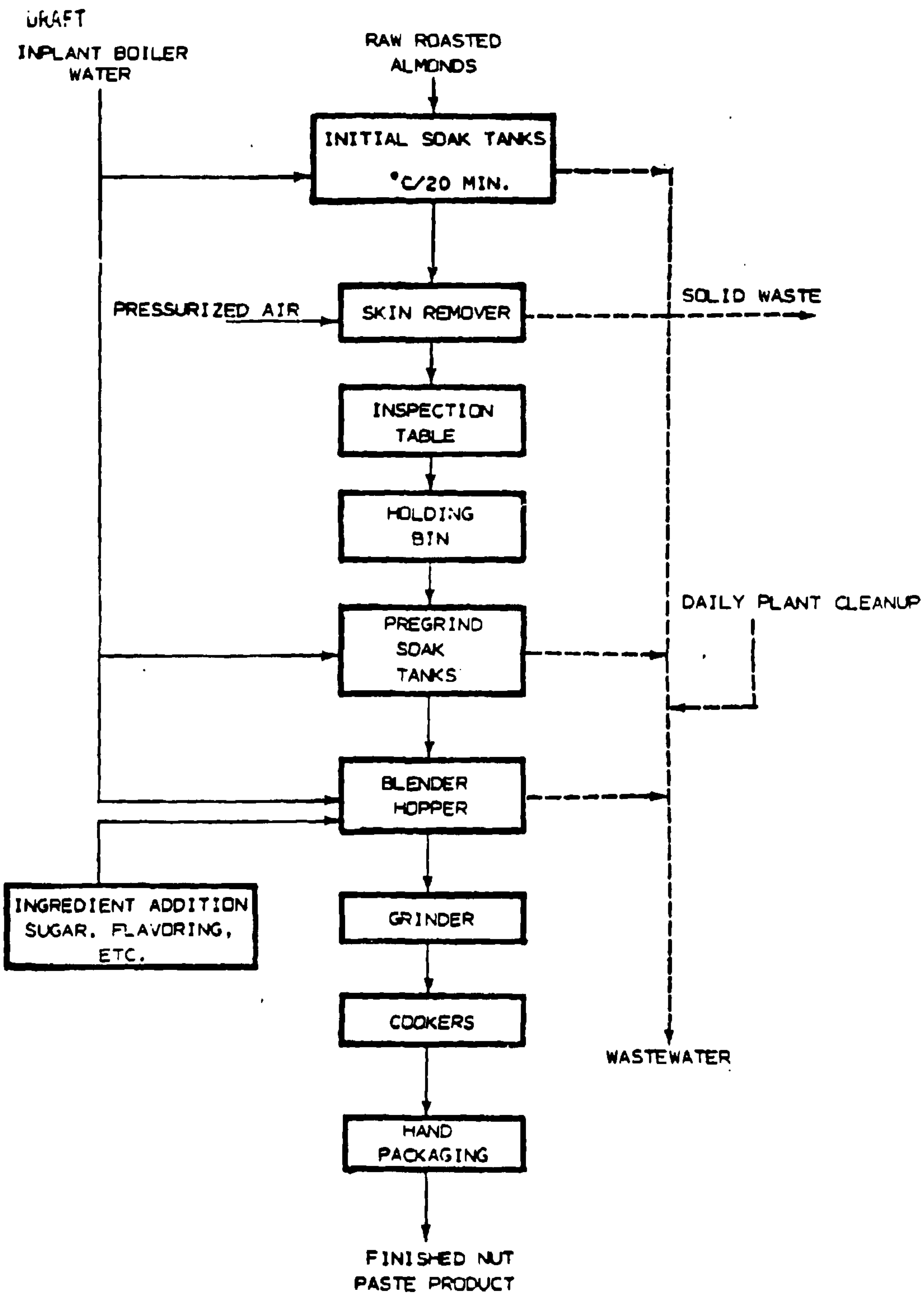


FIGURE 83

A SCHEMATIC DIAGRAM OF ALMOND PASTE PROCESSING

Description of Baking Powder Processing - A simple process flow diagram is presented in Figure 84. The basic operations in the production of baking powder are dry material transport, metering, blending, mixing, sifting, and packaging. The hydrophillic nature of the raw materials and the final product, and the stringent quality standards for the final product make it imperative that water be prevented from contaminating the material handling lines. For this reason, extensive measures are taken to control humidity and to prevent the use of water in the plant, except for emergency situations.

The raw materials used (corn starch, bicarbonate of soda, sodium aluminate sulphate, and monocalcium phosphate) may be delivered and stored either in bulk or in bags, depending primarily on the size of the plant. In the larger plants the material is unloaded from railcars or trucks by air or mechanical transport systems and diverted to dedicated storage silos. In smaller facilities raw materials are received in palletized bags which must be mechanically transported to the blending area, opened, and deposited in storage hoppers. The raw materials are then metered into the blender in proper proportions. The blended material is transferred to a surge hopper to await packaging so that a subsequent batch may be blended. The material is then sifted to remove foreign materials and deposited into the holding hoppers for each packaging line. The finished product is packaged in the appropriate type and size container, palletized, and warehoused for future shipment. The entire operation does not normally require the use of any water either for processing purposes, cleanup, or dust control. In-plant cleanup is entirely by dry methods. i.e., air brushing, foxtail brushes, brooms, and vacuum systems. Water would be used for cleanup only in an emergency situation, such as after a fire or an accident. The bulk raw material unloading docks for the air-slide rail cars or trucks and the bagged raw material unloading and warehousing areas may be hosed by water wash in some plants in order to cleanup spills after unloading operations are finished. However, this cleanup procedure is infrequent and undocumented.

Dust from air transport systems is apparently controlled by cyclone separators, filters, and/or bag houses. Wet scrubbers have not been documented.

SIC 2099 Bouillon

There are only four known producers of bouillon cubes in the United States. In the course of this study all four plants were contacted, three were visited, and wastewater sampling was conducted at one plant. Only one of the four producers manufactured bouillon products exclusively. Of the remaining three, bouillon was a major product in one and a minor product (less than 20 percent total production) in the other two. Products produced along with bouillon include soups, soup mixes, puree, drink mixes and specialty foods.

Retail sales of bouillon products was estimated at 30 million dollars in 1973. Demand for bouillon products has been increasing in recent years and is expected to continue as the cost of meat rises.

DRAFT

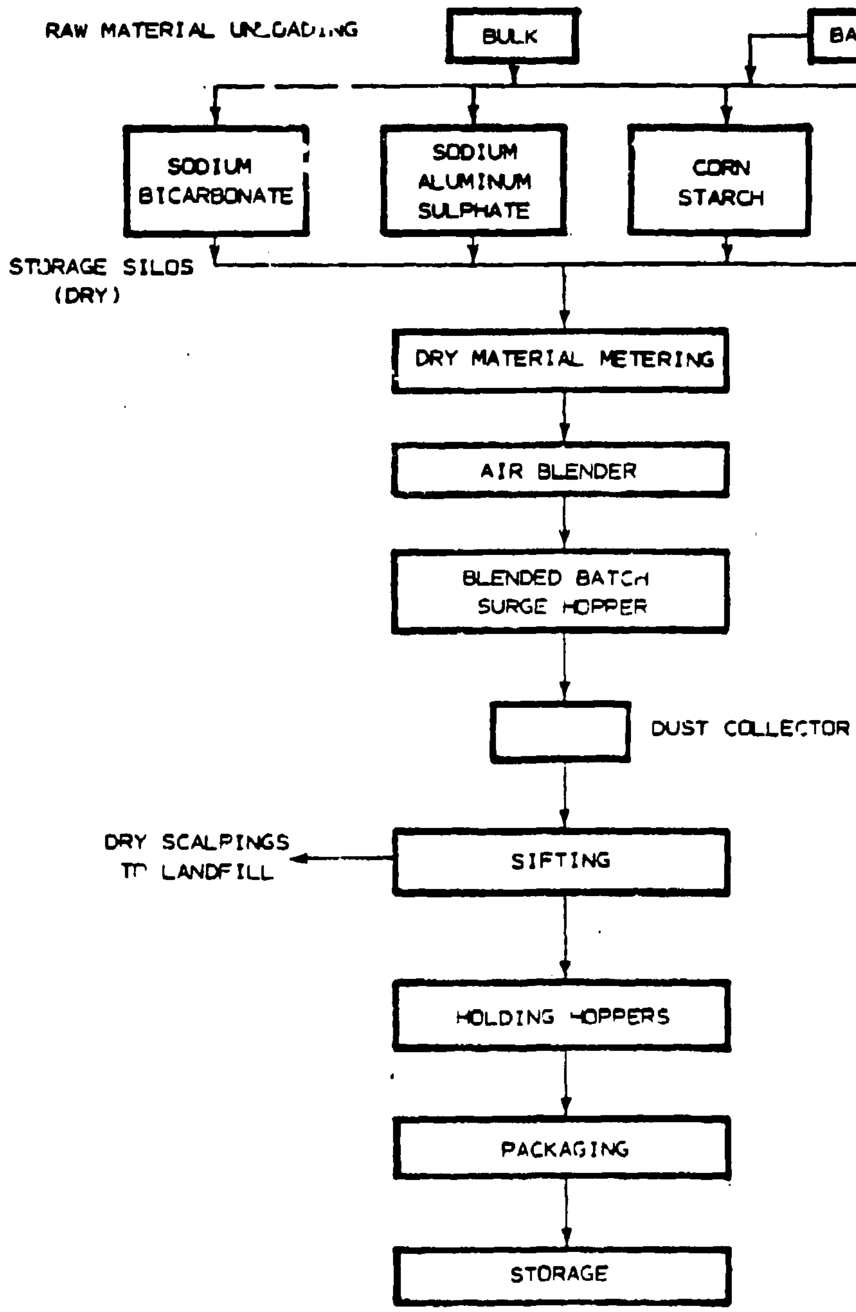


FIGURE 34

BAKING POWDER PROCESS FLOW DIAGRAM

Process Description-Bouillon Products - The manufacturing of bouillon products is basically a four step process as illustrated in Figure 85. The ingredients used to manufacture bouillon products are purchased from a number of other food related areas such as the edible oil, spice, and organic chemical industries. Ingredients are received and stored in fiber drums, boxes, or plastic bags. It is not uncommon for plants to produce a portion of the ingredients in-house. Two plants, for example, are known to produce their own hydrolyzed vegetable protein.

The various ingredients, including hydrolyzed vegetable protein, salt, meat extract, fats, spices, and emulsifiers, are proportioned in a mixing tank. The mixture is dried in an oven and subsequently ground into a granular form. The granular bouillon is either packaged in jars or pressed into cubes.

Wastewater generation in the bouillon process is limited to cleanup water used to wash mixing tanks, ovens, grinders. The packaging area is cleaned with air.

SIC 2099 - Bread Crumbs, Not Made in Bakeries

General - The manufacturing of bread crumbs outside of bakeries is a very limited industry. Four manufacturers of bread crumbs, which are not primarily bakeries, were contacted. The majority of bread crumbs appear to be manufactured and packaged for retail sale by large bakeries.

Description of the Process - Bread crumb production not in bakeries is essentially an assembly process. In all of the plants contacted, baked and ground bread crumbs are the raw material used. These baked crumbs are purchased in 20 to 45 kg (50 to 100 lb) bags from bakeries. These bags of crumbs are emptied into a vibrating mixer where they are blended with the desired combination of spices. From the mixer, the spiced crumbs are transferred to a holding tank on a conveyor belt. The crumbs are then gravity fed from the tank to the packaging machinery. The bread crumbs are packaged in 227 gram (8 oz) or 426 (15 oz) paper cans. Lids are applied and the cans are boxed for storage and shipment. All of the equipment and the floors are dry cleaned, and no water is used in the product. For a schematic representation of the process, see Figure 86.

For all practical purposes, bread crumb processing not in bakeries can be considered as a dry process. There is apparently no process wastewater discharged.

DRAFT

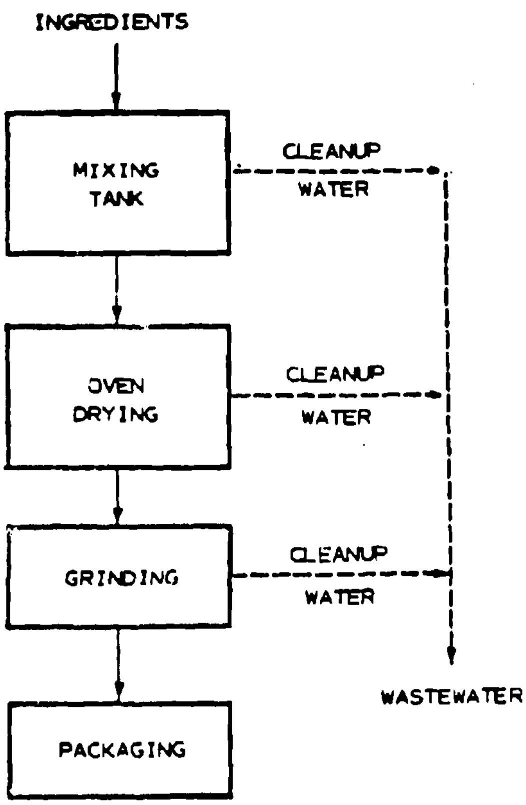


FIGURE 85

BOUILLON PRODUCT MANUFACTURING PROCESS

DRAFT

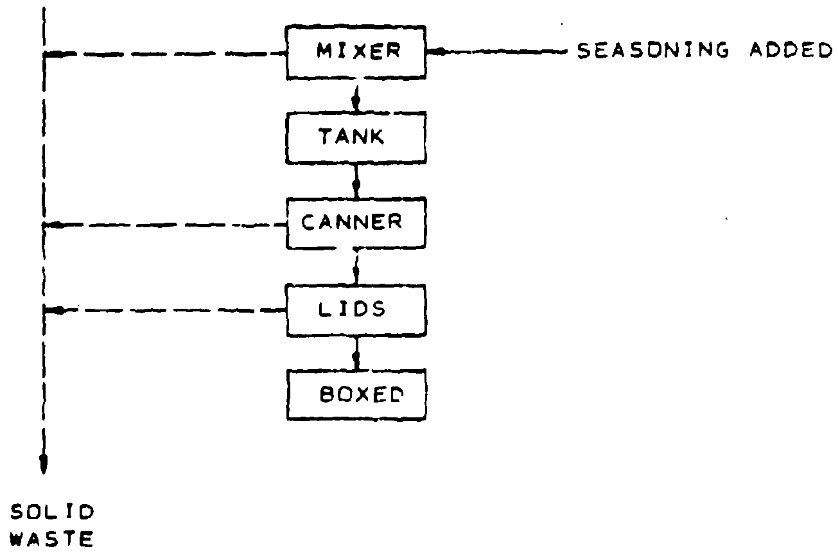


FIGURE 86

BREAD CRUMBS, NOT MADE IN BAKERIES
PROCESS FLOW DIAGRAM

DRAFT

SIC 2099 - Chicory

General - Chicory is a flavoring which is blended with coffee. More chicory is consumed in the South than elsewhere in this country.

Chicory is made from roots of the chicory plant. It is grown in Europe and is pre-processed prior to importing. The pre-processing consists of harvesting the roots, cleaning, slicing, and dehydrating. It is shipped to the United States in burlap bags.

There is only one chicory processing plant in the United States. It produces approximately 2,270 kkg (5 million lb) each year. Both the building and the equipment of the processing plant are relatively old.

Description of the Process - Chicory processing is similar to roasted coffee processing, as illustrated on Figure 87 . The pre-processed dehydrated pieces of root are shipped to the plant and stored in burlap bags. The bags are dumped into a bucket elevator and then a screw conveyor for transfer to roasting ovens which are similar to roasters used for coffee.

After roasting a specified time, the oven is turned off and approximately 4 l (2 gal) of water per 450 kkg (1000 lb) charge is sprayed onto the chicory while it is still in the roaster. This water is used to reduce the potential fire hazard in the roaster. The roasted chicory is then dumped into an air cooler. There are no liquid drippings from this cooler. After air cooling, the chicory is conveyed to the grinder where it is ground into specified degrees of granularity and then packed into polyethlene inner bags and burlap outer bags. Excessively fine particles are reconstituted and reground.

The bags are stored at the plant until distributed. A relatively low humidity must be maintained in the packaging and storage areas in order to prevent "caking" of the chicory. Chicory tends to cake due to the high sugar content of the material. In that form, it is not saleable and must be reprocessed and repacked.

There is no process water. A minor amount of water is used for an air-cooled air conditioner during the summer months and as non-contact cooling water for a small compressor. None of the equipment requires wet cleaning; it is wiped out periodically with rags. General plant cleanup is dry -- predominately dry brooming. More severe spillage areas may first be dry broomed; then mechanically scraped and broomed; and possibly wet mopped using a conventional mop and bucket. The basement floor of the plant was concrete with one floor drain near the back door. The chicory is stored on this level, which prevents use of water for cleaning. The second and third floors of the plant were wood and did not show evidence of water application.

DRAFT

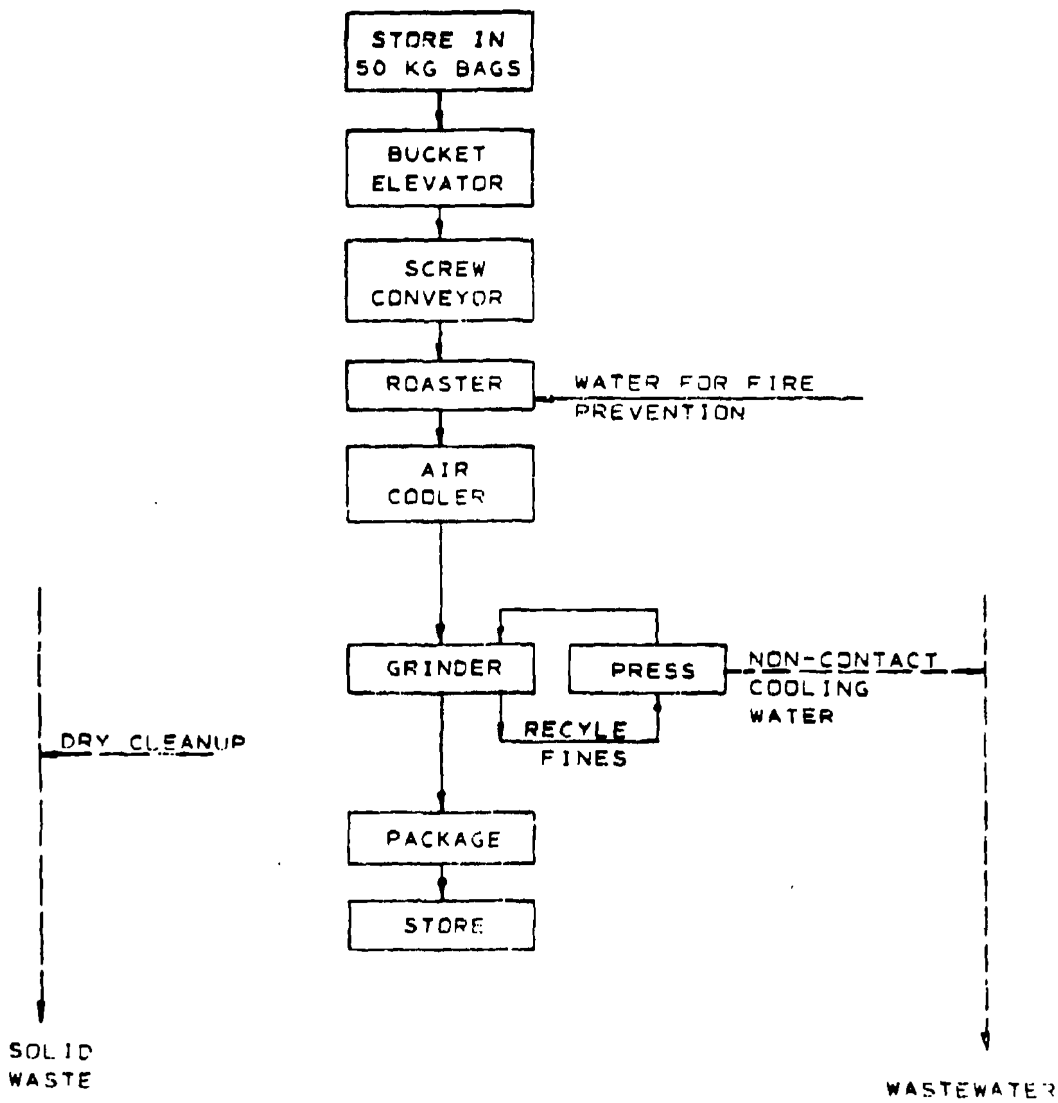


FIGURE 37

CHICORY
PROCESS FLOW DIAGRAM

SIC Code 2099 - Paprika and Chili Pepper

Paprika and chili peppers are major dehydrated vegetables, and are important spices used in many foods. A handful of companies located in the South and West process these commodities. For the purposes of this study, three plants were field visited for the collection of historical data, and composite samples were collected and analyzed to verify these data.

Paprika and chili peppers are virtually identical and generally can only be distinguished by their obvious taste differences. The plants are harvested between early October and December. Harvesting is done mechanically or by hand, depending on the size of field, climatic conditions, and availability of labor.

Preservation of chilis and paprika is accomplished by standard dehydrating techniques. Drying is done either on continuous stainless steel belts or individual tray driers. In either case the original raw moisture content of the vegetable is reduced to below ten percent by the application of heat to the sliced, diced, or shredded vegetable. The combination of heat and moisture reduction preserves the product from bacterial degradation; these low moisture levels are not conductive to bacteria, mold, and yeast growths.

Process Description. Figure 80 shows a typical process flow diagram for denydrated chili peppers and paprika. After harvesting, the peppers are brought to the plant in either large wooden tote bins or in bulk. Storage is less than 24 hours to prevent any microbial breakdown. Typically, the chilis are conveyed through a dry reel to remove dirt and debris. They are then dumped directly into a large soak tank which wets the vegetable and loosens adhering dirt. The chilis are usually removed from the soak tank by a continuous elevated conveyor with high-pressure overhead cold water sprays to further clean the extraneous material.

The soak tanks and water sprays contribute the major volume of wastewater genrration. The tanks may be dumped several times during the day, the frequency depending on the condition of the harvested peppers (mud, vegetable damage, etc.). Tote or storage bin washing can also be a source of significant waste strength.

An inspection typically follows washing at which time defects are removed as culls. The vegetables are conveyed directly to either

DRAFT

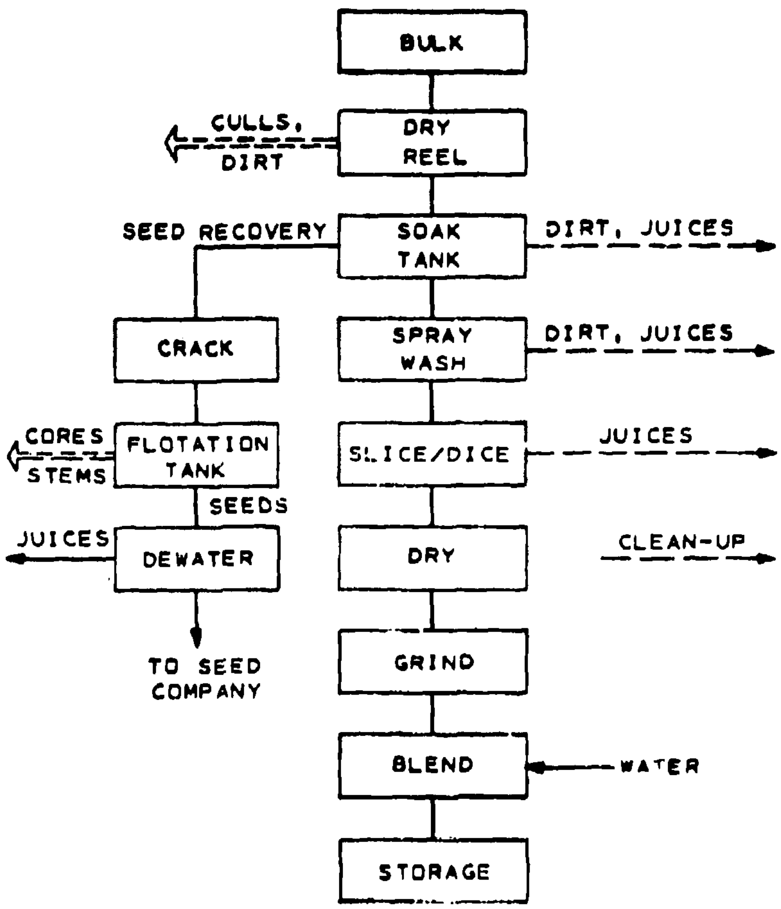


FIGURE 08
PROCESS FLOW DIAGRAM FOR
PAPRIKA & CHILI PEPPERS

a chopper, a slicer, or a dicer where the entire pod is cut. The various cutting operations contribute a strong concentration of organic solids (juices) to the wastestreams due to the macerating of the plant cells. In addition, these machines are periodically washed to reduce bacterial contamination. Finely comminuted organic particles enter the waste flow from these rinsings.

The chopped pieces are coated with fine sulfite sprays to prevent browning during the dehydration process. These sulfited pieces are conveyed to either a continuous stainless belt drier or alternately to wooden trays. If trays are used, then a series of trays are loaded with even layers of the chopped peppers. When sufficient trays have been filled, they are placed into a drying tunnel, and warm air is introduced until the desired finished moisture is attained. With either method of dehydration, final moisture levels of approximately eight percent are obtained.

The other major source of wastewater is standard end-of-shift clean-up, at which time all tanks, conveyors, dicers, etc., are emptied, opened, and thoroughly washed and sanitized before startup of the next day's operation.

The dried flakes may be packaged directly or milled into fine chili powder or paprika powder. The milling is done by conventional hammermill and screens; but after the dried pieces are finally ground, they are added to a type of ribbon blender where water in the form of a fine spray is introduced to raise the moisture level to ten to twelve percent. The increased moisture aids in color retention of these ground powders. The powders are then packaged in the desired container.

Seed recovery is an important by-product of this type of vegetable operation. Carefully selected fields of either chilis or paprikas are identified as being desirable for seed recovery. When these particular lots are brought into the plant to be dehydrated, the pods are cracked and core and seed are separated (usually by flotation). The pods are skimmed from the surface while the seeds are diverted through a dewatering reel. The seeds are sold to a seed company and become the following year's crop.

Water reuse and recycling was not observed in a typical pepper dehydration. In some cases the final water sprays became make-up water for the soak tanks, but the process does not lend itself to water reuse.

DRAFT

SIC 2099 Desserts, Ready-to-Mix (Gelatin)

Background of the Industry - Ready-mix desserts and prepared gelatin desserts are produced in at least 46 plants in the United States with most of these facilities located in the Mid-west and the Northeast. The products, directed primarily at the institutional and individual consumer, are marketed in nearly infinite variety of flavors.

Although the industry has used wet production techniques in the past, technological advances have made dry production techniques virtually universal in the industry. These techniques involve the mixing and packaging of raw materials and no significant contact with process water.

Process Description - Ready-mix desserts and prepared gelatin desserts are manufactured as shown in Figure 89. The basic operations are dry material storage, transport, screening, metering, blending, mixing, sifting, and packaging. The hydrophilic nature of the raw materials and the final product in addition to stringent quality standards make it imperative that water be prevented from contaminating the process lines. For this reason, extensive measures are taken to control humidity and to prevent the material from accidentally contacting water.

The raw materials used are generally delivered and stored in bags or cartons. For ready mix desserts these materials may be dextrose, modified food starch, and/or cornstarch, salt, carrageenan, sodium phosphate, hydroxylated soybean lecithin, nonfat dry milk, citric acid, and miscellaneous flavorings and colorings. Prepared gelatin desserts use edible gelatin, salt, fumaric acid, and miscellaneous flavorings and colorings. Raw materials are deposited in their designated storage and metering systems.

The various types of desserts are each prepared in a batch operation. In larger plants mobile collection hoppers are moved about the facility collecting screened and metered quantities of ingredients. When the desired ingredients are gathered, the hopper is discharged to the mixer.

The prepared gelatin dessert mixing process requires the addition of a small amount of water (less than one part of water per 600 parts of product). The water is incorporated into the product and is not wasted. The ready-mix dessert process uses no water in the mixing step. This is the only difference in the processing of prepared gelatins and ready-mix desserts.

After mixing the product is stored in a holding hopper until it is packaged in the appropriate sized container. The product is then warehoused for future shipment.

DRAFT

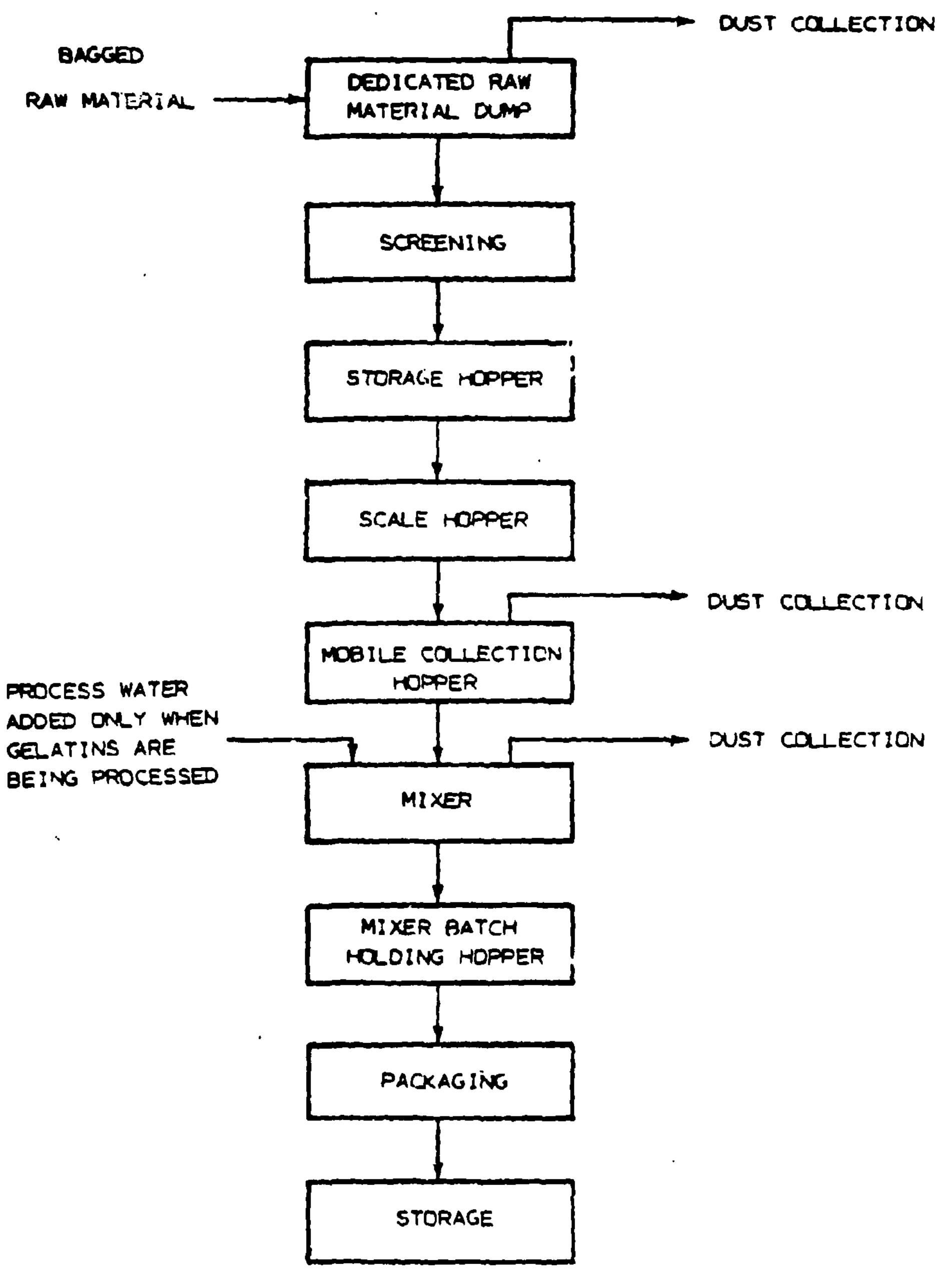


FIGURE 89

PREPARED GELATIN DESSERT PROCESS FLOW DIAGRAM

DRAFT

The only source of wastewater in the processing operation is from the water washout of mixers to prevent color contamination of the product. Wash out takes place in a segregated washroom. All other cleanup in the vicinity of the process line is accomplished by dry means, i.e., vacuum cleaners and brooms.

Newer plants are designed to facilitate dry cleaning through provisions for soft cleaning hoppers, conveyors, and other machinery. Floors and working surfaces may also be coated to improve dry cleaning efficiency.

Wastewater generation rates from equipment wash out are highly variable Mixers are washed only when there is a product change and it happens that the previous product would cause color contamination of the following product.

Dust control facilities are required for these plants, however, dry collection techniques are used exclusively in the plants surveyed.

SIC 2099 Honey

Honey, the oldest known substance used as a food sweetener, was widely used as such prior to the advent of refined sugar. Its utilization today continues as a household condiment and also because of its hygroscopic characteristics as an ingredient to retard drying in baked goods. The annual production of honey in the United States averages 100,000 kkg (110,000 ton). Excluding small farm operations a total of 16 plants produce the bulk of commercial honey. The value of honey products in 1972 was $64 million, a 31 percent increase over 1971.

Description of the Honey Production Process - Honey is a natural food, produced by the honeybee (Apis Mellifera L.), and is available in various forms, e.g. liquid, comb, cut comb, granulated or finely crystallized, and creamed. It requires no elaborate processing and a considerable proportion of the crop passes from the producer direct to the consumer. However, when honey is to be sold in the retail market, it usually goes to local producers for packaging. Figure 90 shows a typical honey process for the retail market.

The honey arrives at the plant already extracted from the cone, unless comb honey is to be processed. Comb honey, which makes up a small proportion of the bottled honey, is usually cut and bottled by hand. Honey which has been extracted from the cone is first stored in heated tanks at the plant receiving area. Heated storage tanks serve two purposes: 1) to make the honey less viscous, and 2) to help remove minute air bubbles entrapped in the cold honey. The tanks are usually kept at a temperature between 60°C and 70°C, according to Manley (47). The storage tanks are generally heated by a recirculating hot water system. Since honey has many flavors and colors, mixing is sometimes employed in the tanks to produce a more desirable blend. From the receiving tanks, honey is then pumped to another set of holding tanks called "filtering tanks." These heated filter tanks are where honey is held prior to pumping through the filter process.

DRAFT

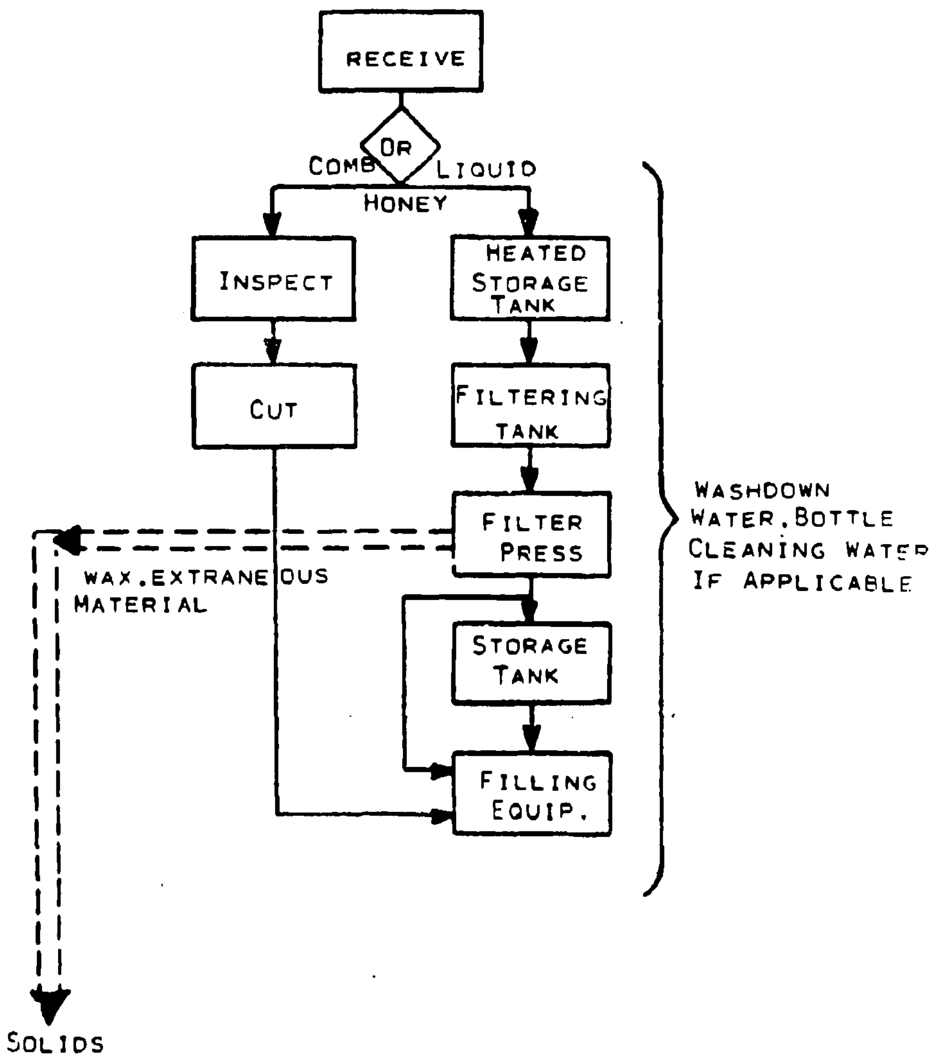


FIGURE 90

HONEY PROCESS

Filter presses employ a series of canvas or textile type screens, through which the honey is forced to remove extraneous material such as wax, bees wings, and other foreign substances. In some cases, a filter aid, such as decolite, is added to the honey prior to filtering. The presses are washed daily (outside wash), and are dismantled usually every other day for a thorough cleaning. From the filter presses, honey can be returned to storage tanks or directly to filling equipment.

Honey is generally bottled in glass or plastic containers; however, for bulk purposes tins or paper containers are sometimes utilized. After bottling and sealing, the containers are cleaned of spillage. Depending on the size of the operation, the cleaning can either be done manually by washing and wiping or mechanically with hot water washers. Usually the use of water in any operation is avoided due to the hygroscopic tendency of honey.

Honey that is to be sold in granulated form is generally bottled cold. However, even heated honey, if allowed to set for a period of time, will granulate.

Washdowns are the only major source of wastewater in honey manufacturing. Usually, steam/water hoses are utilized to clean equipment and floors. Washdown flows, depending on the size of plant or extent of washdown, seldom exceed 800 l/day (200 gal/day).

SIC 2099 Molasses and Sweetening Syrups

Sweetening syrups and molasses are considered in the Census of Manufactures as a single food preparation class and are designated by SIC product code 20993. Included in this group are the producers and/or bottlers of pancake syrup, sorghum syrup, maple syrup, and molasses. Together these establishments accounted for $138.8 million in shipments in 1967.

Maple syrup is produced in the northeastern states from Wisconsin through New England, with Vermont being the largest producer. The annual production averaged 4,000 cu m (1.2 million gallon) during the last ten years and appears to have leveled off since 1949. The syrup has been refined in essentially the same manner since the local Indians passed the knowledge on to the white settlers. The manufacture to date remains a small farm business with only a few establishments engaged in the packaging of a wholesale product.

Sorghum was first introduced into the United States around 1700 primarily as a forage and silage crop. Approximately eight million hectares (20 million acres) of sorghum are planted yearly. The primary species of sorghum grown for syrup manufacturing is S. Saccharatum, which is grown primarily in the southern states. In 1972 the production of sorghum syrup was reported by Agricultural Statistics to be 27,211 cu m (7,189,100 gallons).

Description of the Molasses Process - Molasses is a valuable by-product of beet and cane sugar manufacturing. "Blackstrap" molasses is the final syrup left after repeated crystallizations for the extraction of sugar. The major portion of molasses produced is utilized for animal feed, ethyl alcohol, monosodium glutamate, and yeast production. Smaller quantities are used in the manufacture of glycerine, lactic acid, acetone, and syrup.

The molasses obtained in the early stages of sugar production has a pleasant, palatable flavor and is used in the preparation of edible molasses. As shown in Figure 91, the edible molasses is first heated and filtered, before being pumped to filling machines which deposit the molasses into the appropriate container. The containers are then inspected, sealed, and rinsed prior to transporting to the labeling and final packaging area.

The bottling of molasses produces wastewater from two areas: the periodic cleaning of equipment and the rinsing of the filled bottles. Due to the limited processing equipment and generally small size of the operation, the volume of wastewater discharged is not large.

Description of the Maple Syrup Process - Maple syrup is produced from the sap of the sugar maple tree, Acer Saccharum, which grows in the north central and northeastern states. During the late winter and early spring the trees are tapped to draw off the sap. The sap, containing approximately three percent sugar, is boiled down to a sugar concentration of 66 percent by the individual farmer prior to delivery to the processor. The majority of processors are small farm operations; there are only a limited number of establishments which bottle maple syrup on a large commercial scale for wide distribution. The following process description, which is illustrated in Figure 92, is concerned only with the latter group of processors.

The syrup is received at the plant in drums and subsequently graded according to color and sugar concentration. The raw syrup is heated in kettles and then filtered through a medium of diatomaceous earth. The filtered syrup is filled into the desired container and sealed. The containers are then washed in either a water bath or spray to remove any spilled syrup. After washing, the filled syrup containers are transferred to the labeling and casing area.

In addition to bottling syrup, the plant may also crystallize maple sugar for production of various fondant creme candies. The discussion of the candy process has been handled in the section dealing with confections, SIC 2065. Also, the maple syrup may be carmelized in cooking kettles to intensify the maple flavor characteristics. The carmelized syrup is reconstituted in water and boiled for distribution as maple flavoring.

There are two major sources of wastewater in the maple syrup process: 1) daily cleanup of processing area floors and equipment, and 2) non-contact cooling water. The cleanup of the floors is accomplished

DRAFT

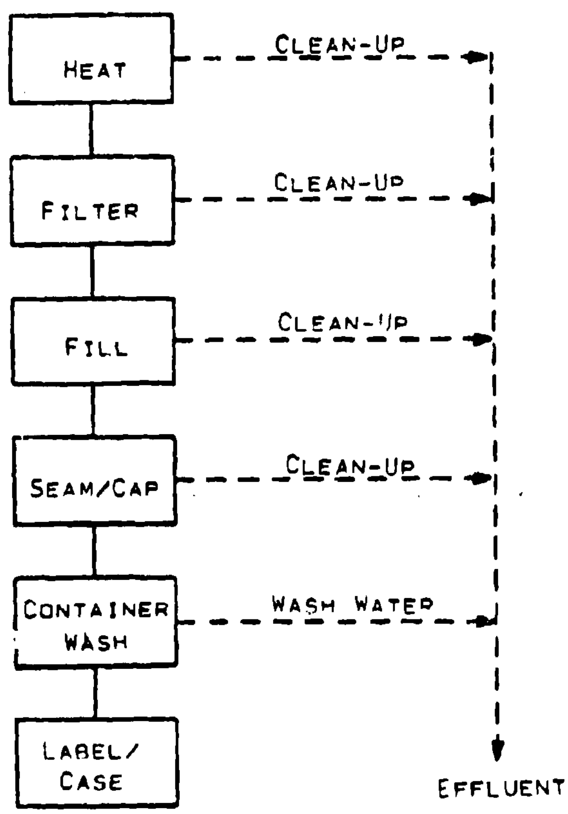


FIGURE 91

MOLASSES

DRAFT

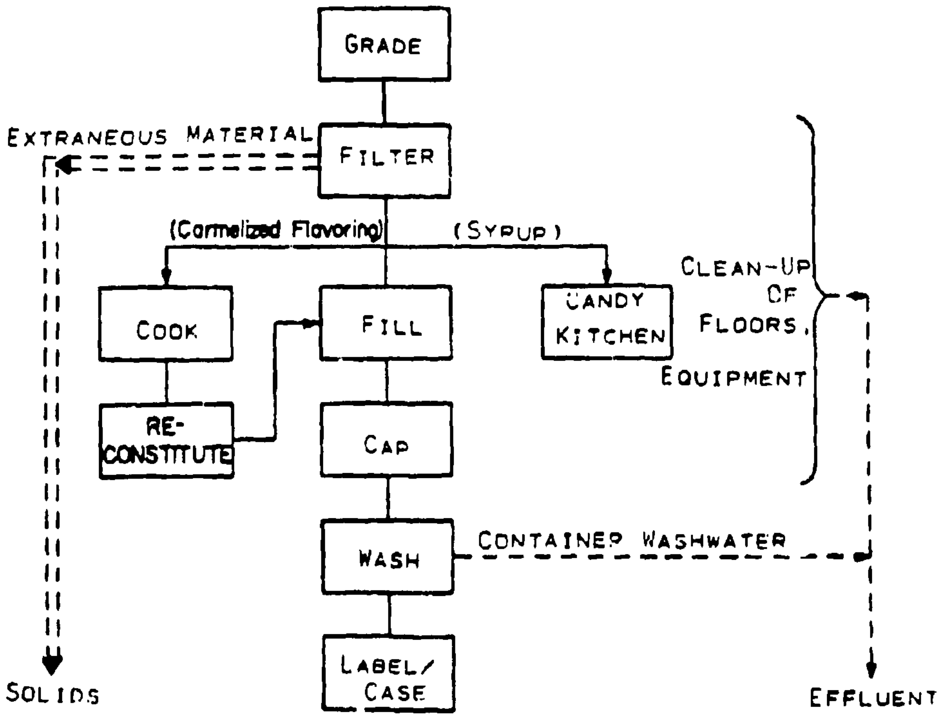


FIGURE 92

MAPLE SYRUP

by mopping; the kettles, filters, and other equipment are rinsed with a small amount of water to maintain cleanliness and efficiency, the total volume of cleanup water being less than 4,000 l/day (1,000 gal/day). The discharge of cooling water may reach 20,000 l/day (5,000 gal/day); however, as it is non-contact, waste loadings are negligible.

Description of the Pancake Syrup Process - The production of pancake syrups from a sugar base is a relatively uncomplicated process which requires little processing prior to bottling. The process, as shown on Figure 93, begins with dissolving corn and or cane sugar in water in heated kettles. Selected flavorings are added to the sugar water solutions and the liquid is cooked until the desired color and viscosity characteristics are achieved. Flavorings may be added before the syrup is pumped to filling machines which deposit the hot syrup into the appropriate preheated container. The containers are subsequently capped, rinsed, and transported to the labeling area for final packaging preparation.

A continuous flow of wastewater, about 9500 l/day (2500 gal/day) per line is generated by the container washer. The other significant source of wastewater is from the daily cleanup of the processing area, kettles, and equipment. Non-contact cooling water would also increase the final volume of wastewater discharged but would not affect the loading.

Description of the Sorghum Syrup Process - Sorghum cane is cultivated primarily in the mid-western and southeastern states. It is harvested and processed during a three month season, normally August through October. Most sorghum syrup producers are small farm operations which dispose of any wastes directly to the land; however, there are a few manufacturing plants with larger production capacities which generate significantly higher volumes of wastewater. The process description and subsequent effluent evaluations will concentrate on the latter.

Upon receipt at the plant, the cane is subjected to a dry cleaning process to remove remaining leaves and extraneous material. As noted in Figure 94, the next step is the crushing of the cane in roller mills to extract the juice which contains about nine percent sucrose and three percent invert sugar. The extraneous material is separated from the juice by settling and skimming. A filter aid is then added to the juice and the mixture is pumped through a filter press for further clarification. Concentration of the sugar is accomplished by boiling in a vacuum pan or, as on the small farm operation, in open kettles. The concentrated product is hot filled in the desired container which is subsequently capped, washed, and labeled for market.

Wastewater is generated on a continuous basis from the container ash operation and from the barometric leg used to draw a vacuum on the reducing kettles. This latter source is the most significant with respect to volume, but low in waste loading as the only potential wastes are small amounts of volatile solids in the condensate. Periodic cleaning of the filtering mechanism necessary to maintain efficiency and daily washdown of the processing area contributes the highest waste loading, but even this is a relatively low volume.

DRAFT

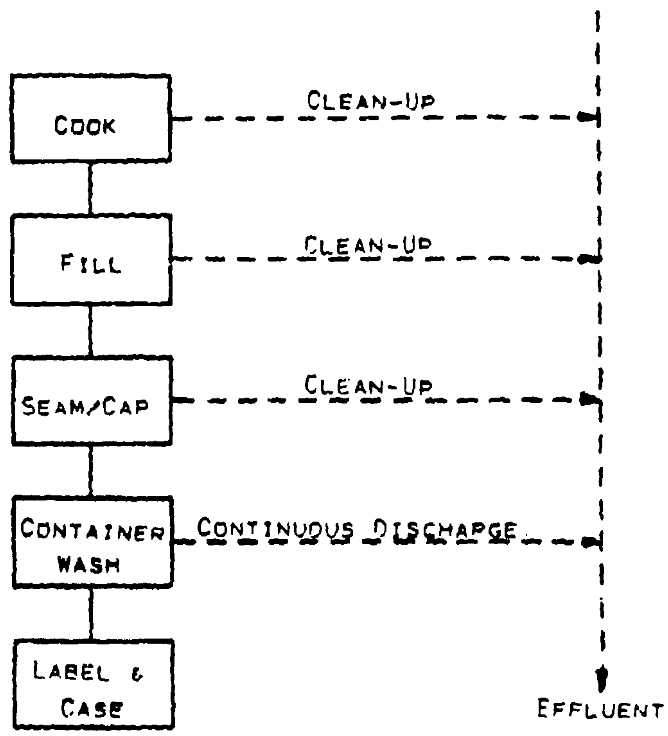


FIGURE 93

PANCAKE SYRUP PROCESS

DRAFT

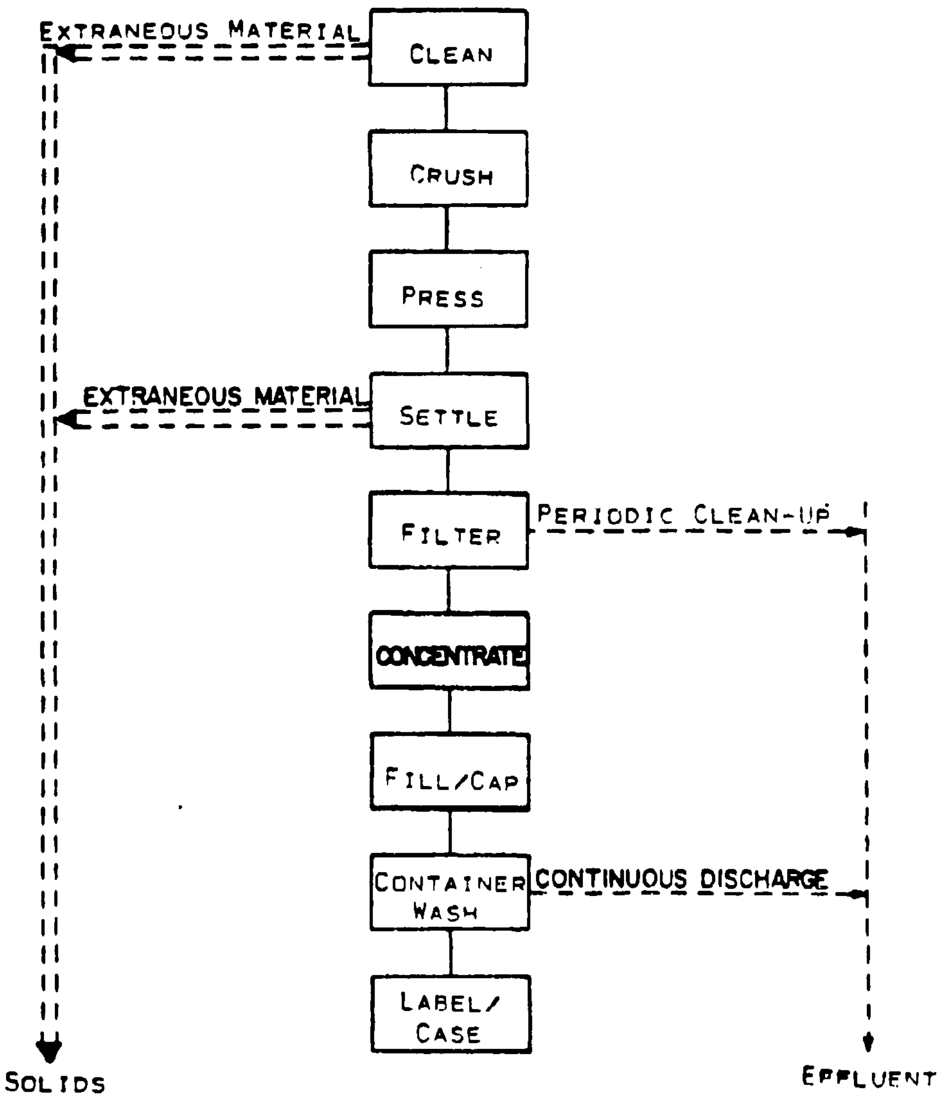


FIGURE 94

SORGHUM SYRUP

DRAFT

SIC 2099 Non-Dairy Coffee Creamer

Non-dairy coffee creamer plants produce one of two distinct products -- dry or liquid non-dairy creamer. The main ingredients used in manufacturing non-dairy creamer are vegetable oil (usually coconut) and corn syrup. If the creamer is to be a dry product, disodium phosphate is the only additional ingredient. On the other hand, if liquid creamer is to be produced, a number of other ingredients such as sodium caseinate, sugar, mono- and diglycerides, esters of fatty acids, and artificial flavor and color are added. Liquid creamer is commonly packaged in half ounce, pint, quart, or half gallon containers. Dry creamer is packaged in jars or in 208 l (55 gallon) drums for sale to distributors.

Virtually all liquid creamer is produced on a regional basis in multi-product plants. Products manufactured along with liquid creamer range from cereals to dessert toppings. Dry creamer is produced by two companies in two plants which produce solely dry creamer.

The demand for non-dairy creamer is dependent on price fluctuations in the dairy and sugar industries and seasonal changes.

Process Descriptions, Liquid Non-Dairy Creamer - Vegetable oil is received in railroad tank cars which must be steam heated upon receipt to allow the oil to be pumped into storage tanks. The other ingredients are received in fiber drums, boxes, and bags and are stored dry. While there is normally no waste generated in the storage of ingredients, occasional spillage of vegetable oil may occur in transfer from tank cars to storage tanks.

The manufacturing of liquid non-dairy creamer is illustrated in Figure 95. The ingredients and water are proportioned into stainless steel mixing tanks where they are mixed at temperatures of approximately 71°C (160°F) to aid in the molecular blending of the ingredients.

The mixture is pumped from the tanks through conventional or flash pasteurizers. In conventional pasteurization the product must be held at a temperature of at least 66°C (150°F) continuously for 30 minutes or 74.5°C (166°F) for 15 seconds, whereas in flash pasteurization the product is pasteurized at 140°C (280°F) for less than one second. The product is then homogenized to provide a smooth consistency and avoid separation of ingredients during use.

The liquid creamer is cooled by passing it between stainless plate coolers and is then pumped into holding tanks before machine packaging into half ounce, pint, quart, and half gallon containers. The packaged products are stored in refrigerated warehouses until shipment to commercial distributors.

DRAFT

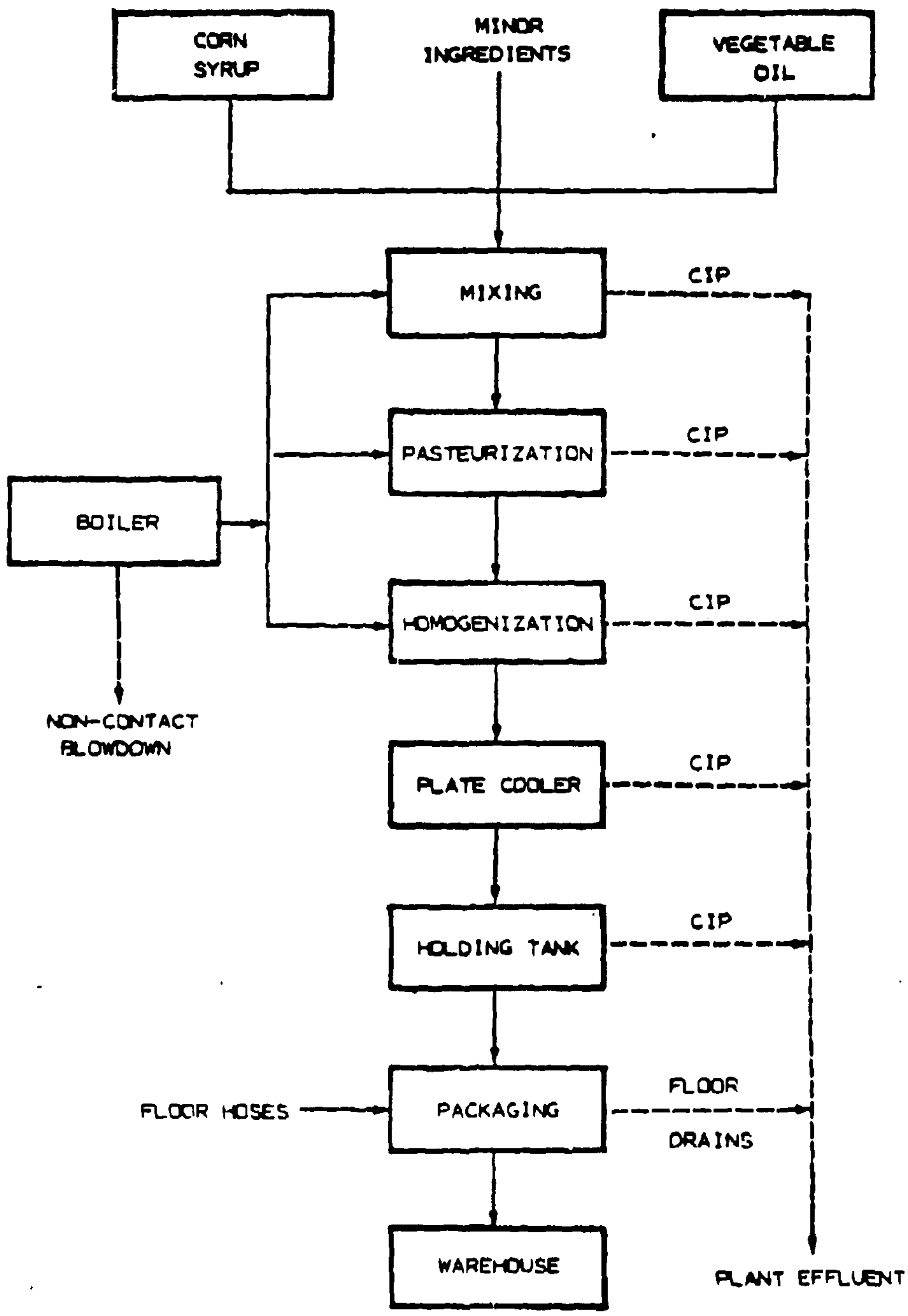


FIGURE 95
LIQUID NON-DAIRY CREAMER MANUFACTURING PROCESS

Wastewater generated from the manufacturing of liquid non-dairy creamer is due solely to cleanup operations. All of the equipment with which the creamer comes in contact must be thoroughly sanitized to prevent bacterial growth. The most common sanitation method is the clean-in-place (CIP) system which may be automatic, stationary, or portable. The sequential cycles involved in the cleanup of liquid creamer equipment are; (1) hot water pre-rinse at approximately 43°C (110°F), (2) detergent rinse, (3) chlorine rinse, (4) final rinse, (5) sanitization, and (6) air drying. Hosing of floors, primarily in the packaging area, is a secondary contributor to the waste stream.

Process Description, Powdered Non-Dairy Creamer - The manufacturing of powdered non-dairy creamer is illustrated in Figure 96 . Vegetable oil and corn syrup are received in railroad tank cars which are heated with steam upon arrival so that the oil and syrup can be pumped into storage tanks. Disodium phosphate is stored in separate holding tanks until use. The corn syrup storage tanks are maintained at a temperature of approximately 71°C (160°F) so that the syrup will remain fluid. Under normal conditions there is no wastewater generated in the storage operations but an occasional spill of oil, syrup, or disodium phosphate may occur during transfer into storage tanks.

The vegetable oil, corn syrup, disodium phosphate, and water are proportioned into stainless steel mixing tanks where they are agitated. The blended product is then passed through a pasteurizer where it is heated in coils to a temperature of 70°C (160°F) for a period of 15 minutes. At this time the product is actually in two phases; oil and liquid-solid. In order to combine the phases so that separation does not occur during use, the product is homogenized by pumping it through small diameter nozzles at approximately 170 atm (2500 psig) to force the molecules in the mixture together. The liquid mixture is transferred by the high pressure nozzles into drying boxes where it is dried by blowing hot air through the mixture. The resulting dry product, with a consistency similar to diatomaceous earth, then passes through a cooling chamber before going to the spray drying process. In the spray dryer the dry product is sprayed through nozzles and falls as a fine mist through a chamber where it is subjected to a stream of steam and then hot air. This process dries and swells the particles and adds the bulk considered desirable in the final product. The dry product is then cooled in shaker coolers and graded for size in a sifter. Particle lumps are disposed as solid waste, fine particles are recovered and returned to the initial mixing step, while particles of desired size are packaged in jars or bulk containers.

Wastewater generated in the production of powdered non-dairy creamer consists of CIP system rinse, sanitizing and caustic wash water (discharged after two washings), floor cleanup of certain areas in the plant, and a small amount of water from wet scrubbers over the spray dryers.

After the initial drying of the product all transfers of product to unit operations are done by vacuum. Since it is undesirable for water to come in contact with the dry product, all cleanup in these areas is done with air.

DRAFT

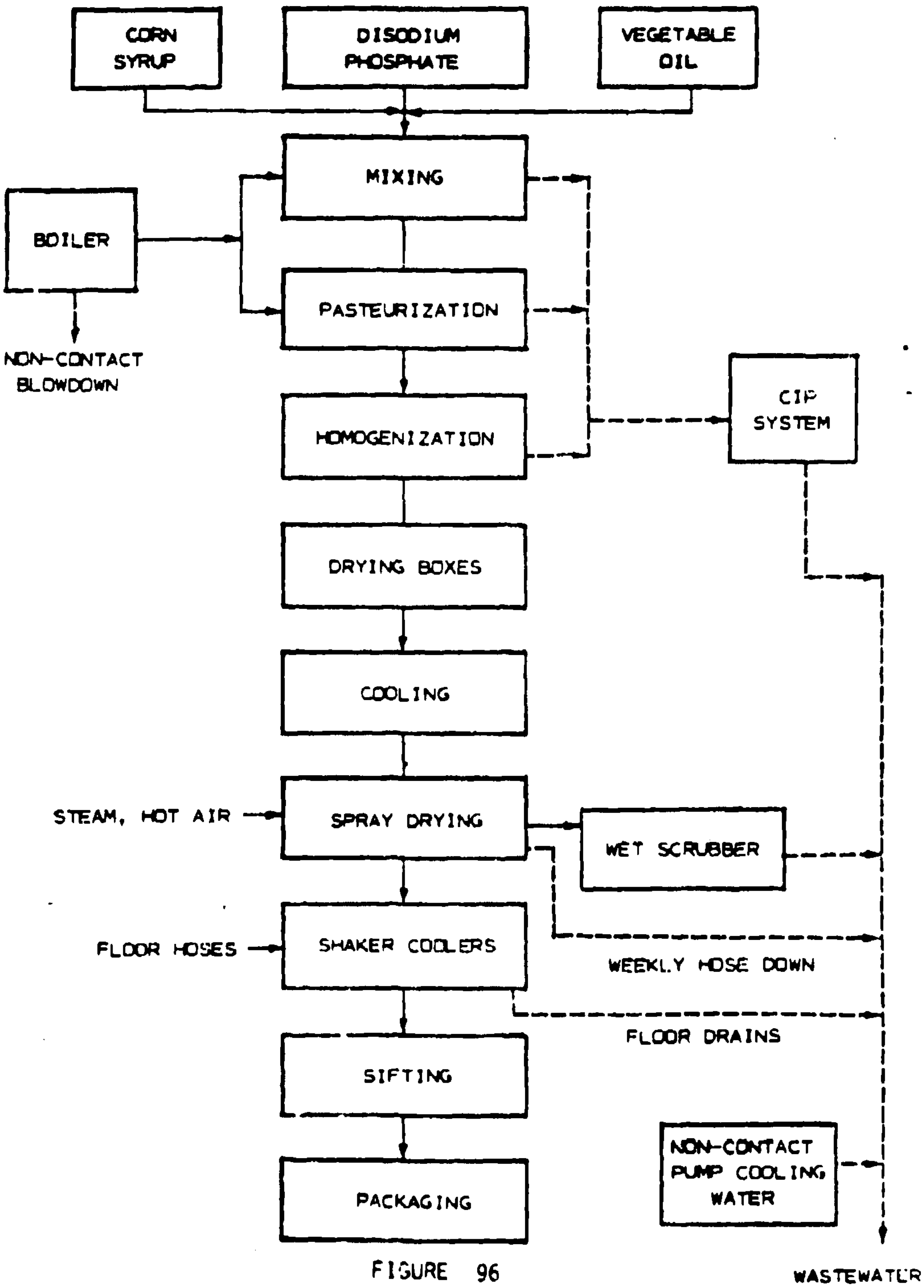


FIGURE 96

POWDERED NON-DAIRY CREAMER MANUFACTURING PROCESS

SIC 2099 Peanut Butter

In the United States, peanuts are grown for such products as peanut butter, candy, and salted and roasted nuts. Surplus peanuts and those too low in quality for food use are crushed for oil and meal. Total edible peanut consumption has increased about 3 percent annually in recent years, and the greatest increase in edible usage has been in the manufacture of peanut butter. Over 63 percent of all edible peanuts go into peanut butter. Use per person increased from 1.1 Kg (2.5 lb) in 1950 to 1.6 Kg (3.5 lb) in 1970, and market outlooks (48) indicate consumption will continue to increase.

In 1970 processors manufactured over 320,000 KKg (350,000 ton) at 115 plants (in 31 states). Woodroof (48) reports two brands, of more than 90, produce 58 percent of the peanut butter found on the market. Over 90 percent of all peanut butter is made from Runner and Spanish type peanuts.

The USDA (49) defines peanut butter as "a cohesive, comminuted food product prepared from clean, sound, shelled peanuts by grinding or milling properly roasted, mature peanut kernels from which the seed coats have been removed and to which salt is added as a seasoning agent". Texture of the finished product may be smooth, regular, or chunky, depending on the size of perceptible grainy peanut particles. Peanut butter types are stabilized or nonstabilized, depending on other added ingredients involved, and are manufactured in three grades determined by color, consistency, flavor and aroma, and absence of defects. The primary use of peanut butter is in homes and schools, and as an ingredient in a variety of snack foods.

Process Description - The manufacture of peanut butter is a relatively simple dry process. No water is added in processing since peanut butter is immiscible. Figure 97 , a simplified process flow diagram for the manufacture of peanut butter from shelled peanuts, illustrates the seven basic process steps of roasting, cooling, blanching, picking and inspecting, grinding and cooling, salting, and packaging.

The shelled peanuts are received and stored dry in 45.5 Kg (100 lb) burlap bags. A mixture of different peanuts is blended and then transported to roasting by an elevator or similar type conveyor. Shaker screens may be used to remove fines or other small fragments at this point.

Dry roasting is done by either batch or continuous methods. In the batch method, peanuts are heated to 160°C (320°F), and held for 40 to 60 minutes in a revolving oven. Different varieties of peanuts may be roasted separately and then blended. An advantage of the batch method is that special attention can be given batches that

DRAFT

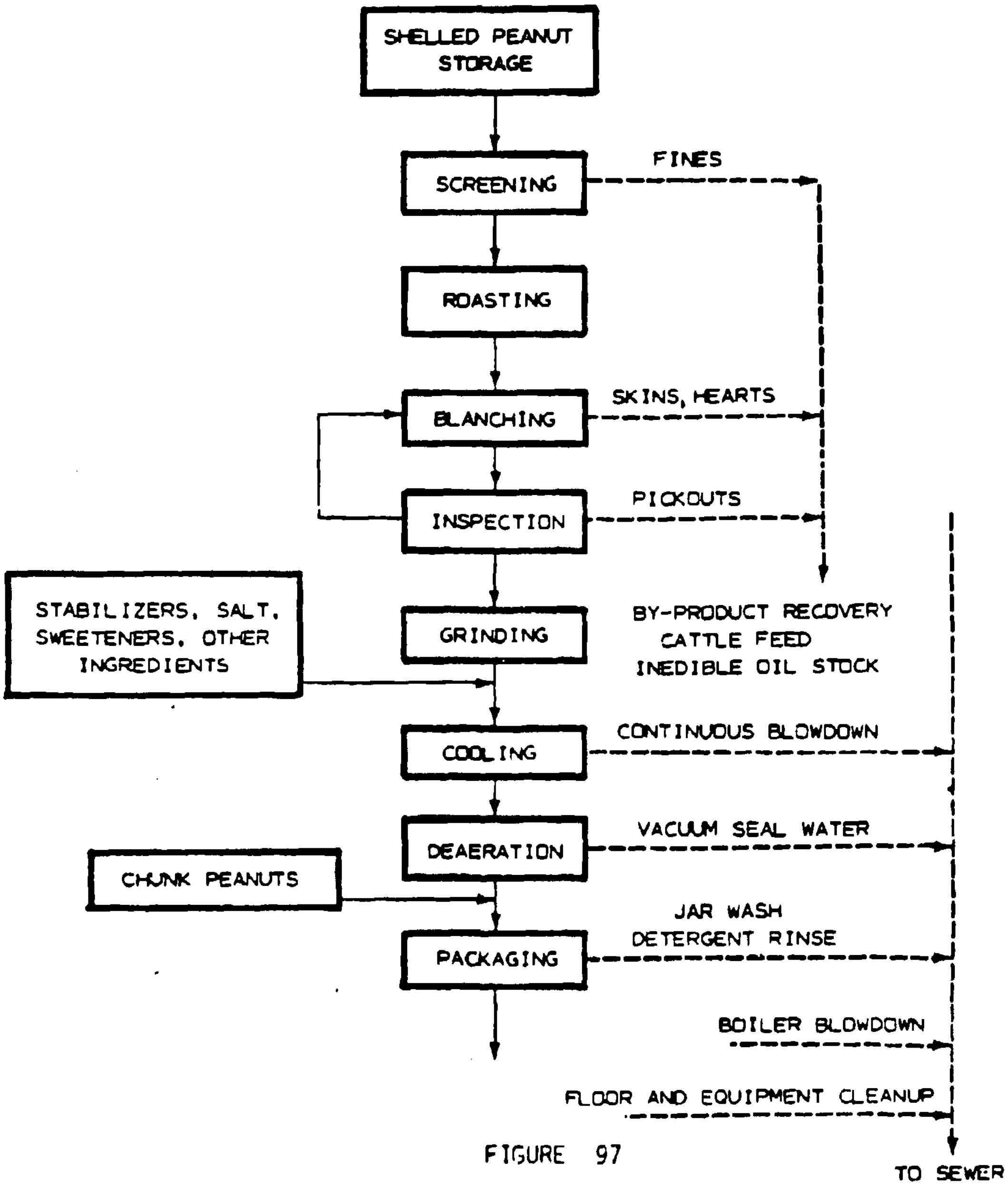


FIGURE 97

PROCESS FLOW DIAGRAM
MANUFACTURE OF PEANUT BUTTER

vary in moisture content or other qualities. In the continuous method peanuts are conveyed through a countercurrent stream of hot air. Continuous agitation provides improved heat transfer, extraction of moisture and volatiles, and an even and complete color from the center to the surface of each kernel. Advantages of continuous roasting are reduced labor and loss due to spills, more uniform roasting, and smoother plant operations. Continuous roasting is the most common method used.

Roasting nuts first become dark during the "white roast" as the skins absorb oil. Then, the peanuts become done or "brown roasted". Moisture content is reduced from 5 percent to less than 2 percent. Oily spots called "steam blisters" form on kernels as volatile components are released to the skins as free oil. After roasting, the peanuts are quickly air cooled using high volume filtered suction fans to stop further cooking. Wastes to this point consist of floor wash, and conveyor cleanup.

Shelled peanut kernels consist of two cotyledons (halves), the heart (germ), and the skin. After cooling, the split peanuts are mechanically dry blanched or whitened by removing the red skins and hearts. Roasted peanuts are heated to 138°C (280°F) to loosen and crack the skins. After cooling, they pass through the blancher continuously where brushes or rubber belts rub off the skins. By-products recovered include peanut hearts separated from the cotyledons by screening, and the skins collected by cyclones. Peanut hearts are bagged and may be sold for poultry feed, bird feed, or oil recovery. Bagged skins may be used in cattle feed, oil recovery, poultry house bedding, or floor sweeping compounds.

The blanched nuts are screened and inspected manually and electronically. Light or scorched nuts and rocks or other foreign matter are removed, and the pickout nuts are sold as inedible oil stock.

Grinding is accomplished in two stages to reduce the peanuts to the desired texture. Constant pressure is applied to produce a uniform product with little air entrainment. A wide variety of grinding machinery is used in the industry. To avoid overheating, grinding mills are cooled by a water jacket.

Various ingredients, including about 2 percent salt by weight, are added before final grinding to improve flavor. Most processors also add sugar to prevent grittiness. Partially hydrogenated vegetable oils are commonly added as emulsifiers to prevent oil separation and improve spreadability. Peanut butter stabilized in this manner may not legally exceed 55 percent fat content, (48) including the natural peanut oil released in grinding. The finished peanut butter is cooled using votators, a type of heat exchanger, and deaerated prior to packaging.

Blanching and inspection produce no wastewater. Boiler condensate and cooling water associated with grinding may be sewered or recirculated. A small amount of water is used in floor and equipment washdown.

Peanut butter is packed in air tight containers since exposure to air produces rancidity by auto-oxidation. Package types range from plastic lined fiber drums to individual servings in flexible plastic. The most common method of packing for retail trade is in glass jars. All processors contacted use new glass which is air cleaned prior to filling, capping, and labeling. Peanut chunks may be added during filling.

In a few plants it is still economically feasible to reclaim imperfectly filled jars. The reclaim operation consists of manually removing the peanut butter from partially filled or improperly sealed containers, and collecting it in lined drums for repackaging. Undamaged jars are fed to an automatic detergent washer and then refilled. Jar washers have prerinse, detergent, and final rinse cycles. Normally, only the detergent solution is reused.

Unusable containers become solid waste. Wastewater produced by floor and equipment washdown is normally sewered. Jar washer discharge is the major wastestream sewered from packaging.

SIC 2099 Pectin

Pectin is a water soluble substance contained in the peel of citrus fruits which binds adjacent cell walls in plant tissues and yields a gel which is used in the preparation of fruit jellies and to some extent in the pharameceutical industry. The recovery of pectin is a complex operation which requires a number of processing days. Pectin is marketed in four standard grades; rapid set, slow set, low methoxyl, and special formula. There are three known producers of pectin in the United States and in the course of this study three plants were contacted and visited.

Pectin is produced by two different processes; alcohol precipitation and precipitation by aluminum compounds. Other than the method of precipitation, the two processes are similar.

Description of Process - Alcohol Precipitation of Pectin - The production of pectin by alcohol precipitation is illustrated in Figure 98 Citrus peels are ground from raw citrus fruit in-house or purchased wet or dry in bulk. Those plants which obtained the peels from raw fruit in-house generally produce citrus juice and citrus oils in addition to pectin. The processing of wet and dry peels is essentially the same except that dry peels must be rehydrated prior to processing.

The peels are subjected to a hammer mill and then washed. The insoluble pectin contained within the peel is extracted by immersing the peels in a vat containing hydrochloric acid, water, and wood fiber while steam is injected through the mixture. The combination of live steam

DRAFT

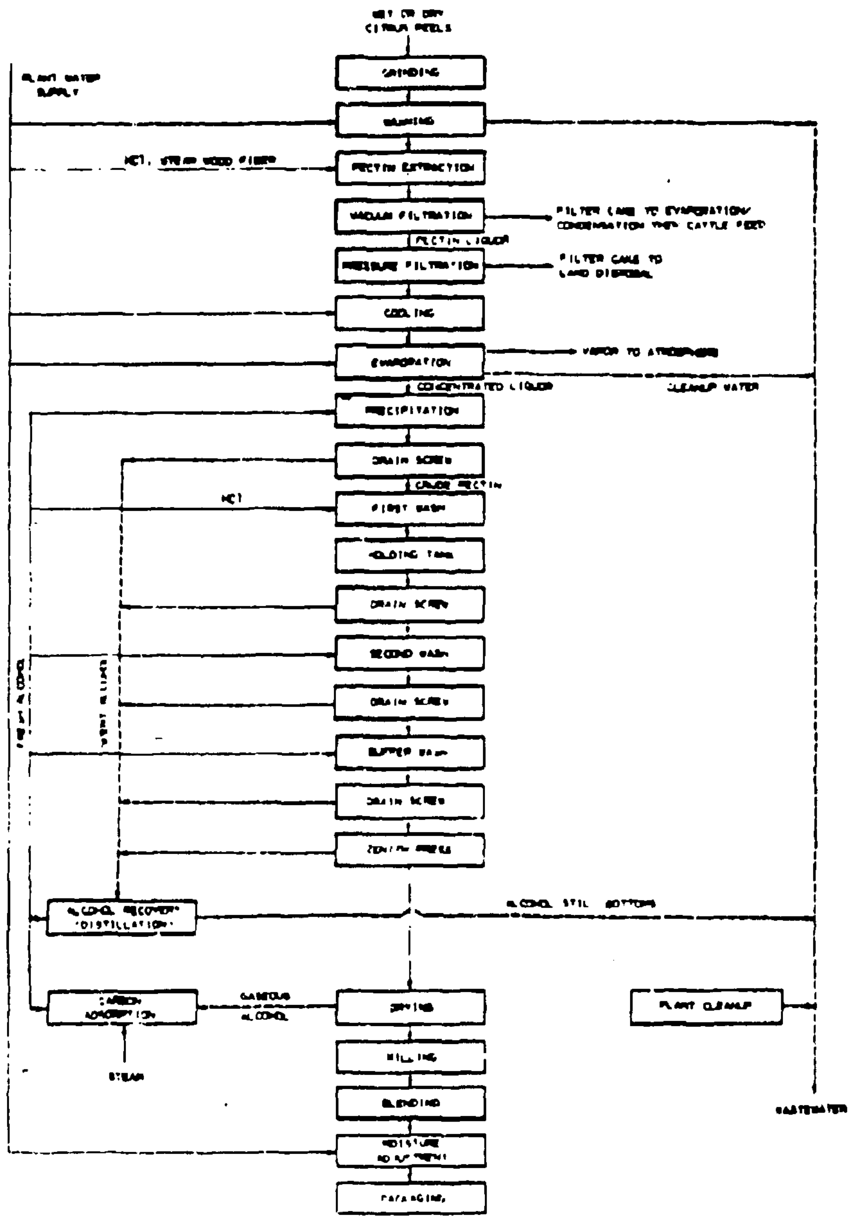


FIGURE 98

PECTIN MANUFACTURING PROCESS BY ALCOHOL PRECIPITATION and acid renders the pectin soluble and the peel and pectin liquor are subsequently separated by vacuum filtration. The pectin liquor is passed through a diatomaceous earth pressure filter to remove insoluble inorganics from the liquor and then cooled. Prior to precipitating by alcohol, the liquor is concentrated under vacuum to three percent pectin by weight thereby decreasing the amount of alcohol required for precipitation. The alcohol removes the water from the liquor leaving the crude pectin which is separated from the mixture by use of a drain screw. The pectin is purified by three successive washings in the following manner: (1) alcohol and acid wash with six to seven hour retention time, (2) alcohol wash, and (3) alcohol wash with ammonia added to adjust the pH to between 4.0 and 5.0. Each of the washings is followed by a drain screw to recover the spent alcohol. The alcohol in the liquid from the precipitation step and the three washings is recovered by distillation.

The purified pectin is dried in a forced air dryer which removes the remaining alcohol and decreases the moisture content to between six and seven percent. The dried pectin is milled to a desired consistency and blended. Four grades of standard pectin are produced from the blended product by varying the corn sugar content in each grade.

Wastewater generated in the alcohol precipitation of pectin consists of the following: (1) alcohol still bottoms, (2) filter sluice from vacuum and pressure filters, (3) peel washing, (4) weekly caustic cleaning of the evaporator, and (5) general plant cleanup. Appreciable quantities of non-contact cooling water and boiler blowdown are also generated with the total discharge of the plant being 1500 cu m/day (0.400 MGD).

Process Description - Pectin Recovery by Aluminum Compound Precipitation - The production of pectin by aluminum compound precipitation is illustrated in Figure 99. Citrus peels are prepared or received in the same manner as previously described. The peels are ground and washed prior to entering the extraction vats where pectin is extracted from the peel by the addition of sulfuric acid and the introduction of steam into the wooden vats. Following a 16 to 20 hour retention time in the vats the mixture is adjusted for pH and the liquor containing the soluble pectin is separated from the peel by vacuum filtration. The pectin liquor is then stripped of insoluble inorganics by pressure filtration or centrifugation. Pectin is precipitated from the liquor by the addition of an aluminum compound, commonly aluminum chloride or sulfate. The pectin precipitate and liquor are run through a press which separates the liquor from the solids containing the soluble pectin. The solid mass is pelletized and then rinsed five successive times with the following sequential rinses; (1) hydrochloric acid-alcohol, (2) alcohol, (3) citric acid, (4) buffer, and (5) final. The purified pectin is then drained of excess liquid by a drain screw and prepared for packaging.

The wastestreams generated by the manufacturing of pectin by this process include leaching water, spent peel and wastewater, spent filter aid and sluice water, press wastewater following precipitation, and press water from pressing of filter cake following sluicing.

DRAFT

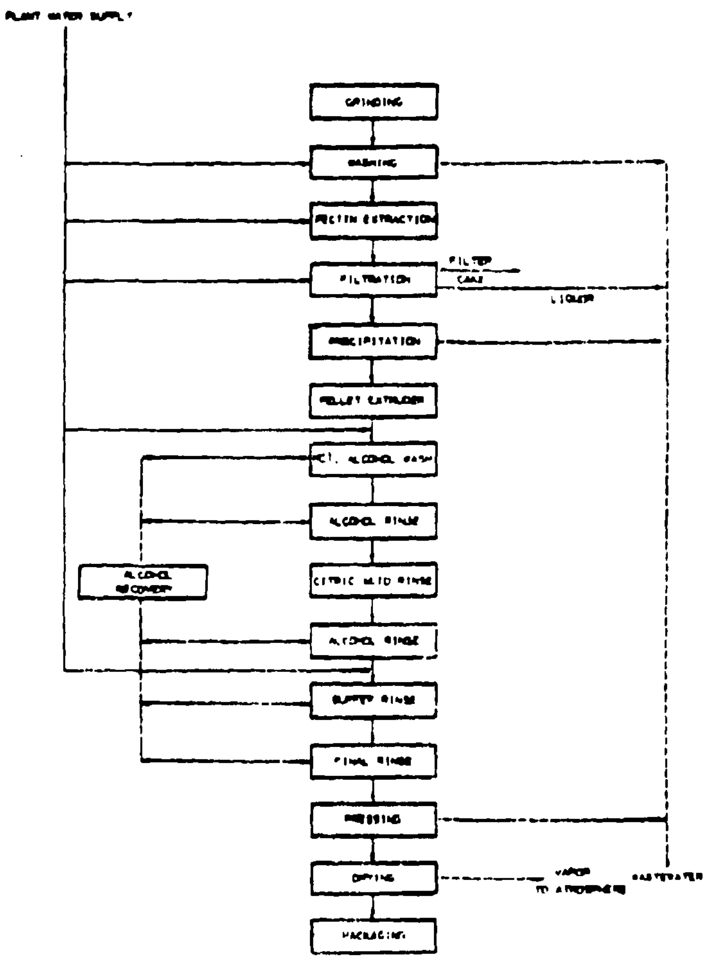


FIGURE 99

PECTIN RECOVERY BY ALUMINUM COMPOUND PRECIPITATION PROCESS

DRAFT

SIC 2099 Popcorn

Popcorn was one of the earliest foods prepared from Indian maize, the native corn of the Americas. "Flint corn," the most primitive of the commercial types and the major variety used for popping is still much like maize. According to Agricultural Statistics, there are 19 plants which prepare popcorn for wholesale distribution which, in 1972, produced 233,883 kkg (257,271 tons) valued at $16 million. The mid-western states of Illinois, Indiana, and Iowa account for the majority of production.

Description of the Popcorn Process - The popcorn process starts with the weighing of the corn as it arrives at the plant from the fields. The corn arrives already detached from the cob in dry kernel form. Figure 100 depicts a typical flow diagram of a popcorn process.

After weighing, the corn is then conveyed to storage bins. From the storage bins the corn goes through a screening operation which removes split kernels and other extraneous material. The whole kernels are then transferred to another set of hoppers which gravity feed directly into density separators. These separators are canted shaker type screens which utilize a vibrating motion to separate the kernel by size. Fine wastes such as "bees wings" (small particles from the kernel edges) adhere to the screen and are washed out daily. This washing of the density separator screens accounts for the major waste loadings derived from a popcorn operation. Washdown flows from this operation range from a low of 200 l/day (50 gal/day) to a high of 800 l/day (200 gal/day) depending on the number of screens utilized.

The separated corn then goes to a final set of hoppers where it is stored until packaging. Packaging can be done either in bulk or the more familiar one to three pound bags. Fumigation with methyl bromide is sometimes employed in the final holding bins.

All cleaning in a popcorn plant is usually done by vacuuming or sweeping since any water coming in contact with the final product can result in product damage. Solid waste from screening operations are generally sold as animal feed. Packaging wastes are hauled away by contractors to local disposal sites.

SIC 2099 Spices

Background of the Industry - Spices are produced by approximately 40 manufacturers in the United States. Most of the facilities are concentrated in the midwest and northeast. The domestic consumer market is dominated by three companies with strong nationwide positions; however, the total domestic and commercial market is much less concentrated. Plants, in general, process and package spices for both market sectors; however, most of the smaller companies rely on a few major institutional customers for most of their work. A typical spice plant processes a large number of raw spices into a nearly infinite variety of final products. Consequently a typical plant may be characterized as being highly flexible in its material handling processes so that it may readily respond to precise customer requirements.

DRAFT

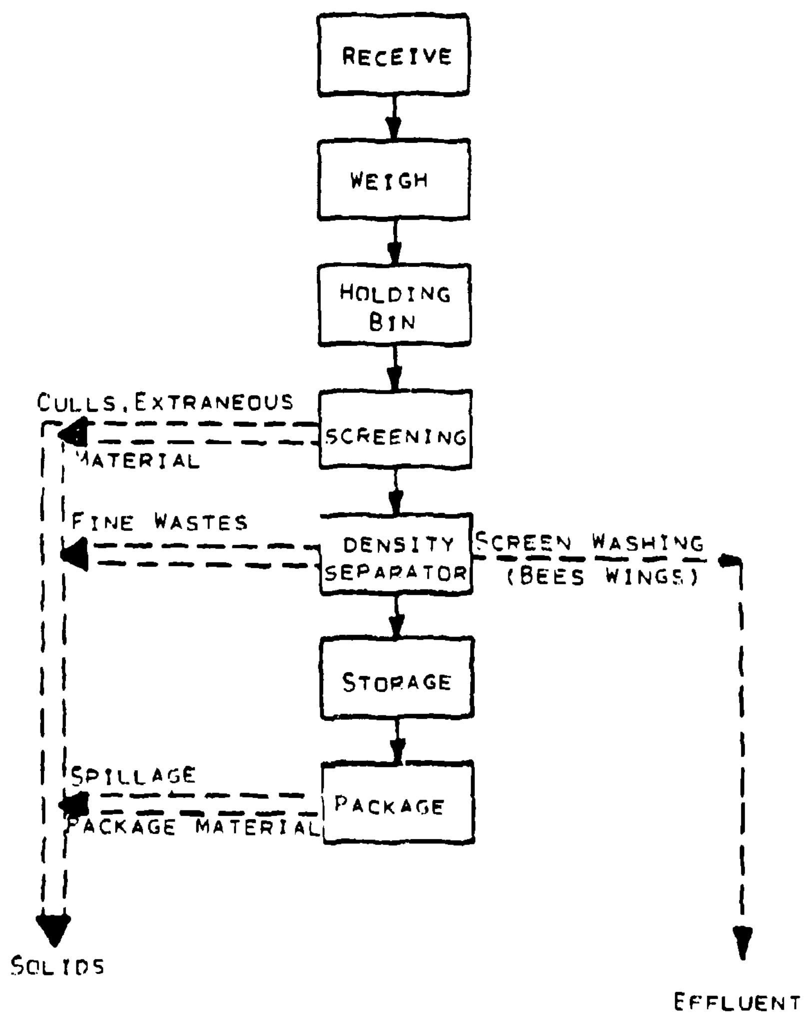


FIGURE 100

POPCORN PROCESS

Process Description - The large variety of spices and seasonings received as raw material are generally in a dried condition and are packaged in cloth bags or sealed bales. In most plants raw material storage, process lines, and final product storage areas are climate controlled to prevent damage from mold, fungus, and condensation. Processing is variable; however, basic steps include cleaning, sorting and grading, chopping, grinding, blending and mixing, temporary intermediate product storage, and packaging. Rejects and spillage from these operations are primarily cleaned and removed by dry methods, i.e. foxtail brushes, brooms, vacuum cleaners, and air brushes. Figure 101 outlines a general process flow schematic for a typical plant. Final products may be packaged as whole spices, chopped and blended spices or seasonings, or as ground spices. In most plants equipment is not dedicated to a single commodity, therefore cleanup is necessary between product changes. This cleanup, except for the grinding mills, is usually dry. Surfaces in many plants have been coated with silicate based paints to expedite dry cleaning techniques.

The grinding mill, however, must be cleaned with hot water or steam after certain products, such as black or red pepper, have been ground. This is necessary to remove oils released by grinding. The mills are removed to a wash room if hot water or steam clean out is necessary.

Spice plants have a significant dust control problem. Modern facilities use their air conditioning system filters to remove fugitive particulates; however, at least one facility (plant 87E01) uses a wet scrubber and discharges to a municipal sewer. This method of control, however, is not widely practiced in the industry.

SIC 2099 Tea, Instant and Blended

The development of instant tea in the early 1950's stemmed from attempts to overcome the perishability of tea leaves, which as a whole are sensitive to odors, high humidity, and excessive heat. Tea leaves are imported into the United States from a number of points in the world, but principally Ceylon, India, and Kenya. The Department of Commerce (50) reports that 1973 imports of tea leaves totaled 78,600 KKg (86,600 ton). Of this imported total approximately 70 to 75 percent is utilized in the production of blended tea while the remainder is processed into instant tea. There are five companies producing blended and instant tea in approximately ten plants. In the course of this study all five companies were contacted, four plants were visited, and verification samples were taken at three plants. The industry has provided documentation to the effect that tea blending is a completely dry process with no wastewater discharge.

The majority of tea plants are located near major ports to facilitate the receipt of the imported tea leaves. Several of the instant tea manufacturers produce instant tea in multi-product plants along with such products as blended tea, soup, salad dressings, instant coffee, and sugar substitutes.

DRAFT

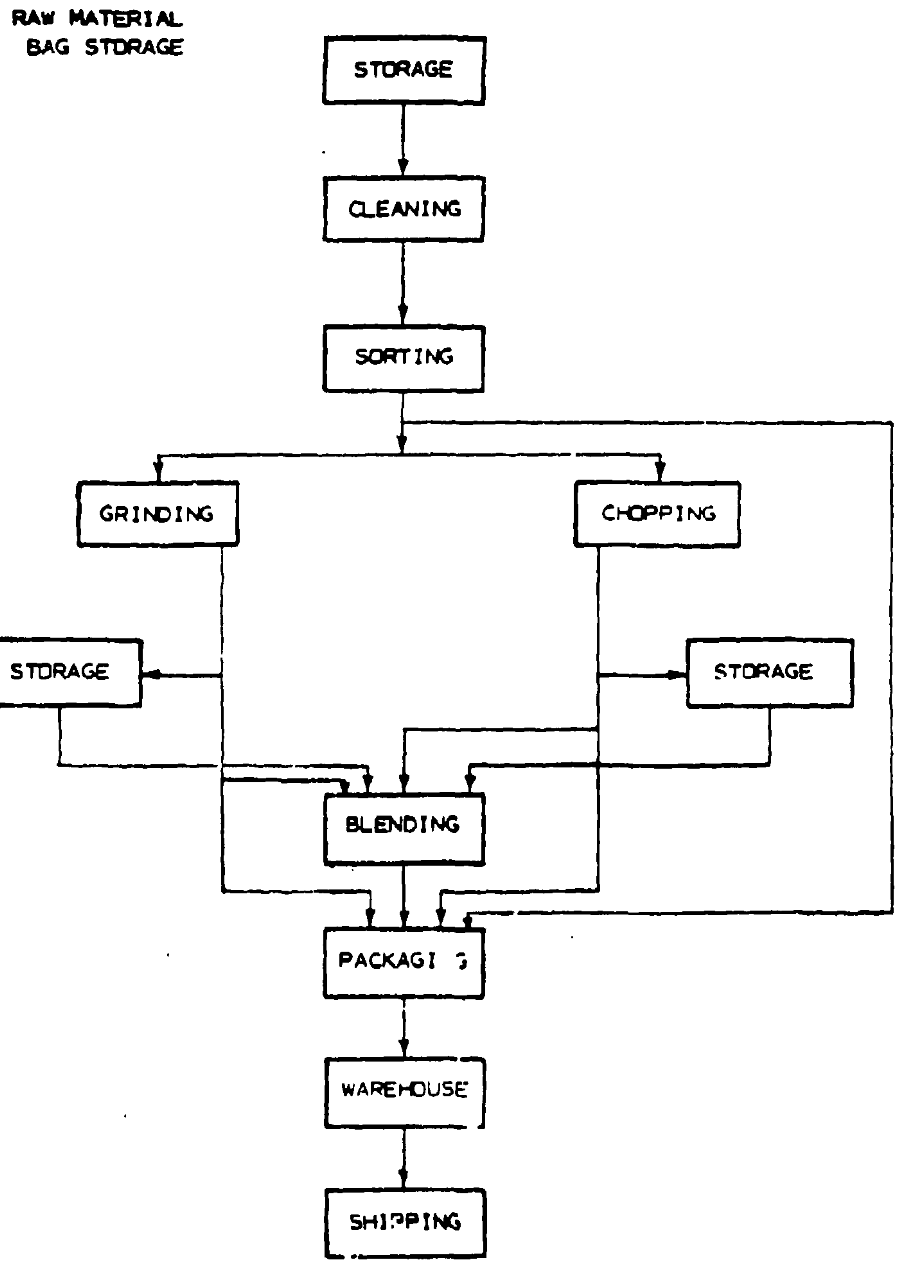


FIGURE 101

SPICE PROCESS FLOW DIAGRAM

Production of blended and instant tea remains relatively constant throughout the year, with the highest demand in the warmer months. The production of instant tea is dependent upon tea crop yield in exporting countries and this yield can fluctuate drastically from year to year.

Process Description - Instant Tea - Figure 102 illustrates the instant tea process. Tea leaves are stored in oil lined wooden tea chests or silos until processing. The tea leaves, with or without prior blending, are carefully proportioned with water into an extractor, with the water-tea ratio being determined by weighing the tea leaves as they enter the extractor. In the extractor tea leaves and water are boiled for a specified period of time after which the tea extract is pumped into the first evaporator. The wet spent tea leaves are centrifuged and the liquid fraction is pumped into the evaporator while the dewatered tea leaves are used for composting or cattle feed.

While the tea extract is being evaporated to a specified concentration, the resulting aromatic tea vapors are passed into an aroma column where they are condensed and retained for later use in the finished tea product. The concentrated tea extract is cooled in coils to render tannins and caffeins insoluble before the extract is passed into gravity clarifiers from which the clarified tea extract is transferred into the final evaporator. Clarifier sludge containing the insoluble tannins and caffeins is adjusted to an alkaline pH and a catalyst, such as hydrogen perioxide, is added. The mixture is regenerated within a heat exchanger where the catalyst aids in breaking down insoluble, long chain hydrocarbon compounds into soluble, short chain hydrocarbon compounds. The altered mixture is cooled to render undesirable components insoluble prior to clarification. The clear tea extract is transferred to the final evaporator and the sludge is recycled to the pH adjustment step.

The clear tea extract contained within the evaporator is concentrated to a composition of approximately 40 to 45 percent total solids and the aromatic tea vapors thus generated are returned to the aroma column. At this point tea vapors (regenerated by heating) from the aroma column and the concentrated tea extract are mixed to a homogeneous blend in a feed tank prior to drying in a spray dryer. The blended tea extract is sprayed in the form of a fine mist from the top of the dryer and while falling is subjected to a stream of hot air. Evaporation of water from the particles of mist produces soluble powdered tea particles which collect at the base of the spray dryer.

Prior to packaging, the "instant tea" may be blended with sugar, artificial sweeteners, or powdered fruit concentrates to yield various tea "mixes". The tea or tea mix is packaged in packets, jars, or fiber drums, depending on whether the final product is for wholesale or retail use.

Essentially, the only process wastestream generated during instant tea manufacturing is periodic dumping of clarifier sludge. All other daily

DRAFT

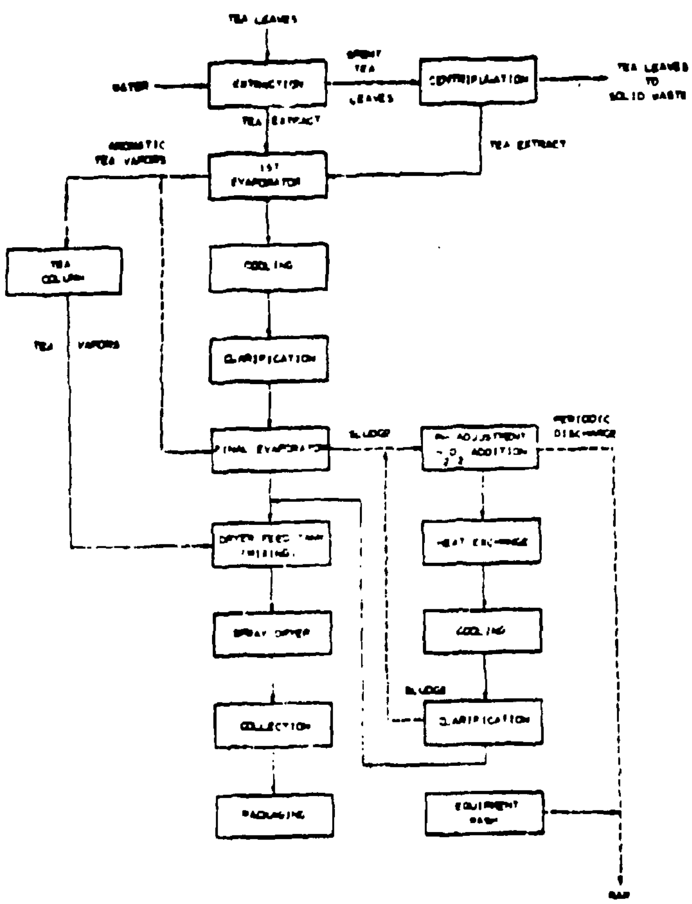


FIGURE 102

INSTANT TEA PROCESS DIAGRAM

waste flow is attributable to cleanup operations. Daily cleanup generally consists of an almost continuous floor washdown to remove spills and leaks from equipment connections.

Since instant tea manufacturers operate on a 24 hour per day basis, equipment cleanup is generally done once per week and consists of the following sequential steps: fresh water prerinse, caustic wash, fresh water rinse, nitric acid wash for removal of silica formations, and fresh water rinse.

Process Description - Blended Tea - The blended tea process is a completely dry process in which tea leaves are received and stored in the same manner as for instant tea manufacturing. Tea leaves are then tasted for quality and dry blended in drums prior to being hopper fed into the packaging line. The crucial step in the blended tea process is the taste testing of tea leaves from each tea chest to determine which leaves should be blended together to yield the richest flavor.

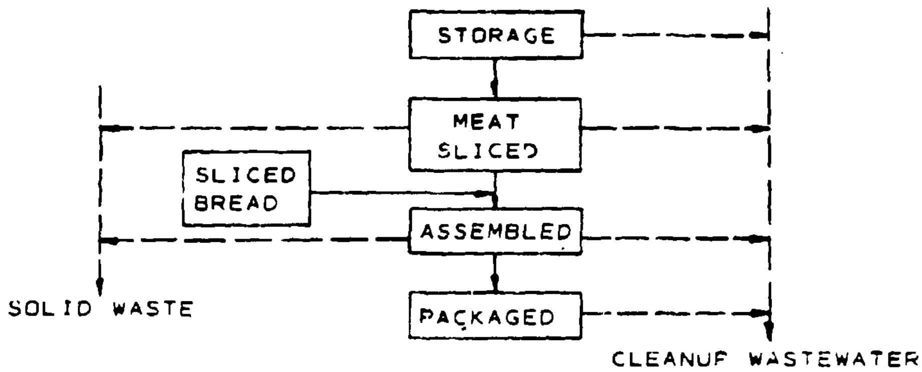
SIC 2099 - Pre-packaged Sandwiches

General - Pre-packaged sandwiches for sale off the premises are distributed primarily from food outlets such as convenience stores and vending machines. The manufacturers of these sandwiches purchase processed materials and assemble sandwiches. The sandwiches are sold either frozen or fresh. According to the Bureau of the Census (?), in 1972, the value of total product shipments of fresh sandwiches was $65.2 million, a 113 percent increase over the $30.6 million figure for 1967. Nationwide sales figures were not available for frozen sandwich production. Plants producing pre-packaged sandwiches are normally located in major urban areas since that is where most of their products are consumed.

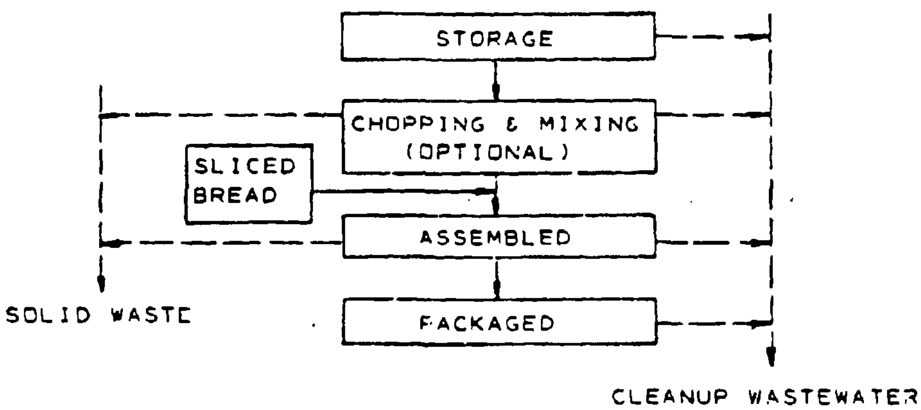
Description of the Process - Plants producing pre-packaged sandwiches are essentially assemblers of processed food items (see Figure 103). Processed meats, cheeses, tuna fish, sandwich spreads, and similar ingredients are purchased from a wholesaler and stored in a refrigerated cooler as required. Sliced bread is normally delivered each day for that day's production. In some plants, bread or rolls are baked on the premises. Meats and cheeses are sliced and the sandwiches are assembled manually. Some plants purchase canned spreads for the preparation of tuna or ham salad type sandwiches. Other plants produce only sliced meat and/or cheese sandwiches. Still other plants prepared salad type fillings on the premises, normally in a chopping machine, for the preparation of sandwiches. After assembly, the sandwiches are cello wrapped mechanically and either frozen or distributed for immediate consumption.

Plants which prepare sandwiches only from processed ingredients generate wastewater only as a result of the cleaning of utensils in a sink and cleaning of the floor with a mop and bucket. Firms which prepare salad type ingredients on the premises will also have wastewater generated from the washing of the chopping machine and the assorted mixing containers.

DRAFT



SLICED INGREDIENT SANDWICH PREPARATION
PROCESS FLOW DIAGRAM



SALAD INGREDIENT SANDWICH PREPARATION
PROCESS FLOW DIAGRAM

FIGURE 103

SANDWICH PROCESS FLOW DIAGRAM

Solid wastes are generated in the slicing and assembly operations and in the salad filling preparation. These wastes are disposed of to a landfill or sold as animal feed.

SIC 2099 Vinegar

The manufacture of vinegar is one of the most ancient of natural fermentations which has been used by man; the principle use being a flavoring or preservative agent in foods. There are currently 94 establishments processing vinegar, some being independent plants while others are closely tied to the production of other products. Although distributed throughout the country, the major concentration of plants is in the eastern states. The value of shipments in 1971 reached $77.9 million, an increase of over $4.6 million from 1970 according to the United States Department of Agriculture's Agricultural Statistics.

Description of Process - Vinegar is defined as a condiment made from sugar or starch containing materials by alcoholic and subsequent acetic fermentation. The product is usually classified according to the materials from which it is made: (1) from fruit juices, e.g., apples, oranges, grapes, berries, etc.; (2) from starchy vegetables, e.g., potatoes or sweet potatoes; (3) from malted cereals; (4) from sugars such as syrup, molasses, honey, maple skimmings; and (5) from alcohol from yeast manufacture. In the United States most table vinegar is derived from apples.

The manufacture of vinegar involves two distinct steps: (1) The fermentation of sugar to ethanol and (2) the oxidation of the ethanol to acetic acid. For the purpose of this study, only the second step of the process will be considered in detail. Indeed, in most cases, the raw material for vinegar production, i.e., either the fruit for fermentation or the ethanol are actually the products or by-products of other industries. Effluent limitations guidelines have been, or soon will be, promulgated for these various industries, e.g., the production of yeast, apple cider, alcoholic beverages, fruit juices, etc.

Vinegar production may exist as both a separate industry or as an ancillary industry and will be characterized herein as an independent process.

As mentioned, the manufacture of vinegar begins with the raw material of either unfermented fruit or ethanol-containing materials. Production Path A (Figure 104) starts with the fermentation of cider or fruit juice. The juice is pumped into fermentation tanks in which the fruit sugars are converted to ethanol by selected varieties of yeasts, belonging to the genus Saccharomyces. As the sanitation of these tanks is important to prevent contamination by undesirable organisms, a significant quantity of wastewater is generated at this point by the washing of the tanks between uses.

DRAFT

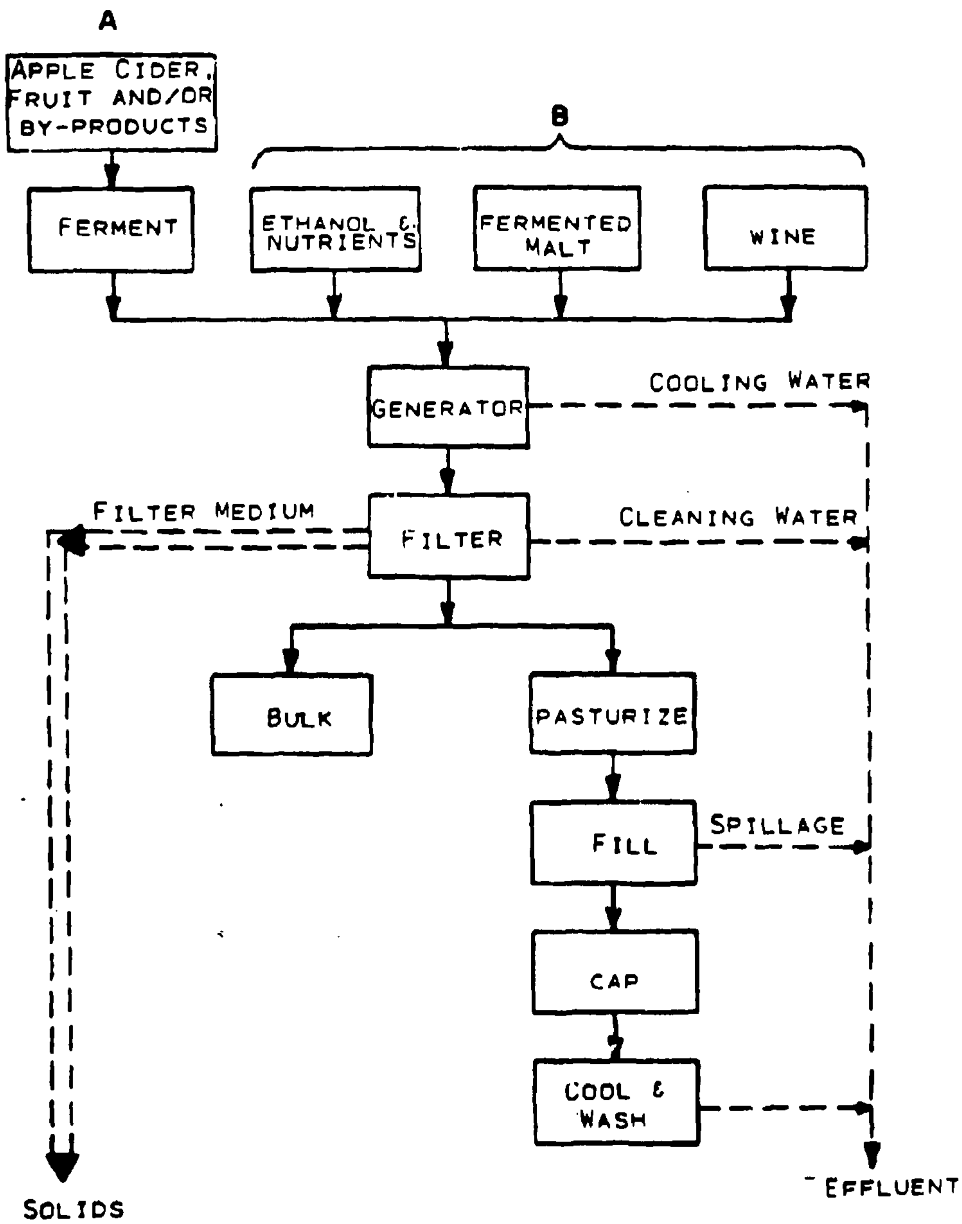


FIGURE 104

VINEGAR PROCESS

DRAFT

Production Path A, and Path B converge at the next step in the process, the oxidation of ethanol to acetic acid which is accomplished by the vinegar bacteria, members of the genus Acetobacter. These organisms are characterized by their ability to convert ethanol to acetic acid. The conversion is accelerated and controlled by the use of a vinegar generator. There are several types of generators in use, although the design principle remains the same; i.e., the rate of acetification is proportional to the amount of oxygen available for reaction, which in turn is proportional to the surface area. The reactive surface may be maximized by either of two general methods: (1) utilizing a fill material such as wood shavings or (2) by continuous aeration and circulation of the liquid. The generators using a fill material require periodic cleaning to avoid plugging by the bacterial growth. This cleaning is, however, not a daily practice and is done only as necessary. The closed system utilizing oxygen injection requires less maintenance and when operated properly produces vinegar more efficiently than the other procedures. Regardless of type, the generators require a cooling system to maintain the optimum temperature for Acetobacter growth. The cooling water is non-contact and may be recirculated.

Vinegar produced by the accelerated generator process is often harsh in flavor and odor and requires aging in wooden tanks to produce an agreeable flavor and odor, as well as to allow it to clear. A final polishing of the product is necessary to produce the characteristic sparkling clarity of most vinegars. This final process may be accomplished by either filtration or fining. Fining consists of introducing a suspension of clay, casein, gelatin, bentonite clay, or other suitable materials and allowing the mixture to settle. The clear vinegar is then racked. The more common method of clearing vinegar is that of filtration. The filter system must be cleaned periodically in order to maintain its efficiency.

The refined vinegar is either marketed in bulk or bottled in retail containers at the plant. In order to prevent the continued growth and subsequent clouding by the Acetobacter organisms, the vinegar is pasteurized at 60°C for a few seconds. Pasteurization may be accomplished in bulk by passing a continuous stream of vinegar through a steam jacketed tube or plate pasteurizer and then cooling it in a water cooled unit. Bottled vinegar may be pasteurized by immersion or by flash pasteurization prior to bottling. The bottled product is subsequently capped, washed and transported to labelling and casing. During bottling, most of the wastewater is generated by the pasteurization cooling cycle and the final bottle wash.

The major source of wastewater from the bulk operation is from the filtration system. Periodic cleaning of floors, generators, and bottling equipment also contributes variable amounts of wastewater depending upon process and housekeeping differences. Transient surges of wastewater occur when wooden storage tanks are drained of the water to keep them from drying out between uses.

SIC 2099 Yeast

Currently in the United States there are 13 active yeast processors representing four companies producing an estimated 204,000 KKg (250,000 ton) of yeast annually. The largest producer reports supplying approximately 35 percent of the total market. Production facilities are located near metropolitan areas in the states of New York, New Jersey, Maryland, Illinois, Missouri, Texas, Louisiana, Washington, and California.

Market demand for yeast products is reported (51) to be closely related to growth in the baking industry, and is expected to increase slowly in future years. During the last two years, the industry has witnessed the closing of one new yeast plant, while another new plant is presently under construction. Industry trends and economics indicate that new production plants will be large scale, highly automated facilities.

Background of the Industry - As early as 3500 years ago, man collected yeast deposits (52) from the surfaces of plant life and consumed them for medicinal and dietary purposes. Science has since shown that yeast is high in proteins and vitamins. However, despite its high food value, yeast is primarily used for fermentation. In the baking industry, yeast ferments sugar in bread dough producing carbon dioxide gas responsible for the rising or leavening of bread. In the brewing industry, yeast ferments or breaks down sugars to alcohol and carbon dioxide.

In the nineteenth century, brewers supplied most of the commercially grown yeast for the baking industry. During World War I, the scarcity and high price of grain mashes led to the development of a method of yeast production using molasses as the primary raw material. This process was highly successful, and with subsequent minor refinements is used by the industry today.

Description of Process - The three basic products produced by the yeast industry are (1) "bakers compressed yeast" (2) "active dry yeast", and (3) pharmaceutical dry yeast" (52). The primary product, "bakers compressed yeast", is utilized by large baking companies as a leavening agent, while smaller bakeries, blenders of ready-to-bake cake mixes, and repackagers require the active dry yeast. Pharmaceutical dry yeast, which represents a small portion of total yeast production, is used by the pharamaceutical industry as a protein and vitamin dietary supplement.

The basic raw materials necessary for yeast growth are cane and beet molasses, water, chemical sources of nitrogen and phosphorus, and a pure stock culture of the desired yeast strains. Other required production materials may include sulphuric acid for fermenter pH adjustment, vegetable oil or chemical defoamers, and small amounts of plasticizing agents for forming and packaging. Although individual plants vary according to size, age, and water usage, the processing steps and raw materials are virtually identical throughout the industry. Figure 105 presents a simplified flow diagram for the following basic process steps: (1) molasses feed wort preparation, (2) stock yeast preparation, (3) fermentation, (4) yeast cream separation, (5) dewatering and drying, and (6) packaging.

Yeast production begins when the yeast food, called feed wort, is prepared by combining cane and beet molasses, diluting the mixture with water, and adjusting the pH to 4.5 before sterilization. The mixture is heated with steam in a high pressure continuous cooker, and after some solid matter is removed by vibrating screens, the sterilized molasses is fed to centrifugal clarifiers where additional solids are removed and retained in the clarifier bowl. The clear wort is pumped to storage tanks. Molasses provides the primary source of carbon and sugar for yeast food, and supplies calcium potash, and other elements. The ratio of cane to beet molasses depends on availability and nutrient content, but a mixture is always used to provide a balanced yeast diet except that nitrogen and phosphorus must be added since any molasses is deficient in both.

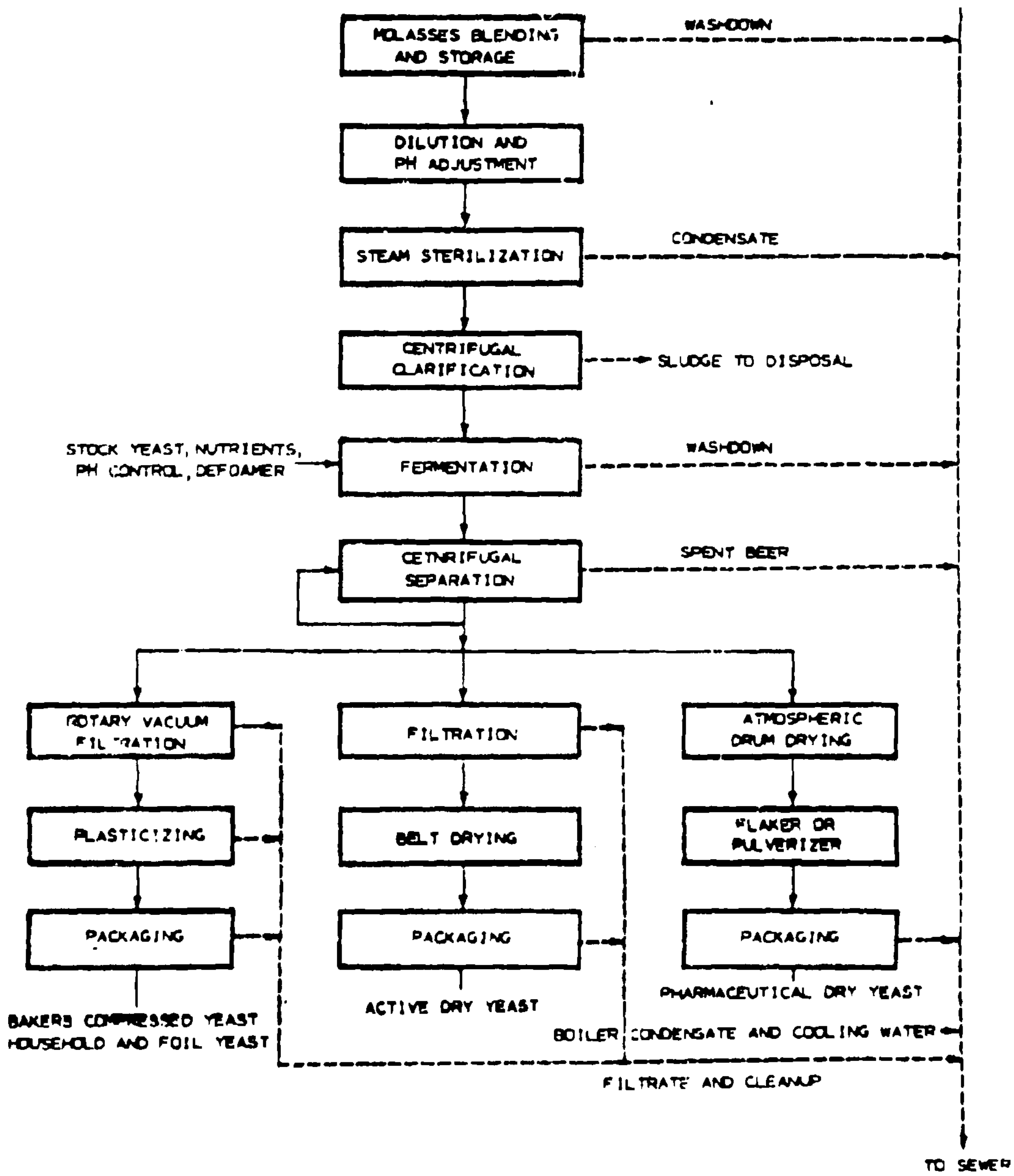
Clarifier sludge, being mainly inorganic and of little value, is hauled to landfills or ploughed into agricultural land. Other wastes from feed wort preparation are clarifier, tank, and piping sterilization and cleanup.

Parallel to feed wort preparation, a test take containing sterile molasses is inoculated with a few cells from pure culture of the desired yeast strain. These grow to a larger mass that is transferred to successively larger vessels until there is a sufficient quantity of stock yeast for starting growth in the main fermenting tanks. During each transfer, the contents of the "seed" fermenters are sent to continuous centrifugal separators to remove spent nutrients from the stock yeast. Wastes normally discharged from the culture stages include water used in sterilizing and cleaning of tanks and piping, and spent nutrients.

Both stock yeast and feed wort are then delivered to the main fermenters. Water and stock yeast are placed in the sterile tank. Feed wort, nitrogen, and phosphorus are continuously added as the steadily aerated yeast is allowed to ferment for about ten hours. Aqua ammonia and phosphoric acid are commonly used sources of nitrogen and phosphorus. Foam caused by aeration is cut back periodically by adding sufficient vegetable oil or chemical defoamers.

Under ideal conditions the yeast growth is exponential. Since any surplus nutrients tend to be fermented to alcohol, thus wasting raw materials and retarding yeast growth, the feed wort and other chemicals are added by automatic metering equipment at a predetermined, exponential rate. During growth fermentation, the physiological activities of yeast cells cause a progressive pH decrease. Since yeast grows best in an acid medium, pH is maintained at 4.5 by the addition of aqua ammonia. Because fermentation is exothermic, cooling water is circulated through coils to maintain an optimum 30°C (85°F) temperature. Near the end of the 12 hour growth stage, the temperature is further lowered and aeration discontinued to stop growth and allow the yeast cells to fully mature.

DRAFT



FIGURE

PROCESS FLOW DIAGRAM DRIED FOOD YEAST

DRAFT

After fermentation, the cream yeast is separated from the fermented wort by centrifugal separation. The separated waste resulting from first separation is called first separator beer. After first separation, the yeast cream is put through a second and third separation. In each of the last two separations, the yeast slurry is diluted in a cold water washing process, and then separated. Wastes from these steps is called second separator beer and third separator beer. At least two of the largest production plants use third separator beer as the second separation wash water. Other discharges from fermentation and separation include fermenter, centrifuge, and wort tank and piping cleanup.

The process for making bakers compressed yeast, active dry yeast, and pharmaceutical yeast are identical up to this point.

The yeast cream slurry must be filtered and dewatered prior to packaging. Bakers compressed yeast and active dry yeast are pumped to either recessed-plate filter presses or a rotating vacuum filter drum. If a filter press is used, yeast cream is pumped into the filtering compartments and pressure applied. After opening the press, yeast cake is scraped into stainless steel carts for delivery to a mixer. No filter aids are used. If a vacuum filter is used, a revolving drum covered by a circular band of filter cloth is evacuated and revolved in a vat of yeast cream. A thin layer of solid yeast forms on the cloth, and the effluent is discharged from the interior of the drum. Potatoe starch may be used as a filter cloth precoat or filter aid, and is normally reclaimed by settling of the effluent.

Compressed yeast cake is fed to a mixer where it is blended and plasticized to adjust moisture content and improve extrudability. Plasticizing agents typically used are vegetable oils, emulsifiers, and shaved ice. After mixing, bakers compressed yeast is continuously extruded as a ribbon, and cut into blocks for packaging. Package sizes range from blocks weighing several ounces to 50 pounds, although 1 and 5 pound blocks are most common. Bakers compressed yeast in saleable condition has a 73 percent moisture content, and must be kept refrigerated until used.

The slurry for active dry yeast is extruded directly after filter pressing. Then it is fed into rotary or belt type warm air dryers for 12 hours and the granular product packaged in filter drums. Active dry yeast contains only eight percent moisture, and keeps well without refrigeration. Four parts of active dry yeast equal ten parts of bakers compressed yeast.

The slurry for pharmaceutical dry yeast is pumped to the vertex of a rotary double-drum dryer where it is preheated and passed in a thin film over rotating drums heated internally by live steam. The slurry spread on the drum surface dries and is scraped for conveyor transport to a pulverizer or flaker. Both powder and flakes are packaged in bags and drums.

Process wastes from yeast drying are filter effluent, spent filter precoat, and equipment backflushing and cleanup. Drying and packaging produce only minor wastes from machinery and floor cleanup.

DRAFT

SECTION IV

INDUSTRY SUBCATEGORIZATION

In the development of effluent limitation guidelines and standards of performance for the Miscellaneous Foods and Beverages Industry, it was necessary to determine whether significant differences exist which form a basis for subcategorization of the industry. The rationale for subcategorization was based on emphasized differences and similarities in the following factors: (1) constituents and/or quantity of waste produced, (2) the engineering feasibility of treatment and resulting effluent reduction, and (3) the cost of treatment. While factors such as process employed, plant age and size, and nature of raw material utilized tend to affect the constituents and quantity of waste produced, the emphasis herein is not merely on an analyzation of these factors but on the resulting differences in waste production, engineering feasibility, and cost.

The Environmental Protection Agency preliminarily subcategorized the miscellaneous foods and beverages point source category into the SIC Codes listed in Table 12. As discussed in Section III, most of these codes encompass numerous manufacturing processes, and the possibility that some of the codes could be consolidated was well recognized.

Several factors or elements were considered with regard to identifying any relevant subcategories. These factors included the following:

1. Process variations
2. Raw materials
3. Age of plants
4. Size of plants
5. Plant location
6. Products and by-products
7. Climatic influences
8. Seasonal variations

After consideration of all of the above factors it is concluded that the miscellaneous foods and beverages industry should be further divided into subcategories as given in Table 13. The rationale for the subcategorization is given below.

PROCESS VARIATIONS

The production of miscellaneous foods and beverages, as indicated in Section III, involves considerable variation in process operations. These variations, whether caused by the end product desired or other factors, can result in markedly different wastewater characteristics, applicable control and treatment alternatives, and costs of control and treatment alternatives. Of all factors considered, process

DRAFT

TABLE 12

CLASSIFICATION OF THE MISCELLANEOUS FOOD AND BEVERAGES INDUSTRY BY STANDARD INDUSTRIAL CLASSIFICATION CODES

SIC 2017	Poultry and Egg Processing (Egg Processing Only)
SIC 5744	Shell Eggs
SIC 2034	Dehydrated Soups
SIC 2038	Frozen Specialities
SIC 2047	Dog, Cat, and Other Pet Food
SIC 2051	Bread and Other Baking Products, Except Cookies and Crackers
SIC 2052	Cookies and Crackers
SIC 2065	Candy and Other Confectionery Products
SIC 2066	Chocolate and Cocoa Products
SIC 2067	Chewing Gum
SIC 2074	Cottonseed Oil Mills
SIC 2075	Soybean Oil Mills
SIC 2076	Vegetable Oils Except Corn, Cottonseed, and Soybean
SIC 2079	Shortening, Table Oils, Margarine and Other Edible Fats and Oils, Not Elsewhere Classified
SIC 2082	Malt Beverages
SIC 2083	Malt
SIC 2084	Wines, Brandy, and Brandy Spirits
SIC 2085	Distilled, Rectified, and Blended Liquors
SIC 5182	Bottling of Purchased Wines, Brandy, Brandy Spirits, and Liquors
SIC 2086	Bottled and Canned Soft Drinks and Carbonated Waters
SIC 2087	Flavoring Extracts and Flavoring Syrups Not Elsewhere Classified
SIC 2095	Roasted Coffee
SIC 2097	Manufactured Ice
SIC 2098	Macaroni, Spaghetti, Vermicelli, and Noodles
SIC 2099	Food Preparations, Not Elsewhere Classified

DRAFT

TABLE 13

RECOMMENDED SUBCATEGORIZATION OF THE MISCELLANEOUS FOODS AND BEVERAGES POINT SOURCE CATEGORY

VEGETABLE OIL PROCESSING AND REFINING

A1 Establishments primarily engaged in the production of unrefined vegetable oils and by-product cake and meal from soybeans, cottonseed, flaxseed, peanuts, safflower seed, sesame seed, sunflower seed by mechanical screw press operations.

A2 Establishments primarily engaged in the production of unrefined vegetable oils and by-product cake and meal from soybeans, cottonseed, flaxseed, peanuts, safflower seed, sesame seed, sunflower seed by direct solvent extraction or prepress solvent extraction techniques.

A3 Establishments primarily engaged in the production of olive oil and by-product cake or meal from raw olives by hydraulic press and solvent extraction methods.

A4 Establishments primarily engaged in the production of olive oil and by-product cake or meal from raw olives by mechanical screw press methods.

A5 Establishments primarily engaged in the processing of edible oils by the use of caustic refining methods only.

A6 Establishments primarily engaged in the processing of edible oils by the use of caustic refining and acidulation refining methods.

A7 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, acidulation, bleaching, deodorization, winterizing, and hydrogenation.

A8 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, bleaching, deodorization, winterizing hydrogenation.

A9 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, acidulation, bleaching, deodorization,

DRAFT

TABLE 13

A10 Establishments primarily engaged in the processing of edible oils utilizing the following refinery methods: caustic refining, bleaching, deodorization, winterizing, hydrogenation, and the plasticizing and packaging of shortening and table oils.

A11 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, acidulation, bleaching, deodorization, winterizing, hydrogenation, and the plasticizing and packaging of shortening, table oils, and margarine.

A12 Establishments primarily engaged in the processing of edible oils utilizing the following refining methods: caustic refining, bleaching, deodorization, winterizing, hydrogenation, and the plasticizing and packaging of shortening, table oils, and margarine.

A13 Establishments primarily engaged in the processing of edible oils into margarine.

A14 Establishments primarily engaged in the processing of edible oils into shortening and table oils.

A15 Establishments primarily engaged in the refining and processing of olive oil.

BEVERAGES

A16 Production of malt beverages by breweries constructed since January 1, 1950 and with a production capacity in excess of 800 cubic meters per day. In addition, this subcategory includes plant 82A16.

A17 Production of malt beverages by breweries constructed before January 1, 1900 and with a production capacity in excess of 2000 cubic meters per day.

A18 Production of malt beverages by breweries not included in subcategories A16 and A17.

A19 Installations primarily engaged in the production of malt and malt by-products.

A20 Wineries primarily engaged in the production of wine, brandy, or brandy spirits, and not operating stills.

A21 Wineries primarily engaged in the production of wine, brandy, or brandy spirits, and operating stills.

DRAFT

TABLE 13 (CONT'D)

A22 Distilleries primarily engaged in the production of beverage alcohol from grains and operating stillage recovery systems.

A23 Distilleries primarily engaged in the production of beverage alcohol from grains and not operating stillage recovery systems.

A24 Distilleries primarily engaged in the production of beverage alcohol by distillation of molasses.

A25 Installations primarily engaged in the blending and bottling of purchased wines of spirits.

A26 Installations primarily engaged in the production of soft drinks; and which package exclusively in cans.

A27 Installations primarily engaged in the production of soft drinks; and which are not included in Subcategory A26.

A28 Installations primarily engaged in the production of beverage base syrups, all types

A30 Installations primarily engaged in the production of instant tea.

C8 Installations primarily engaged in the production of roasted coffee.

C9 Installations primarily engaged in the decaffeination of coffee.

C10 Installations primarily engaged in the production of soluble coffee.

F1 Installations primarily engaged in the blending of tea.

BAKERY AND CONFECTIONERY PRODUCTS

C1 Production of cakes, pies, doughnuts, or sweet yeast goods, separately or in any combination, by facilities using pan washing.

C2 Production of cakes, pies, doughnuts, or sweet yeast goods separately or in any combination by facilities not using pan washing.

DRAFT

TABLE 13 (CONT'D)

C3 Installations primarily engaged in the production of bread related products

C7 Installations primarily engaged in the production of cookies or crackers separately or in any combination.

C13 Installations primarily engaged in the production of bread and buns in any combination.

C14 Installations primarily engaged in the production of bread and snack items, in any combination.

D1 Installations primarily engaged in the production of candy or confectionery products separately or in any combination, except glazed fruits.

D2 Installations primarily engaged in the production of chewing gum.

D3 Installations primarily engaged in the production of chewing gum base.

D5 Installations primarily engaged in the production of milk chocolate with condensory processing.

D6 Installations primarily engaged in the production of milk chocolate without condensory processing.

PET FOODS

B5 Installations primarily engaged in the production of canned pet food, low meat.

B6 Installations primarily engaged in the production of canned pet food, high meat.

B7 Installations primarily engaged in the production of pet food, dry.

B8 Installations primarily engaged in the production of pet food, soft moist.

MISCELLANEOUS AND SPECIALTY PRODUCTS

A29 Installations primarily engaged in the production of flavorings, or extracts, separately or in any combination.

A31 Installations primarily engaged in the production of bouillon products.

A32 Installations primarily engaged in the production of non-dairy creamer.

DRAFT

TABLE 13 (CONT'D)

A33 Installations primarily engaged in the production of yeast and by-product molasses, if recovered.

A34 Installations primarily er[illegible]n the production of peanut butter by facilitie[illegible]g jar washing.

A35 Installations primarily engaged in the production of peanut butter by facilities not using jar washing.

A36 Installations primarily engaged in the production of pectin and peel by-products, if recovered.

A37 Installations primarily engaged in the production of almond paste.

B1 Installations primarily engaged in the production of frozen prepared dinners.

B2 Installations primarily engaged in the production of frozen breaded or battered specialty items, separately or in any combination.

B3 Installations primarily engaged in the production of frozen bakery products.

B4 Installations primarily engaged in the production of tomato-cheese-starch products.

B9 Installations primarily engaged in the production of chili pepper and paprika, in combination.

C4 Installations primarily engaged in the production of processing of eggs.

C5 Installations primarily engaged in the production of shell eggs.

C6 Installations primarily engaged in the production of manufactured ice.

C12 Installations primarily engaged in the production of prepared sandwiches.

D5 Installations primarily engaged in the production of vinegar.

DRAFT

TABLE 13 (CONT'D)

E1 Installations primarily engaged in the production of molasses, honey, glazed fruit or syrups, separately or in any combination.

E2 Installations primarily engaged in the production of popcorn.

E3 Installations primarily engaged in the production of ready-mix desserts or gelatin desserts, separately or in any combination.

E4 Installations primarily engaged in the production of spices.

E5 Installations primarily engaged in the production of dehydrated soup.

E6 Installations primarily engaged in the production of macaroni, spaghetti, vermicelli, or noodles, separately or in any combination.

F2 Installations primarily engaged in the production of baking powder.

F3 Installations primarily engaged in the production of chicory.

F4 Installations primarily engaged in the production of bread crumbs variation has generally been found most significant in determining subcategorization.

The consideration of process variations resulted in the following subcategorization:

Vegetable Oil Processing and Refining:

The production of unrefined vegetable oil from soybeans, cottonseeds, flaxseeds, peanuts, safflower seeds, sesame seeds, sunflower seeds and olives by mechanical screwpress operations.

The production of unrefined vegetable oil from soybeans, cottonseeds, flaxseeds, peanuts, safflower seeds, sesame seeds, sunflower seeds and olives by direct solvent extraction and prepress solvent extraction.

Edible oil refining only.

Edible oil refining and acidulation.

Edible oil refining, acidulation, oil processing and deodorization.

Edible oil refining, oil processing, and deodorization.

Edible oil refining, acidulation, oil processing, deodorization and the production of shortening and table oils.

Edible oil refining, oil processing, deodorization, and the production of shortening and table oils.

Edible oil refining, acidulation, oil processing, deodorization, and the production of shortening, table oils and margarine.

Edible oil refining, oil processing, deodorization, and the production of shortening, table oils, and margarine.

Margarine production only.

Shortening and table oil production only.

Beverages:

Malt beverages.

Malt.

Wineries without distilling operations.

Wineries with distilling operation.

Grain distillers with stillage recovery systems.

Grain distillers without stillage recovery systems.

Molasses distillers.

Plants primarily bottling wines and distilled liquors.

Soft drink canning plants.

Soft drink bottling, or combined bottling/canning plants.

Plants producing flavor base syrups and/or concentrates.

Roasted coffee.

Coffee decaffeination.

Soluble coffee.

Instant tea.

Tea blending.

Bakery and Confectionery Products:

Bread and bread related products.

Cakes, pies, doughnuts, and sweet yeast goods utilizing pan washing.

Cakes, pies, doughnuts, and sweet yeast goods not utilizing pan washing.

Cookies, crackers, and other "dry" bakery products.

Candy and confectionery products except glazed fruit.

Glazed fruit.

Chewing gum products excluding the preparation of natural gum base.

Chewing gum base prepared from artificial and natural materials.

Chocolate and cocoa products prepared from cocoa beans.

Pet Food:

Canned pet food.

Dry pet food.

DRAFT

Miscellaneous and Specialty Products:

Shell egg handling (SIC 5144).

Egg processing (SIC 2017).

Frozen specialties.

Non-dairy coffee creamers.

Production of specific flavors from the blending of extracts, acids, and colors.

Manufactured ice.

Bouillon production.

Yeast production.

Peanut butter manufacturing not including jar washing.

Peanut butter manufacturing including jar washing.

Chili pepper and paprika.

Prepackaged sandwiches.

Vinegar.

Molasses, honey, and syrups.

Dehydrated soup.

Prepared desserts, gelatin.

Spices.

Macaroni, spagetti, vermicelli, noodles.

Almond paste.

Pectin.

Baking powder.

Chicory.

Bread crumbs.

The rationale for the above subcategorization due to process variation is as follows.

Vegetable Oil Processing and Refining

Unrefined Vegetable Oil - The production of crude vegetable oil from oilseeds involves three distinct processes each resulting in different wastewater stream loadings. Mechanical screw press operations have been documented by plant visitations and telephone surveys to have zero discharge of process wastewater. The extraction processes of direct solvent extraction and pre-press solvent extraction do contribute an average daily wastewater flow of approximately 100 cu m/day (0.03 MGD). This wastewater results from 1) wastewater generated by wet scrubber systems, 2) degumming operations, 3) steam condensates contaminated by oil, fatty acids or hexane solvent, and 4) in-plant cleanup resulting from spillage of oil or miscella, tank leakage or pump failure.

Edible Oil, Shortening, and Margarine - Wastewaters generated from edible oil refineries, on the other hand, vary greatly with respect to the degree of process integration existing at each plant. For example, a large full-scale edible oil refinery may have an entire sequence of operations in which vegetable oils are transformed into finished products such as shortening, margarine or table oil. A conventional full-scale operation would include: 1) storage and handling facilities, 2) caustic refining, 3) soap-stock acidulation, 4) bleaching, 5) hydrogenation, 6) formula blending, 7) winterization, 8) deodorization, and 9) plasticizing and packaging a number of finished products. In contrast there exists a number of small scale operations consisting of only tank farm storage and handling facilities with steam or kettle refining. These smaller plants usually sell the refined oil to other edible oil processors who in turn produce a finished product.

Due to the variations in plant size and process integration, it was necessary to adopt a "building block" approach to the assessment of wastewater loadings within the industry. The eight unit processes listed in Table 14 have been identified, each generating a different wastewater effluent. Table 15 presents a list of the various unit process combinations within the industry and the number of plants utilizing each combination in the U.S. during 1970.

Three processes are common to about 95 percent of the industry. These include 1) raw material storage in storage tanks, 2) tank car cleaning, and 3) caustic refining. Seng (53) reports that as a result of handling large volumes of edible oils there are erratic flows resulting from washing and cleaning processes to remove oils and greases that accumulate due to tank leaks, transfer operations pump failures, and the accumulation of refuse materials and settled dust. These materials become a major waste load problem when washed into plant storm sewers by rain. Becker (54) reports that in some cases the BOD increase as a result of storm water runoff is considerable.

DRAFT

TABLE 14

EDIBLE OIL PROCESS UNITS

1. Edible oil refining (i.e., caustic, steam and kettle refining, and including intersterification rearrangements)
2. Soapstock acidulation
3. Edible oil processing (i.e., bleaching, winterization, and hydrogenation)
4. Contact cooling tower blowdown from deodorization barometric condenser systems
5. Tank car cleaning
6. Storage and handling
7. Plasticizing and packaging (i.e., shortening and table oils production)
8. Margarine processing

DRAFT

TABLE 15

PROCESS INTEGRATION IN THE EDIBLE OIL REFINING INDUSTRY[a]

Process Integration*	Number of Plants Utilizing Process Integration
1. R	21
2. R	6
3. RP	7
4. RDW	10
5. RDWH	2
6. RDWP	5
7. RDWHP	29
8. RDH	9
9. RDHP	10
10. RDP	5
11. RHP	1
12. DP	2
13. P	3
TOTAL	110

[a] R = Refine; D = Deodorization; H = Hydrogenation; W = Winterize; P = Plasticize

* All plants are assumed to have tank car cleaning and storage transfer facilities.

Source: 1970 Directory to Edible Oil Refineries

Tank car cleaning operations are usually adjacent to outdoor tank farm facilities and may at times contribute to the storage and handling wasteload. On the average, about 10 tank cars are washed per week during the day shift. The wasteload of this operation consists primarily of bulk oil and detergents flushed out of the tank car by cleaning. Usually a holding tank is used to recover the bulk oil. The recovered oil is then pumped to an inedible oil holding tank. Seng (53) reports that crude oil is treated with caustic and is centrifuged to remove microorganisms and soapstock. These "foots" are pumped to an outdoor tank farm for sale or for acidulation purposes. The refined oil is then washed and centrifuged. Caustic refining constitutes a continuous source of process wastewater with a pH value ranging from 10 to 12. Water usage for the oil washing process is estimated to be about 10 to 15 percent by weight of the oil processed. The acidulation of soapstock or "foots" for fatty acid content produces a continuous wasteload low in pH (1.5 to 2.0) and higher in organic content. The total water volume is estimated to be 65 to 75 percent of the soapstock treated by weight.

Francois (55) reports that the thermo-compressor condensates from the deodorization process constitutes a continuous wasteload high in organic impurities or "unsaponificable" substances. Certain fatty acid materials are concentrated within the stripping stream and are removed by barometric condenser water where they are eventually concentrated in the contact cooling tower blowdown.

In general, the steps of bleaching, hydrogenation, and winterization represent a relatively small wasteload in comparison to the above defined unit processes. Seng (53) reports that bleaching produces a wasteload containing a small amount of spent filter material that is flushed down the sewer during cleanup; a source of suspended solids found in the wastewater. In the hydrogenation process very small amounts of nickel catalyst sometimes reach the sewer from cleanup operations. In the winterization process, the only wastewater that would result is from general cleanup activities.

Wastewater generation for the plasticizing and packaging of shortening is quite different from that of margarine processing. In general, filling rooms that process shortening require much smaller volumes of cleanup water than do packaging operations that require the maintenance of bacteria free filling equipment. The packaging of margarine, salad dressings, mayonnaise, and other milk products capable of supporting pathogenic bacteria require daily cleaning and sterilization of all filling equipment. Therefore, margarine processing produces a larger volume of wastewater containing high strength disinfectants (chlorine, detergents) in comparison to shortening and table oil filling rooms.

Beverages

Malt Beverages - The sources of pollutants from the malt beverage industry can be documentated on a plant by plant basis. There are no process variations justifying further subcategorization of the industry. As discussed in Section III, one brewing company uses beechwood chips during fermentation. The cooking and washing of the chips, as well as yeast recovery from the chips, creates unit process wastes different from other brewers.

Malt - All maltsters in the United States process malt by steeping, germinating, and kilning. Most of the resulting wastewater is associated with steeping, and all plants use submerged steeping. Process variation is not considered to be a factor for further subcategorization of the malt industry because of the uniform nature of the process.

Wine, Brandy, and Brandy Spirits - Data and field observations support the contention that wineries operating stills have considerably higher wasteloads in the distilling (crushing) season than those who do not operate stills. Wastewater from stillage represents a 300 percent increase over normal wasteloads.

Distilled Spirits - Grain distillers must be subcategorized according to whether they do or do not operate stillage recovery systems. Those plants which do not operate stillage recovery systems generally sell wet spent stillage as cattle feed and consequently do not generate a wasteload from stillage recovery (condensate from evaporation). Molasses distillers stand as a separate subcategory since a majority neither recover nor sell stillage, but dispose of it directly to the ocean.

Soft Drinks - There are basically three types of soft drink plants: 1) those that produce only canned drinks, 2) those that produce only bottled drinks, and 3) those that produce both bottled and canned drinks. From a process point of view, there is a discrete difference between bottling and canning operations -- the former involves bottle washing while the latter is primarily a mixing-filling operation.

As documented in Section V, the pounds of pollutant per unit of production are decidedly less in canning plants than in bottling or bottling/canning plants. This difference is due primarily to the wastewater generated by a bottle washer processing returnable bottles. This difference in wastewater will vary depending on the percent of returnable or non-returnable bottles processed.

Therefore, based on process variations, available data justifies two subcategories of soft drink production: 1) those operations producing only canned drinks and 2) those operations producing only bottled drinks and others producing both bottled and canned drinks.

Coffee - Virtually all production processes are common to all producers of roasted coffee as a final product. These include: 1) raw material storage and weighing, 2) air cleaning, 3) blending and roasting, 4) grinding, and 5) packaging. Coffee roasting requires no process water, with two exceptions. First, some plants use a water spray to check the roasting process, but this water is evaporated and incorporated into the product. Second, a few plants have wet stack scrubbers which generate small quantities (up to 200 l/day) of wastewater. Cleaning of all coffee roasting equipment is a dry process.

Decaffeination is a separate step that may or may not exist in soluble and roasted coffee processes depending on product requirements of the individual plant. Water is used in the caffeine extraction process and the rinsing of the decaffeinated green beans. The caffeine extraction process (including equipment cleaning) is a significant source of wastewater volume and concentration. Even though more than one decaffeination technique is recognized to exist, available wasteload data does not substantiate a clear basis for differentiating among the process for effluent guidelines development purposes.

The soluble coffee process utilizes water to extract the soluble coffee from the ground roasted coffee. General plant cleanup, extractor equipment cleaning, and drying tower cleaning are significant sources of wastewater volume and concentration. Freeze drying and spray drying are the normal methods of preparing soluble coffee for marketing. Available data does not warrant differentiation between the freeze-dried and the spray-dried product.

Tea - The instant tea manufacturing process is essentially uniform throughout the tea industry. As noted in Section III, one source of process wastewater generated from instant tea manufacturing is the periodic dumping of clarifier sludge when regeneration of tea extract from the sludge becomes minimal. Equipment cleanup water is the major source of process wastewater. The production of blended tea involves no process wastewater generation and may be designated a dry process. Subcategorization of the tea manufacturing industry to account for process differences between instant tea and blended tea production is necessary.

Flavoring Extracts and Syrups - The processes involved in the manufacture of flavoring extracts and syrups include solvent extraction, distillation, expression, evaporation, dehydration, and blending. These individual processes are discussed in Section III of this document. The small amount of information available from the industry for these products indicates that most flavoring extract plants perform blending, as well as several of the extraction processes listed above, and possibly some dry spice grinding and blending. The one exception to this is the production of beverage bases, the majority of which are produced by major soft drink companies in plants solely manufacturing beverage bases. Most beverage base plants purchase rather than produce the flavoring materials used and the principle process is merely one of blending. The separation of beverage base plants from flavoring extract plants is further reinforced by the fact that more wash water is used in the former.

Bakery and Confectionery Products

Bakery Products - In the production of bread and other baked products, except cookies and crackers, bread and bun production are virtually identical and can be separated from cake and pie production because bread production requires no filling, icing, enrobing, or other finishing operations. Additionally, significantly less cleaning of equipment is necessary. In bread production, pans are rarely, if ever, wet cleaned. Other equipment is only cleaned weekly.

Cakes, pies, and sweet yeast goods can be produced by methods which may or may not require pan washing. This difference plays a major role in the strength of a plant's wasteload. The BOD of pan wash water has been reported (7) as high as 54,000 mg/l.

Many processes are common to all cookie and cracker manufacturers. These include: 1) mixing, 2) baking, 3) cooling, 4) stacking, and 5) packaging. Principal variations in the other processing steps are the result of the category or style of the end product. The principle process variations are the forming, oiling, and icing, or enrobing, procedures. Forming of cookies is usually done by either rotary dyes or extruding machines while crackers are formed by sheeting or stamping the dough. The forming equipment in both cases is dry cleaned with the exception of rotary formers. This wet cleaning of the rotary formers is not, however, a significant source of wastewater strength, although it does contribute a relatively small amount to the volume. Some types of crackers are sprayed with oil following baking in order to help improve the flavor. The equipment used for the oil spraying of crackers is normally not wet cleaned, and is therefore not assumed to be a contributor to the wasteload. Certain varieties of cookies are either iced or enrobed. In the cleaning of this equipment is additional source of waste. However, virtually all plants produce a variety of cookie and cracker products and discharge a combined effluent. As a result, available data does not justify further subcategorization of the cookie and cracker industry on the basis of process variations.

Candy Confectionery Products - The candy and confectionery industry produces a wide range of products and employs a number of different processing methods. However, some common denominators in processing lend a certain amount of homogeneity. The several diverse processes have in common a "candy kitchen" for the initial preparation of the candy base and it is at this point that most cleanup water is used and most wastewater generated, regardless of what later processing is involved in producing the final product. Glazed fruit production, however, employs processes which generate wastewater with distinct treatment generations. The glazed fruit process often involves a bleaching of the fruit and subsequent discharge of sulphur dioxide.

While the production of chewing gum and chewing gum base involves rather similar processes, sodium hydroxide is used as a bleaching agent in the preparation of chewing gum bases and presents a pH characteristic which must be given consideration in treatment.

In the production of chocolate and cocoa products from cocoa beans, the incompatability of moisture in chocolate requires a careful control of the use of open water. However, large volumes of water are used in several aspects of the process, e.g., cooling water. These establishments characteristically discharge large volumes of water of a relatively low waste loading.

Pet Foods

The principal variations in pet food processing result from the type of product being produced. The dry pet food product does not require processing of fresh and frozen meat and meat by-products. The processing of fresh and frozen meat and by-products requires an extensive separate sequence of specialized equipment which may include grinders, screw conveyors, slurry tanks and interconnecting piping. All of the special meat handling equipment is a significant source of waste generation during operation and cleanup. In contrast the dry pet food operation is composed of almost entirely dry ingredients which may require only dry grinding prior to expanding.

The canned pet food product differs from the dry and semi-moist products because of the necessity for the can filling--can washing retort operation. The canning operation is a signficant source of wastewater volume in organic pollutant generation.

In terms of processing steps, the soft moist product lies between the canned and dry product in terms of number of processing steps and resultant waste generation. The soft moist product will normally utilize some fresh or frozen beef products and by-products and will therefore have a preliminary meat processing line. In formulation, the soft moist product is generally similar to the low-meat canned product except for the lower moisture level and the addition of preservatives. The soft moist product does not go through a canning operation.

The extruding and expanding operations using soft moist and dry pet food manufacturing are not major sources of waste generation. Equipment is typically cleaned daily producing a short-term, high strength waste which is relatively insignificant in terms of pollutant generation per volume of production.

These variations in production processes result in substantially different waste generations per ton of production, as described in Section V and support the subcategorization of the industry into canned, soft moist, and dry pet food.

Miscellaneous and Specialty Products

Shell Egg Handling and Egg Processing - Shell egg handling and egg processing are distinct operations in that shell egg handling involves storage, washing, oiling, handling, and grading of eggs in the shell, while egg processing utilizes shell eggs as a raw material, whether broken on the premises or by another processor, and produces dried, frozen, or canned eggs or albumen. Food and Drug Administration regulations require that all egg products be pasteurized. The type of products produced varies widely among egg processing plants and even within a given plant as a result of changing seasons and demands; however, available data on wastewater generation preclude further subcategorization.

Frozen Specialties - While many production processes are common to all frozen specialty manufacturers, variations do occur in some processing steps as a result of the style of end product. However, these process variations are not considered to be of significant magnitude to justify further subcategorization of the frozen specialties industry.

Non-Dairy Coffee Creamer - The production of both liquid and powdered non-dairy creamer has the following unit processes in common: 1) mixing, 2) pasteurization, and 3) homogenization. Following the homogenizing of the liquid product, the unit processes differ in that the product to be powdered is dried while the product to remain a liquid is cooled. Based on existing evidence, this production variation does not cause an appreciable difference in wastewater generated per ton of solid product. The distinction of solid product is necessary because liquid creamer is approximately 50 percent water by volume.

Cleanup water from clean-in-place systems is the major source of wastewater, the quantity and character of which would be the same for both liquid and powdered creamer. Consequently process variations do not substantiate further subcategorization of the non-dairy creamer industry.

Ice Manufacturing - Block and fragmentary ice are produced by significantly different processes, as detailed in Section III of this document. Block ice is produced by partially submerning rectangular cans filled with water in refrigerated brine tanks. Fragmentary ice is produced as small pieces, such as disks or cylinders, by machines especially designed for that purpose.

The major volume of wastewater in many block ice plants is once-through cooling water discharge. In addition, wastewater may be generated in the production of block ice from treatment of incoming water, dipping of the cans to loosen the ice; replacement of the unfrozen core with fresh water; ice and snow losses; and from scoring, cutting, and crushing. Conversely, block ice plants that follow good water conservation practices do not generate these large volumes of wastewater. In fact, some block ice plants generate less wastewater per kkg of production than fragmentary ice plants. The quantity of wastewater is dependent upon primarily plant management rather than process variations.

Fragmentary ice making machines are semi-automatic. Wastewater is generated from excess water not frozen, defrost water, and blowdown. The range in quantity of wastewater is relatively narrow, because it is not highly operator-dependent.

Therefore, although block ice and fragmentary ice processing methods differ, data indicates no appreciable difference in organic loading, suspended solids, or potential treatment for the wastewater generated by the respective processing methods. No further subcategorization of ice manufacturing is justified.

Yeast - The production processes necessary to produce commercially acceptable yeast are standard throughout the industry. These include: 1) raw material storage and preparation, 2) fermentation, 3) separation of the mature yeast from residual nutrients, 4) dewatering, and 5) packaging. Spent beer wash separated from the yeast by centrifugal methods accounts for over 70 percent of the pollutant loading of combined wastes. Spent nutrients, which may comprise from 15 percent to 50 percent of the total waste volume, depending on dilution water use and reuse, have a BOD of 2000 to 15,000 mg/l. Although these process variations cause differences in combined waste volume, no substantial differences in waste generation per unit of production were found. Spent beer is normally discharged to a sewer or pumped to an evaporator for molasses by-product recovery. Yeast dewatering practices, using filter presses and rotary vacuum filters, constitute the second largest waste stream in most yeast plants. Since there are virtually no differences in the equipment and procedures used in yeast factories, no basis for further subcategorization is judged to exist.

Vinegar - As illustrated in Section III, the process of vinegar production is a discreet operation resulting in a wastewater differing in characteristics from that of other food and beverage processors.

Pectin - As illustrated in Section III, the production of pectin is a unique process distinctly different from any other in the miscellaneous foods and beverages industry. This process variation results in a wastewater with significantly different characteristics as compared to that of other food and beverage processors.

DRAFT

Bouillon Products - The process involved in bouillon production is unique in its simplicity and the fact that equipment cleanup water is the only source of wastewater generated in the process.

Peanut Butter - All peanut butter processors roast, blanch, inspect, and grind shelled peanuts to produce peanut butter. All of these are dry process steps, although water is used in heating, cooling, and aeration. In packaging operations, some plants remove the product from partially filled or improperly sealed jars, and then wash the jars before refilling. Jar washer discharge is a low volume, concentrated wastestream which significantly increases plant waste generation per unit of production when sewered. The increased wasteload from jar washing constitutes a strong basis for subcategorization of this industry. Other wastestreams include floor and equipment cleanup.

Chili Pepper and Paprika - The unit processes employed by the paprika and chili pepper industry are generally uniform. New techniques from time to time have been employed to effect reduced volumes and/or strengths of liquid process wastes. Special efforts have been made on those production processes which generate the greatest amounts of pollutants: washing, fluming, and chopping. It may be concluded that the use of alternate process equipment may substantially reduce raw waste generation.

Since the new techniques are not entirely proven, they are viewed as being pollution control options rather than a basis for subcategorization. Subcategorization on the basis of these new methods is considered to be inequitable for several reasons: 1) the new techniques are largely still experimental for most commodities; 2) the magnitude of the new techniques' effect upon raw waste load reduction is still largely undetermined, and 3) the establishment of a separate (more stringent) subcategory now for those plants which are attempting pioneering efforts would be unreasonable.

Prepackaged Sandwiches - As described in Section III, the wastewater generated by the production of prepackaged sandwiches results from the cleaning of utensils and other equipment, and from floor washing. No justification for further subcategorization of the prepackaged sandwich industry has been determined to exist.

Baking Powder, Chicory, Bread Crumbs - These processes have been identified to result in no water use or process wastewater generation and may therefore be appropriately considered as "dry" operations.

Miscellaneous Products - The preparation and packaging of popcorn, molasses, the various syrups, honey, prepared gelatin desserts, dehydrated soup, and the various macaroni products, while involving diverse operations, is characterized by low levels of wastewater generation. Therefore, no further subcategorization of these products is considered justifiable on the basis of process variations. For the purposes of effluent guidelines development, these products have been given the designations E1 through E6.

RAW MATERIAL VARIATIONS

Vegetable Oil Processing and Refining

Unrefined Vegetable Oils - With the exception of olives, available data do not justify subcategorization of unrefined vegetable oil production on the basis of raw materials since most processing plants crush different oilseeds at various times. Raw material and process variation are to some extent interrelated since processing techniques are often specially related to the type of oilseed being processed. Solvent extraction is the most common method used to extract soybean oil while cottonseed oil is usually extracted by screw press operations.

A significant difference in wastewater characteristics results when olives are processed for olive oil. As indicated in Section V, a considerably more concentrated wastestream results from the handling of whole olives and olive pits as compared to other oilseeds. Therefore, it is necessary to place the production of olive oil into a separate subcategory from other oilseed processing. No further subcategorization is justifiable as a result of raw material variations.

Edible Oil, Shortening, and Margarine - Variations in raw materials offer no justification for further subcategorization of edible oil, shortening, and margarine (excluding olive oil). The refining of different oils does generate different wasteloadings, but a given plant frequently changes the type of oil being refined and refines more than one type at one time. As a result, there is no basis for further subcategorization of the industry on the basis of raw material variations.

However, olive oil refining is done exclusive of other oils and generates a distinctive wastestream. Therefore, olive oil refining must be considered as a separate subcategory.

Beverages

Malt Beverages - Raw materials for the brewing industry include malt, cereal, grains, hops, and yeast. In terms of wastewater generation, there is essentially no difference in the raw materials utilized within a brewery. Some breweries use hop extracts instead of hop flowers, thereby eliminating the spent hop disposal problems, but the disposal practice with spent hops is normally the addition of this material to spent grains. No further subcategorization of the malt beverage industry as a result of raw material variation is justified.

Malt - Although different types of barley are used for the production of malt, data presently available does not substantiate any differences in wastewater generated. No further subcategorization is justified based on raw material variations.

Wine, Brandy, and Brandy Spirits - Wineries in the western United States use the *V. Vinifera* variety of grape and those in the east utilize the *V. Labrusca* variety. The eastern grape is lower in sugar and higher in acidity than the western grape. Although eastern wineries practice amelioration prior to fermentation, there is no data existing to indicate that the type of grape, per se, creates a difference in wastewater discharged. Therefore, no further subcategorization of the industry as a result of raw material variations is considered justifiable.

Distilled Spirits - Differences in raw materials contribute to differences in processes as a rationale for subcategorizing molasses versus grain distillers. Citrus and blackstrap are used in molasses distilleries whereas corn, rye, and malt are used in grain distilleries.

It should be mentioned that any grain distiller utilizing a 100 percent rye mash bill may generate a higher wasteload than that from a straight whiskey mash bill, although current data does not indicate the justification of a separate subcategory for this type of operation.

Soft Drinks - Since diet soft drinks inherently utilize less sugar during processing than regular soft drinks, lower wasteloads might be expected. Diet soft drink production, however, is generally less than 10 percent of the production at any one plant. Available data indicate the waste characteristics of plants utilizing diet soft drink production to not be significantly different from other operations. Further subcategorization on the basis of raw material variation is not felt to be justified.

Coffee - Coffee processors utilize green beans as the basic type of raw material, with two exceptions. Some producers utilize partially roasted green beans as their raw material. However, since coffee roasting is a dry process, this variation does not require further subcategorization. Second, at least one producer of soluble coffee products imports a coffee extract from which to manufacture the desired product. This procedure produces less wastewater than the production of soluble coffee from ground roasted coffee, but technical data is not available to support further subcategorization of the soluble coffee process. Further subcategorization of the coffee processing industry on the basis of raw material cannot be justified because the industry has adequate control over its raw material quality and basically the same raw materials are used by all manufacturers.

Tea - Raw materials in the tea industry consist of tea leaves imported from various parts of the world. There is no reason to believe, nor do available data indicate, that there is any difference in wastewater resulting from the variety of tea leaves utilized. Therefore, no further subcategorization of the tea industry as a result of raw material variation is justifiable.

Bakery and Confectionery Products

Bakery Products - All baked goods manufacturers utilize raw materials such as flour, sugar, shortening, and water. In the production of bread, these are the only major ingredients. In the production of cakes and pies, fruit, chocolate, spices, flavorings, and a larger amount of sugar are consumed in addition to those ingredients used for bread production. The result of this difference in ingredients is a significant difference in the wastewater volume and strength generated by the production of bread and the production of cake and related products. The ingredients used in the production of cake require more frequent wet cleaning of the equipment associated with their preparation. The large amounts of sugar used in cake production also contributes significantly to the strength of the wastewater discharged.

These variations in raw materials result in substantially different waste generation per unit of production, and support the recommended subcategorization of bread vis-a-vis cake products.

All cookie and cracker manufacturing plants utilize the same basic types of raw materials or ingredients. As detailed in Section III of this document, these ingredients include flour, sugar, shortening, and assorted additives, flavorings and colorings. In the production of crackers, these are the only major ingredients. In the production of cookies, chocolate is also a major ingredient and a much larger amount of sugar is consumed per kkg of product. The result of this variation is undoubtedly a greater wasteload from cookie production than from cracker production. However manufacturers normally produce both products and discharge a combined effluent. Consequently, no data exists to support the further subcategorization of the cookie and cracker industry on the basis of raw material differences.

Candy and Confectionery Products - The refined condition of sugar and corn syrup, the major ingredients used in the confectionery industry, leads to no requirement for pre-cleaning or pre-processing. The same situation is true for chewing gum which uses natural gum base as a prime ingredient. In contrast, the cleaning of raw materials for gum base and for chocolate and cocoa products generates wastes of significant differences. In general, while raw material variations lend support to the subcategorization proposed because of process variations, further subcategorization is not justified.

Pet Foods

All pet food plants use the same basic types of raw materials or ingredients. As detailed in Section III of this document, these ingredients fall into the following general categories:

1. Meat and meat by-products,
2. Poultry and poultry by-products,
3. Fish and fish by-products,
4. Cereal grain and grain products principally derived from soybeans, corn, wheat, barley, and oats,
5. Vegetables, fresh, frozen, and dehydrated,
6. Sugars and syrups,
7. Gums and food starches,
8. Milk based products,
9. Fats and oils,
10. Minor ingredients such as flavorings, vitamins, minerals, colors, preservatives, and others.

In general, the raw materials listed above have to some extent been preprocessed elsewhere prior to arrival at the pet food manufacturing plant. For example, the meat and meat by-products are typically delivered from meat-packing plants where the animals have been slaughtered and dressed. Accordingly, the pet food manufacturer has good control over the quality and condition of his raw materials. If they do not meet standards. he may refuse to accept them.

The formulations used by different manufacturers in preparing various styles of dog and cat food are described in Section III of this document. Generally, all or most of the ingredients listed are used to some extent in each formulation. The principal differences are in the respective percentages of animal and grain derived ingredients used.

The ratio of meat (fish) to dry ingredients has a profound effect upon raw waste generation and strength. Results analyzed from twelve canned pet food plants in Section V show that the organic pollutants strength of the raw wastes generated increases significantly with increase in use of fresh and frozen meat (fish) and meat (fish) by-products (not including dry meal). Thus, the data support the subcategorization of the canned pet food industry into high-meat (fish) and low-meat (fish).

DRAFT

Miscellaneous and Specialty Products

Shell Egg Handling and Egg Processing - All egg processors utilize shell eggs as the predominant raw material, whether broken on the premises or by another processor. Sugar, salt, and assorted food additives are also utilized as raw materials by some processors. However, these additional ingredients do not produce a wasteload which distinguishes plants utilizing them from plants which process only egg products. The strength and cleanliness of the eggs' shell also varies. However, insufficient data exists for subcategorization on this basis. The chemical composition of eggs is primarily responsible for the characteristics of egg processing wastewater and consequently for the need for a single egg processing subcategory.

Some processing plants break (and sometimes pasteurize) eggs for shipment to other processors for pasteurizing, drying, freezing, or canning. However, available data does not justify a separate subcategory for egg processors who do not break eggs.

Frozen Specialties - Frozen baked goods require rich ingredients such as butter, sugar, cream, etc., and these are purchased in bulk, received, blended under controlled conditions, further assembled into final product form, sometimes baked or fried, and packaged and frozen.

The frozen baking dessert plant must thoroughly clean with hot water all the mixing vats, cooking kettles, measuring devices, pumps, piping, etc., which have come in contact with the ingredients and product. This cleanup is continuous during plant operation as different products are manufactured. For example, one section of the plant may run several different kinds of pies during a shift. A peak in cleaning is normally reached during the massive final cleanup at the end of operation each day.

The ingredients for frozen T.V. dinners and ethnic foods usually include meat, fowl, or fish, vegetables, gravies, and minor additives. In addition, there may be added starches (such as noodles), grains (such as rice), and a variety of small dessert dishes. These ingredients are usually prepared elsewhere and are then further processed, cooked, assembled, packaged, and frozen at the prepared dinner plant. The bulk of the wastes generated originates from preparation of the ingredients. Prepared poultry arrives at the processing plant in a form ready for deskinning and deboning (if desired). Beef and other meat normally arrive in bulk. Some vegetables, such as carrots that require a longer cooking time, may be partially precooked prior to being brought to the assembly line. Potatoes are usually prepared from dehydrated potato products.

The primary wastewater generation results from equipment and container cleanup, and the differences in ingredients greatly affect the characteristics of the wastewaters. Raw material variations further support the subcategories proposed above for frozen specialties. No further subcategorization is felt to be justified.

Non-Dairy Coffee Creamer - Raw materials used in the manufacturing of liquid and powdered creamer are discussed in Section III. The main difference in raw materials between the two products is the use of sodium caseinate, mono- and di-glycerides, sugar and fatty acids in the production of liquid creamer. However, the percent by volume of these materials in the final product is small and has insignificant effects on the wastestream. Therefore, raw materials variations do not necessitate further subcategorization of the industry.

Flavoring Extracts and Syrups - The raw materials used by the flavoring extract and syrup industry include whole plants, plant tissues (fruit, stems, leaves, etc.), essential oils, synthetic flavoring extracts, alcohol, acids, sugar, solvents, and colors. These materials are generally used by all flavor producers. The exceptions are the beverage base producers which use only natural and synthetic flavoring extracts, acids, sugar and colors in their production. The distinct difference in raw material usage further supports the previous subcategorization, but does not justify further subcategorization.

Ice Manufacturing - All ice manufacturers utilize potable water as their raw material. It may be supplied by the local purveyor or a well. In many areas, the water available is not satisfactory for the production of quality ice. Treatment of the incoming water may contribute some additional concentration of minor pollutant parameters to the wasteload, but further subcategorization of ice manufacturing is not justified by this difference alone.

Yeast - Cane and beet molasses is the primary raw material used in growing yeast. Differences in such diverse factors as sugar content, trace metals, and minerals, physical stratification, amino acid content and mix and nutrient content may produce daily variations in the total plant wasteload due to the controls used in batch processing of yeast. Since all processors are subject to the same raw material variations, no further subcategorization on the basis of raw materials is justified.

Bouillon Products - The nature of raw materials used in the manufacturing of bouillon products result in a wastewater high in proteins and thus highly biodegradable. Therefore, raw materials usage supports subcategorization of bouillon products as a discrete subcategory.

Peanut Butter - All processors use shelled peanuts as the primary raw material. Small amounts of salt, sugar, stabilizer, and other ingredients.

are added to improve product quality. Raw material quality may affect roasting and grinding parameters, but there are no existing data to document any effect on wasteloads from jar washing and cleanup.

Chili Peppers and Paprika - Paprika and chili peppers, as explained in Section III, are virtually identical raw products, indistinguishable except for taste. Some of the contributing variables influencing raw material quality as it arrives at the processing plant include the following:

1. Physical quality:
   - Dirt and foreign objects - type of soil
   - Weather at time of harvest - muddy fields
   - Unfavorable climatic conditions - yield decreases

2. Biological quality:
   - Climatic influences, drought, etc.
   - Insect damage
   - Bacterial or mold damage

It is not considered necessary, however, to subcategorize on the basis of such unpredictable events which would usually be localized in occurrence. It is concluded that variations in raw product quality are normal and should be expected from week to week and season to season. Therefore, the waste management program should be designed with sufficient flexibility to handle the problems inherent in the industry due to expected raw product quality variations. It is also suggested that a processing plant attempt to work out beforehand with its regulating agency an emergency plan to handle a situation where uncontrollable significant deterioration in its raw product quality may cause subsequent upsets in treatment facilities.

Other variables which influence raw product quality and which are to some extent under the control of the processor are listed below:

1. Harvest method,

2. Type of container and length of haul,

3. Degree of preprocessing in field, sorting, and washing.

These variables should be considered when control options are being considered to help meet the best available treatment limitation for 1983. They are not completely capable of quantitative evaluation at the present time, but are deemed to represent good engineering practice and pollution reduction benefits.

DRAFT

PLANT AGE

The effective age of a processing operation is usually difficult if not impossible to define -- the reason being that there is often little correlation between the age of a plant building and the age of the equipment within the building. A processor may constantly replace worn out equipment with new equipment, or, in some cases, install old equipment in a new building. In general, data is not available or is it likely to result to support clean differences in waste generation and treatability within the overall miscellaneous foods and beverages industry on the basis of plant age alone.

One very notable exception occurs in the malt beverage industry. The construction of breweries has for the most part occurred prior to 1900 or after 1950, with the exception of those built immediately after the repeal of prohibition. Data indicates that differences in the wastewater loading as well as the applicable control and treatment technology, is significant. Basically, the older breweries were not designed with waste disposal in mind. Smaller tankage is common in the older breweries, thus providing more surface area, and making cleanup more difficult. Older mashing vessels do not separate grain as effectively as newer ones, thus creating additional loads for by-product recovery operations. Intricate and often unknown plumbing systems make isolation and segregation of wastestreams economically impractical.

On the other hand, breweries built after 1950 have been increasingly aware of wastewater disposal. Newer plants feature efficiently designed vessels in conjunction with automated cleanup. Wastes which might be sewered in an older brewery are reused or added to by-product recovery in the newer brewery. Plant design in the last few decades has allowed for ease in waste collection. Wastewater monitoring has identified problem areas and plant personnel are subsequently trained to be more cognizant of these problems.

Otherwise, age of plant provides no rationale for further subcategorization of the miscellaneous foods and beverages industry.

PLANT SIZE

The size of the plant may be significant from both a technical and economic point of view. On the technical side, no correlation to justify a subcategorization on the basis of size was found between plant size and either raw waste characteristics or wastewater volume, except in the malt beverage industry.

Plant size is more important from an economic viewpoint. Virtually all in-plant and end-of-pipe waste reduction technology is subject to economy of scale, and the larger plant will almost always benefit from economy of scale.

In the malt beverage industry, size of plant correlates to subcategorization based on plant age. Plants constructed after 1950 have for the most part been constructed for a production of more than 800 cu m (7000 barrels) per day due to the tendency for demand to be met by large capacity. It can be expected that this trend will continue and any future plants will be both large and automated.

Although there is no strict correlation between brewery size and waste generation, a generalization may be logically made about old, large breweries. These plants tend to be situated over relatively large areas with segmented operations occurring in different buildings. The product must be transferred more frequently and farther; supervision and consolidation of wastes are more difficult. Therefore, size of plant is another key factor in the subcategorization of breweries, but is not considered as an element of subcategorization for other products.

PLANT LOCATION

Plant location can be an important economic factor determining the availability of suitable land, and of municipal treatment facilities. Other potential effects connected with plant location include the following:

1. Both climate and weather affect end-of-pipe waste treatment processes. Variations in temperature, rainfall, evaporation rate, and sunshine can all affect the performance of different types of treatment systems. This has been taken into account to the extent possible in the selection of control and treatment alternatives in Section VII. While variation of performance of treatment systems has been recognized, it is known that high loads of pollutant removal efficiency can be maintained under variable climatic conditions with proper design, operation, and maintenance.

2. Availability of solids disposal facilities or marketing opportunities near the plant. The cost of solids disposal (screenings and sludge) varies considerably depending on local situations.

3. The quality of the receiving water and the state industrial discharge limitations being imposed. Plants located in areas designated by a state as being water quality limited generally have to meet very stringent requirements.

The factors listed above are local in nature and cannot be considered as factors for subcategorization for industries located throughout the United States. In general, the technologies developed for reaching the recommended effluent limitation guidelines set forth in this document are largely land-independent. Use of land-based treatment measures where this option exists may in many instances substantially reduce the cost of effectively achieving the recommended effluent reduction level.

Of all the products within the miscellaneous foods and beverages industry, the one most definable by location is wine spirits production. As previously mentioned, virtually all of the wineries producing spirits are located in the San Joaquin Valley of California. These factors, however, merely serve as substantiation of the subcategorization dictated by process variations and do not justify further subcategorization of the industry.

PRODUCTS AND BY-PRODUCTS

Many of the types of plants discussed in this document produce a variety of products and by-products -- some change products with the season or as the market demands, others produce varying styles of the same product.

There is no question that the nature of the products and by-products produced by a plant usually affects the wastewater of that plant; however, the subcategories previously developed adequately account for these effects. No further subcategorization on the basis of products and by-products is warranted.

CLIMATIC INFLUENCES

Influences of climate correlate closely with plant location discussed above, and it is impossible to subcategorize nation-wide industries on the basis of climate. The location of virtually all wineries with stills is in the San Joaquin Valley where the climate is relatively dry thereby encouraging the use of land disposal of wastewater for this previously defined subcategory.

SEASONAL VARIATIONS

The seasonal demand of a number of products in the miscellaneous foods and beverages industry, e.g., soft drinks, beer, candy has been discussed under the topic of process variations. Certain raw materials are available on a seasonal basis. These include various fruits, vegetables, and perhaps most notably grapes. The availability of grapes restricts the pressing (crushing) season to a short period of time during the fall of the year. Since the material for distilling is generating in the pressing season, distilling takes place at the same time as pressing with a small amount of time lag. Although this factor does not directly lead to subcategorization, it supports the subcategorization for the distilling industry.

DRAFT

SECTION V

WATER USE AND WASTE CHARACTERIZATION

The purpose of this section is to identify, for those subcategories defined in Section IV, the wastewater quantities and constituents which are characteristic of the subcategory. For each subcategory discussed herein, a representative model is developed and defined in terms of wastewater flow and characteristics.

It should be carefully noted that within this document, all pollutant concentrations and loadings, unless otherwise specified, are in terms of net units, i.e., do not include pollutants entering the process in the fresh water supply.

It should also be noted that the raw wastewater flows and characteristics described for each model plant are intended only to be representative of the subcategory, primarily as a basis for developing control and treatment technology and cost analyses to be developed subsequently in Sections VII and VIII of this document. These values should not under any conditions be construed as being exemplary nor used as a basis of pretreatment guidelines for industrial discharges into publicly owned treatment works.

All pollutant parameters (except pH, color, and temperature) are ultimately expressed as a ratio of their mass in kilograms to a process unit. The process unit may be kkg or cu m (or in one case proof gallons) of product or raw material produced or consumed per day. Table 16 defines the process units used for each subcategory.

VEGETABLE OIL PROCESSING AND REFINING

That segment of the miscellaneous foods and beverages industry involved in the processing and refining of vegetable oil (including the production of margarine) has been subcategorized into subcategories A 1 through A 15 (see Table 13 in Section IV.)

Subcategories A 1 through A 4 cover those installations processing unrefined vegetable oil from various oilseeds and the production of olive oil by hydraulic press and solvent extraction in combination, and by mechanical screw press extraction.

Subcategories A 5 through A 15 include those installations engaged in what can generally be called edible oil refining. The historical data complied for this study by the Institute of Shortening and Edible Oils (ISEO) in conjunction with contractor plant visitations and verification sampling of ten plants represents the most current information available on the wastewater characteristics of edible oil refineries. Wastewater

DRAFT

TABLE 16

PROCESS UNITS EMPLOYED FOR

THE MISCELLANEOUS FOODS AND BEVERAGES

POINT SOURCE CATEGORY

SUBCATEGORY		PROCESS UNIT
	VEGETABLE OIL PROCESSING AND REFINING	
A1, A2,		kkg of oilseed crushed/day.
A3, A4		kkg of raw olives crushed/day.
A5 - A12		kkg of crude oil processed/day.
A13, A14, A15		kkg of finished product.
	BEVERAGES	
A16, A17, A18		cu m of beer produced/day.
A19		kkg of barley processed/day.
A20, A21		during crushing, kkg of grapes crushed/day; during processing, cu m of wine produced/day.
A22, A23		kkg of grain mashed/day.
A24		proof gallons of spirits produced/day.
A25		None.
A26, A27		cu m of beverage produced/day.

DRAFT

TABLE 16 (CONT'D)

SUBCATEGORY	PROCESS UNIT
BEVERAGES	
A28	cu m of syrup or concentrate produced/day.
A30	kkg of instant tea produced/day.
C8, C9, C10	kkg of green coffee beans.
F1	None.
BAKERY AND CONFECTIONERY PRODUCTS	
All Subcategories	kkg of finished product/day
PET FOODS	
All Subcategories	kkg of finished product/day.
MISCELLANEOUS AND SPECIALITY ITEMS	
A29	cu m of finished product/day.
A31	kkg of granular bouillon produced/day.
A32	kkg of solid product produced/day.
A33	(1) kkg of yeast packaged/day.

DRAFT

TABLE 16 (CONT'D)

SUBCATEGORY	PROCESS UNIT
A34, A35	kkg of peanut butter produced/ day.
A36	kkg of dry pectin produced/day.
A37, B1-B4, C6, C12, D4	kkg of finished product/day.
C4, C5	kkg of raw eggs processed/day.
E1-E6, F2-F4	None.

characteristics within the industry vary widely from plant to plant due to differences in degrees of process variation, plant size, and the types of oils processed daily. However, for the most part, process variation is the single most important factor in determining the total waste load for a particular refining operation. The total waste loading for an edible oils refinery is dependent upon the individual waste load contributions from the various integrated process units within the refinery. In general terms, large, integrated, full scale refineries produce significantly higher wasteloads than small, less integrated operations.

The principle sources of wastewater discharge within the industry are from the following process units: acidulation; caustic refining; contact cooling tower blowdown from barometric condensers; tank car cleaning; storage and handling facilities; margarine; shortening; and table oils packaging; and general cleanup from oil processing procedures such as hydrogenation, bleaching, deodorization, and winterization. Figure 42 in Section III presents a schematic diagram of the various wastewater flows from individual process units for a typical full scale, integrated, edible oils refining operation. Table 17 presents a summary of the waste loading characteristics of individual unit processes commonly associated with edible oil refineries as described in Section III. Due to the high degree of variability in refinery plant size and process integration, it was necessary to adopt a building block approach for the formulation of the model plant and its associated unit process waste streams. Model plants were developed for subcategories A 5 through A 14 by combining the waste load for the various unit processes making up a subcategory. For example the Subcategory A 5 model plant, includes the unit processes of caustic refining, tank car cleaning and storage and handling. A total waste load for Subcategory A 5 was derived by converting all unit process waste loads to a 454 kkg (500 ton) per day plant and then, by summation of the unit waste loads, a total waste load was assumed for each parameter. The hypothetical model plants developed utilizing this procedure are intended to be representative of the subcategory as it presently exists, but cannot be expected to be identical to any particular plant. In some cases the model may be representative of an actual refinery only to a limited extent, but in all cases the model is considered adequate for the purpose of developing control and treatment technology (Section VII) and for cost analyses (Section VIII).

<u>SUBCATEGORY A 1, OILSEED CRUSHING, EXCEPT OLIVE OIL, FOR DIRECT SOLVENT EXTRACTION AND PREPRESS SOLVENT EXTRACTION OPERATIONS</u>

A total of six direct solvent extraction plants and two prepress solvent extraction facilities were visited and verification sampling was conducted at four direct solvent extraction plants.

TABLE 17

SUMMARY OF UNIT PROCESS RAW DATA ON EDIBLE OIL REFINERY WASTEWATER CHARACTERISTICS

Unit Process		Production KKG/DAY	Flow M^3/DAY	BOD kg/kkg	COD kg/kkg	SS kg/kkg	O & G kg/kkg	PH Range	BOD/COD Ratio	BOD/O & G Ratio
Caustic Refining	Ave.	320	72	1.01	1.8	0.51	0.61	7.3 - 11.9	0.46	3.4
	Std. Dev.	221	145	1.58	1.7	1.13	0.86		0.19	3.9
Acidulation	Ave.	486	225	4.69	14.97	1.66	1.20	0.6 - 3	0.58	77.69
	Std. Dev.	459	148	5.08	23.44	3.84	3.06		0.20	153.56
Contact Cooling Tower Blowdown	Ave.	348	178	2.21	4.24	0.31	0.30	3.3 - 7.3	0.53	15.91
	Std. Dev.	264	135	3.51	5.73	0.37	0.34		0.16	25.78
Oil Processing*	Ave.	389	25	0.09	0.22	0.05	0.02	7.3 - 13.0	0.48	13.99
	Std. Dev.	212	22	0.23	0.47	0.08	0.03		0.22	34.33
Tank Car Cleaning	Ave.	167	38	0.49	1.38	0.19	0.20	5.5 - 8.9	0.42	4.36
	Std. Dev.	112	32	0.84	2.41	0.24	0.31		0.25	4.87
Storage and Handling	Ave.	285	83	1.36	3.83	0.87	0.69	2.5 - 11.1	0.51	53.89
	Std. Dev.	80	159	4.33	14.60	2.54	2.47		0.11	201.79
Shortening and Table Oil Production	Ave.	195	75	0.48	0.19	0.18	0.19	6.1 - 11.5	0.52	5.08
	Std. Dev.	103	113	0.75	0.15	0.24	0.38		0.10	6.68
Margarine Production	Ave.	112	169	1.93	4.23	1.34	2.86	6.0 - 8.0	0.53	4.14
	Std. Dev.	61	139	4.06	5.63	2.41	5.6		0.23	4.29

* Includes floor wash and general cleanup of the following unit processes: Hydrogenation, deodorization, winterization, and Bleaching.

The principal sources of contact process wastewater generated from solvent extraction operations include wastewater generated from soybean oil degumming operations to remove and recover phosphatides (lecithin); wastewater generated from wet scrubber systems to reduce air particulate emmissions from mill preparation areas; wastewater containing oil, grease, and solvents, resulting from the extraction of oilseeds; steam condensates contaminated by oils, fatty acids, or hexane solvent; and periodic in-plant floor washing and equipment cleanup represented by oil or miscellaneous spillage, valve or pump leakage, etc. In addition to these process wastes, a large number of processors were observed to combine their process wastewaters with non-contact cooling water from cooling tower and boiler blowdown.

Historical data supplied by the NSPA and the National Cottonseed Producer's Association (NCPA) for 18 solvent extraction facilities in combination with four verification surveys found the following averages for Subcategory A 1 plants:

Production	780 kkg/day (860 ton/day)
Flow	140 cu m/day (0.037 MGD)
BOD	311 mg/l; 0.058 kg/kkg (0.115 lb/ton)
COD	619 mg/l; 0.140 kg/kkg (0.281 lb/ton)
SS	140 mg/l; 0.035 kg/kkg (0.07 lb/ton)
O&G	253 mg/l; 0.064 kg/kkg (0.128 lb/ton)
pH	5.2 to 10.4
BOD/COD Ratio	0.50
BOD/O&G Ratio	19.8

Table 18 presents a statistical description of the process wastewater characteristics compiled during the study including mean, standard deviations, minimum and maximum values.

There was a significant correlation observed in the industry between the volumes of process wastewater discharged per day and total daily production as is evidenced in Figure 107. However, there was no correlation indicated between production, BOD, COD, or oil and grease concentrations. These data are summarized by the scatter diagrams presented in Figures 108, 109, and 110.

Total Process Effluent

As indicated in the data presented above, the pollutant concentrations and waste loadings for solvent extraction plants are highly variable due to the following in-plant variations: (1) the amount of wet cleanup and general housekeeping practices utilized by each plant, (2) the quality of seed being crushed, and (3) plants that perform soybean oil degumming periodically in combination with solvent extraction processes.

DRAFT

TABLE 18

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR SOLVENT EXTRACTION PROCESS WASTEWATER

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	58	0.037069	0.019112	0.000365	0.003000	0.089300	51.557
Prod. (ton/day)	58	859.996552	828.025181	185205.555777	220.000000	1881.000000	49.771
BOD (mg/l)	49	311.367347	403.988381	163206.612245	60.000000	2800.000000	129.747
SS (mg/l)	52	139.884615	198.246297	39301.594269	3.000000	874.000000	141.721
COD (mg/l)	48	619.333333	572.188450	327397.333333	190.000000	2976.000000	92.387
*FOG (mg/l)	45	252.788667	759.765755	577244.002545	1.000000	4430.000000	300.556
BOD (lb/day)	49	78.002431	56.857093	3237.279242	4.508300	244.758850	72.943
COD (lb/day)	48	176.221113	154.727087	23940.471477	23.369366	804.644928	87.803
SS (lb/day)	52	38.317027	53.246701	2834.572216	0.626376	236.310372	138.948
FOG (lb/day)	45	68.104652	205.259085	42131.292056	0.191017	1197.774540	301.388
Lb/Ton-BOD	49	0.115201	0.121087	0.014662	0.015659	0.731781	105.109
kg/kkg-BOD	49	0.057601	0.060544	0.003666	0.007830	0.365890	105.109
Lb/Ton-COD	48	0.281114	0.350194	0.122636	0.024973	1.788100	124.574
kg/kkg-COD	48	0.140557	0.175097	0.030659	0.012486	0.894050	124.574
Lb/Ton-SS	52	0.070004	0.118903	0.014138	0.000783	0.525134	169.851
kg/kkg-SS	52	0.035002	0.059451	0.003534	0.000391	0.262567	169.851
Lb/Ton-FOG	45	0.127937	0.421886	0.177988	0.000239	2.661721	329.762
kg/kkg-FOG	45	0.063968	0.210943	0.044497	0.000119	1.330861	329.762
BOD/COD Ratio	40	0.503020	0.203246	0.041309	0.373925	0.931416	40.405
BOD/FOG Ratio	37	14.806625	32.029051	1025.860082	0.191972	135.000000	181.709
Flow Ratio	58	46.204019	19.213248	369.148884	13.636364	91.228070	41.583

* FOG = Fats, Oils, and greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

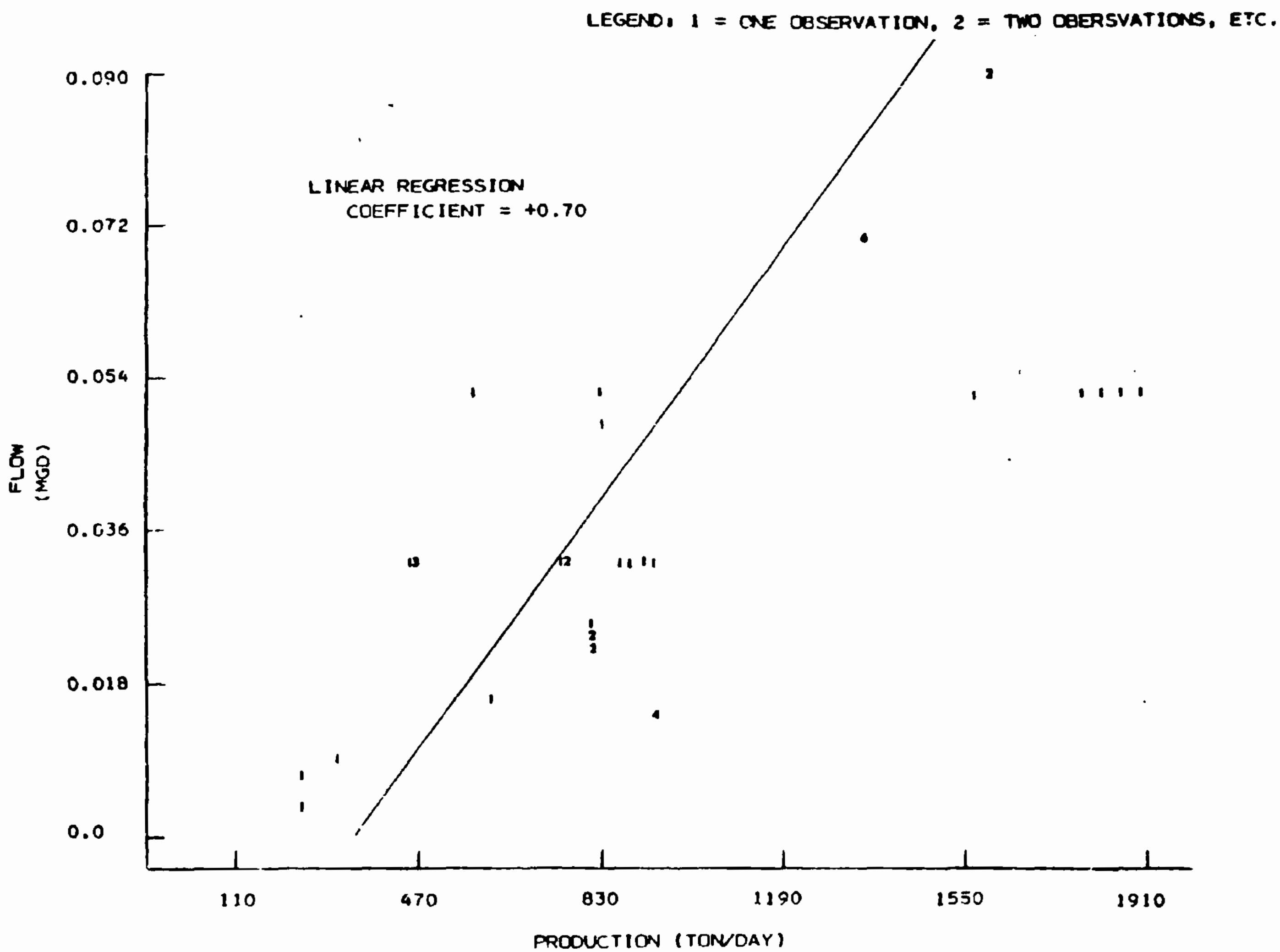


FIGURE 107

A LINEAR REGRESSION PLOT OF FLOW (MGD) VERSUS PRODUCTION (TON/DAY)
FOR PROCESS WASTEWATERS DISCHARGED FROM OILSEED SOLVENT EXTRACTION PLANTS, SUBCATEGORY A1

DRAFT

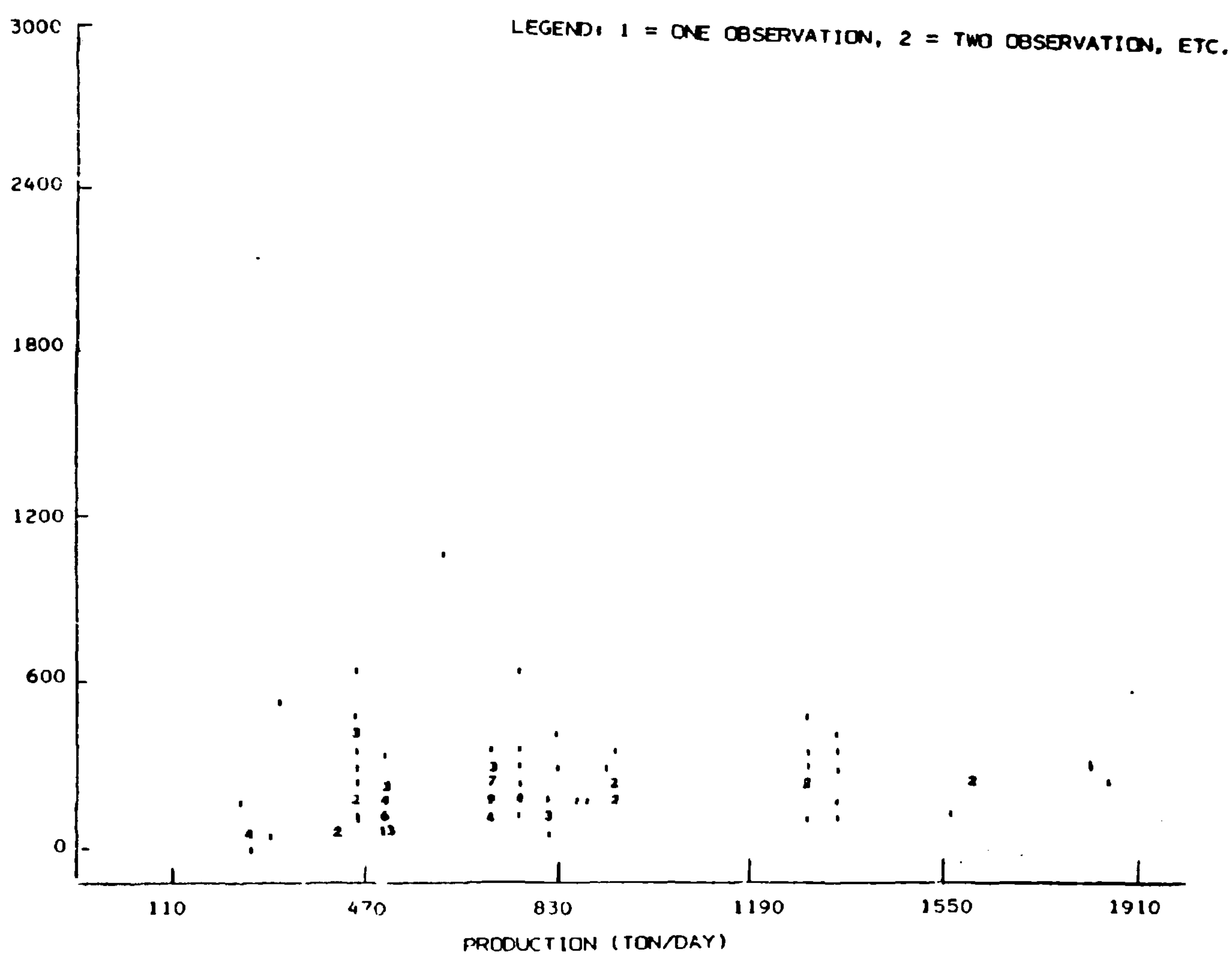


FIGURE 108

A SCATTER DIAGRAM PLOTTING BOD CONCENTRATION VERSUS PRODUCTION (TON/DAY) FOR THE PROCESS WASTEWATERS GENERATED FROM OILSEED SOLVENT EXTRACTION PLANTS, SUBCATEGORY A 1

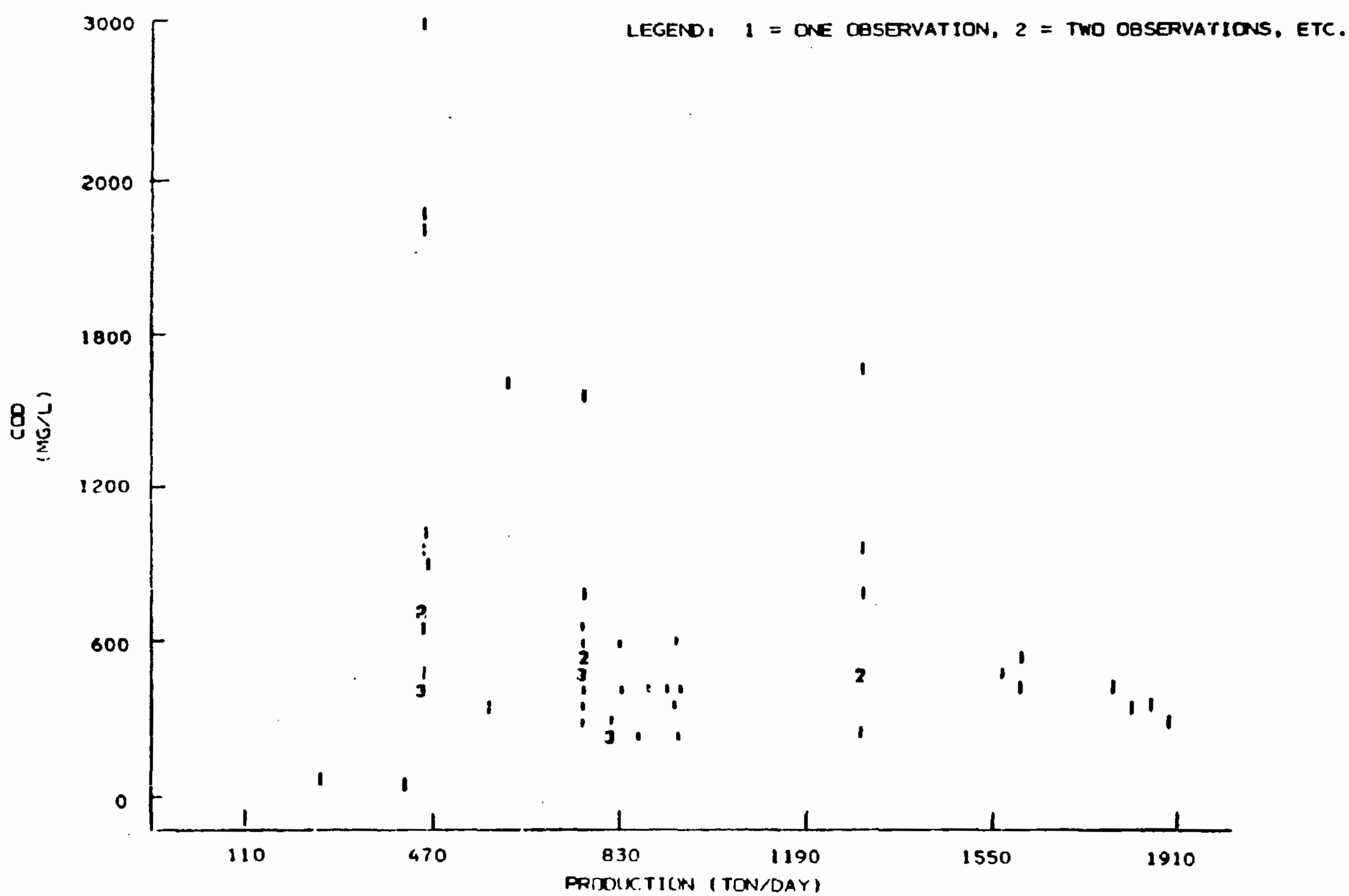


FIGURE 109

A SCATTER DIAGRAM PLOTTING COD CONCENTRATIONS VERSUS PRODUCTION (TON/DAY) FOR THE PROCESS WASTES FROM OILSEED SOLVENT EXTRACTION PLANTS, SUBCATEGORY A1

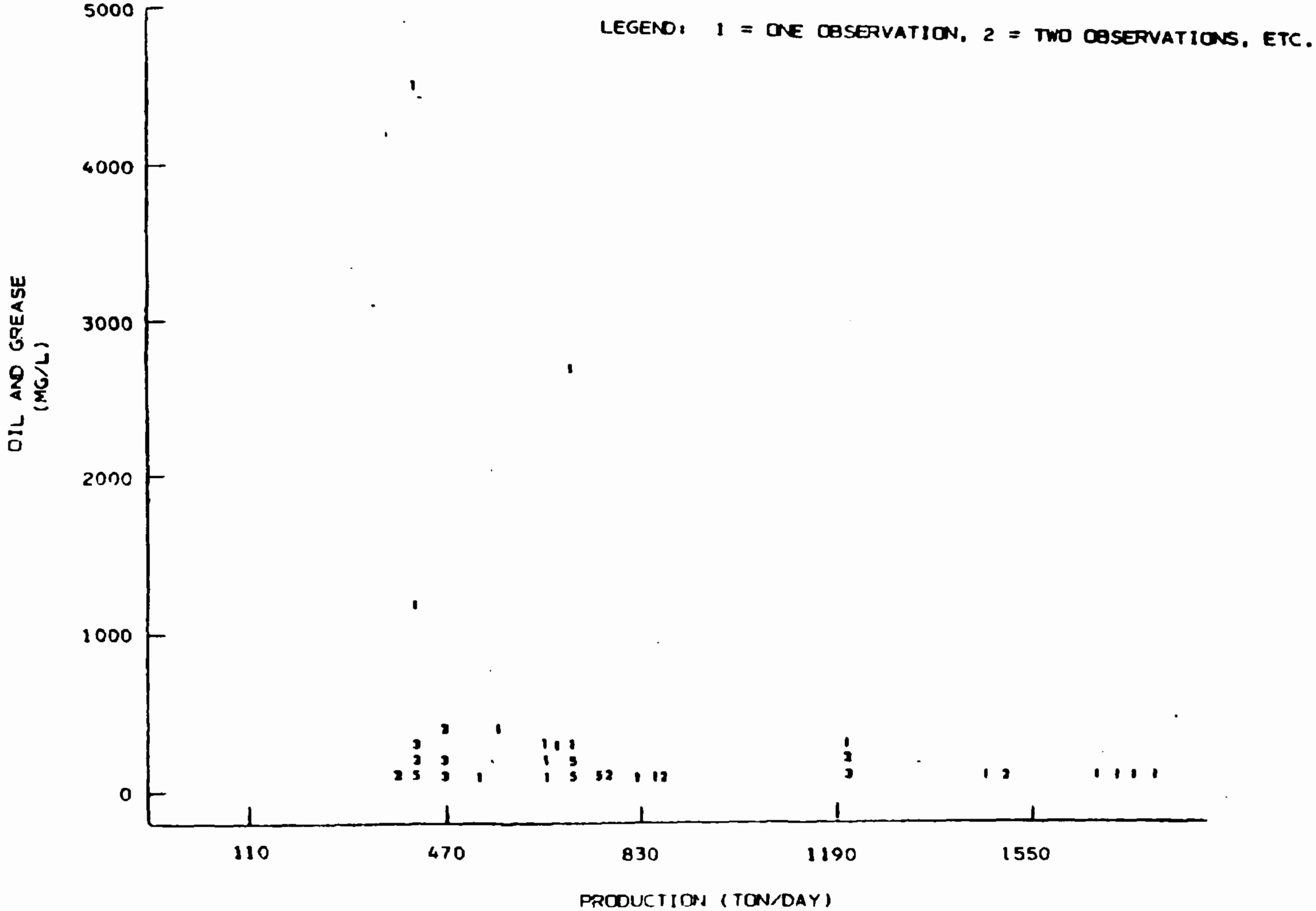


FIGURE 110

A SCATTER DIAGRAM PLOTTING CONCENTRATIONS OF OIL AND GREASE VERSUS DAILY PRODUCTION (TON/DAY) FOR THE PROCESS WASTEWATERS DISCHARGED FROM OILSEED SOLVENT EXTRACTION PLANTS, SUBCATEGORY A1

Model Plant

The model plant for subcategory A 1 is based on the following assumptions:

1. The model plant is assumed to have a daily production of 816 kkg (900 ton).
2. The model plant has a flow volume of 0.144 cu m/day (0.039 MGD).
3. The model plant may or may not have the unit process of degumming.
4. The model plant may or may not have a wet scrubber system for removing air particulates.

By converting the data base compiled for this study to a model plant production of 816 kkg (900 ton) per day by multiplying by a factor of 1.05 (i.e., 816 kkg/780kkg = 1.05), the following wastewater characteristics were derived for the Subcategory A 1 model plant.

Production	816 kkg/day
Flow	148 cu m/day (0.039 MGD)
BOD	340 mg/l; 0.061 kg/kkg (0.122 lb/ton)
COD	815 mg/l; 0.147 kg/kkg (0.244 lb/ton)
SS	210 mg/l; 0.038 kg/kkg (0.076 lb/ton)
O&G	380 mg/l; 0.069 kg/kkg (0.138 lb/ton)
BOD/COD Ratio	0.50
pH Range	6 to 8

SUBCATEGORY A 2 - OILSEED CRUSHING, EXCEPT OLIVE OIL, BY MECHANICAL SCREW PRESS OPERATIONS

Seven typical mechanical screwpress extraction plants (three cottonseed crushers and four peanut crushers) were visited in conjunction with information from the National Cottonseed Producer's Association and the Southeastern Peanut Association. Only two sources of contact wastewater were observed. These consisting of 1) contaminated steam condensate from steam cooker operations and 2) wastewaters generated from infrequent floor and equipment cleanup. Four sources of non-contact wastewater were observed from the following unit processes: 1) non-contact cooling water circulated through the hollow expeller worm shaft to keep the oilseed cakes from burning, 2) boiler blowdown, 3) non-contact cooling tower blowdown (only during the winter months), and 4) storm water runoff. In general, the resultant contact wastewater generated from screw press operation is less than 4,000 liters (1000 gallons) per day. Screw press operations near to or in conjunction with an edible oils refinery dispose of wastewater by trucking it to the refinery where the oil is recovered in the acidulation process. Three plants were also observed to recycle their wastewater into the boiler feed water. Due to the small volume of wastewater discharged, it is not necessary to develop a model plant for Subcategory A 2.

SUBCATEGORY A 3 - OLIVE OIL EXTRACTION BY HYDRAULIC PRESSING AND SOLVENT EXTRACTION

The process descriptions of the extraction of olive oil by hydraulic pressing and solvent extraction were presented in Section III. At present, there is only one plant which utilizes either the hydraulic press or solvent extraction processes for the recovery of olive oil. The only source of wastewater generated by the extraction of olive oil by hydraulic pressing is centrifuge fruit water. Wastewater attributable to solvent extraction consists of a small amount of water which drains from pits and culls during storage, and an equally small non-contact condenser water flow. Equipment is wiped clean.

The wastewater from the hydraulic pressing process was determined to have the following characteristics:

Flow	10.9 cu m/day (0.0029 MGD)
BOD	63,000 mg/l
SS	14,000 mg/l
FOG	3,220 mg/l
pH	5.1

Model Plant

The model plant for this subcategory is plant 79102. Between the months of October and June, the plant generally operates 24 hours per day, seven days per week with the operating schedule dependent on olive crop yield and availability of harvesters.

The total plant effluent consists of centrifuged fruit water with the characteristics listed above.

SUBCATEGORY A 4 - OLIVE OIL EXTRACTION BY MECHANICAL SCREW PRESSING

At present there is only one olive oil manufacturer in the United States which extracts olive oil by the mechanical screw press process. The extraction of olive oil by screw press operations produces wastewater from the following sources:

1. Washing of whole ripe olives prior to pulverizing
2. Centrifuged fruit water
3. Centrifuged sludge
4. General plant cleanup

Fruit Wash Water

Prior to grinding in the hammer mill the fruit is washed by pump and air percolation washers. These wash tanks are filled and discharged

DRAFT

at least once per day or more depending upon fruit condition. The quantity of wastewater discharged from the washers varies between 19 cu m/day (0.005 MGD) and 38 cu m/day (0.010 MGD).

Centrifuged Fruit Water

The quantity of fruit water generated by the centrifuge is approximately 38 l/min (10 gal/min) for a total centrifuge effluent of 54.5 cu m (0.0144 MGD). The constituents of the centrifuged fruit water indicate a BOD concentration of 60,000 mg/l and a fat content of 25 percent.

Centrifuged Sludge

Approximately 38 cu m/day (0.010 MGD) of centrifuged sludge is generated from the initial centrifuge following pressing. The pollutant concentrations of the centrifuged sludge were determined to be as follows:

BOD	48,000 mg/l
SS	51,000 mg/l
FOG	34,000 mg/l

General Plant Cleanup

Cleanup of equipment is done on an irregular basis with little generation of wastewater. Due to the irregular nature and inherent variability of the cleaning operation, representation of waste flow cannot be reliably determined. It is, however, reflected in the total waste discharge.

Total Plant Effluent

The total effluent from the plant would amount to approximately 114 cu m/day (0.03 MGD) and would have the following characteristics:

BOD	30,000 mg/l
SS	57,000 mg/l
FOG	20,000 mg/l
pH	5.5

Selection of Model Plant

The model plant, illustrated in Figure 39 in Section III, processes 44 kkg/day (48 ton/day) of olives. The total plant effluent consists of the combined waste streams as previously presented. The plant operates 24 hours per day, seven days per week between the months of September and April except during unpredictable harvesting lulls. The plant's wastewater has the following characteristics:

Flow	114 cu m/day (0.03 MGD)
BOD	30,000 mg/l
SS	57,000 mg/l
FOG	20,000 mg/l
pH	5.5

SUBCATEGORY A 5 - PROCESSING OF EDIBLE OIL BY THE USE OF CAUSTIC REFINING METHODS ONLY

The individual unit processes characteristic of Subcategory A 5 plants include: (1) caustic refining operations; (2) general cleanup of storage and handling facilities; and (3) tank car cleaning operations.

Caustic Refining

A principle source of wastewater generation from Subcategory A 5 refineries results from the caustic refining of crude vegetable or animal oils. Wastewater discharged from the washing of refined edible oils will vary considerably from day to day depending upon the nature of the crude oil being refined. Seng (53) reported an Illinois caustic refining operation to have the following average pollutant concentrations: BOD, 1240 mg/l; COD, 5000 mg/l; suspended solids, 690 mg/l; and ether solubles, 1800 mg/l. The average waste loads for the Illinois plant were: BOD, 0.27 kg/kkg (0.55 lb/ton) COD, 1.1 kg/kkg (2.2 lb/ton); suspended solids, 0.15 kg/kkg (0.30 lb/ton); and ether solubles 0.4 kg/kkg (0.8 lb/ton). The average flow was recorded as 0.054 cubic meters per day (0.0144 MGD).

Historical and verification survey data compiled for this report from six edible oil caustic refining operations found significantly higher concentrations of BOD, COD, suspended solids, and oil and grease. Mean concentrations and wasteload values from all data collected were:

Production	353 kkg
Flow	75.7 cu m/day (0.02 MGD)
BOD	6,900 mg/l; 1.01 kg/kkg (2.02 lb/ton)
COD	14,800 mg/l; 1.8 kg/kkg (3.6 lb/ton)
SS	3,700 mg/l; 0.5 kg/kkg (1.0 lb/ton)
O&G	5,000 mg/l; 0.6 kg/kkg (1.2 lb/ton)
pH Range	7.3 to 11.9
BOD/COD Ratio	0.46

Table 19 provides a statistical description of the data compiled from six refineries including mean, sample size, standard deviations, minimum, and maximum values. Table 20 presents a summary of caustic refining waste loadings from the six plants visited and sampled during the course of this study. As would be expected, calculated correlation coefficient statistics show a significant correlation between the concentrations of BOD and COD in the caustic refining wastewater with a calculated BOD/COD ratio of 0.46. A significant correlation also exists between the kg/kkg of BOD, suspended solids, and oil and grease. These data indicate that much of the hexane extractable material exists as oil attached to suspended solids particles with a specific gravity close to that of water.

Tank Car Cleaning

The cleaning of tank cars to remove residual oil constitutes a major waste stream associated with all Subcategory A 5 through A 12 edible

TABLE 19

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR THE EDIBLE OIL CAUSTIC REFINERY PROCESS

DRAFT

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	41	0.019002	0.038381	0.001	0.001000	0.216000	201.982
Prod. (ton/day)	41	352.902439	243.959882	59516.024	38.309000	1016.000000	69.130
BOD (mg/l)	39	6933.418256	7747.790968	60028264.680	35.000000	38300.000000	111.746
SS (mg/l)	41	3715.784488	7573.994969	57365398.276	20.000000	41660.000000	203.833
COD (mg/l)	37	14781.675676	14655.931695	214795454.503	100.000000	61352.000000	99.149
*FOG (mg/l)	41	5045.658537	8905.132516	79301385.130	8.000000	49456.000000	176.491
BOD (lb/day)	39	552.153229	636.396225	405000.155	3.087650	2461.023950	115.2[illegible]
COD (lb/day)	37	1182.617660	1469.454629	2159296.908	20.078070	7167.754160	124.318
SS (lb/day)	41	233.036323	390.209634	152263.550	1.268400	1657.817709	167.046
FOG (lb/day)	41	396.045192	649.220977	421487.902	6.375580	3619.159740	163.926
Lb/Ton-BOD	39	2.020632	3.170595	10.053	0.056093	18.697367	156.911
kg/kkg-BOD	39	1.010316	1.585298	2.513	0.028046	9.443680	156.911
Lb/Ton-COD	37	3.620473	3.405427	11.597	0.074529	13.408468	94.060
kg/kkg-COD	37	1.810237	1.702713	2.899	0.037264	6.704234	94.060
Lb/Ton-SS	41	1.027417	2.259675	5.106	0.030129	12.723083	219.938
kg/kkg-SS	41	0.513708	1.129837	1.277	0.015065	6.361541	219.938
Lb/Ton-FOG	41	1.229976	1.712138	2.931	0.018893	8.491982	139.199
kg/kkg-FOG	41	0.614958	0.856069	0.733	0.009447	4.245991	139.199
BOD/COD Ratio	35	0.466189	0.191399	0.037	0.153782	0.878490	41.056
BOD/FOG Ratio	39	3.648033	3.909349	15.283	0.059710	20.277778	113.379
Flow Ratio	41	55.133023	90.653221	8959.232	9.145953	496.551724	171.682

* FOG = Fats, Oils, and greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

TABLE 20

POLLUTANT LOADINGS FOR CAUSTIC REFINING WASH WATERS

DRAFT

Edible Oils Refinery (Process Code)	Production (kkg/day)	Volume Wastewater Discharged (cu m/day)	BOD (kg/kkg)	COD (kg/kkg)	SS (kg/kkg)	Oil and Grease (kg/kkg)
75R08	424	29.2	0.39	0.99	0.55	0.86
75R09	388	331.6	0.88	2.18	0.11	0.64
75R15	310	36.6	0.49	2.53	0.38	0.28
75R17	245	54.5	0.28	1.11	0.15	0.40
75R05	227	31.5	1.43	2.37	0.36	0.54
75R06	276	56.1	2.15	0.90*	1.46	0.75

* COD sample size was less than BOD sample size.

oil refining facilities. Average concentrations and waste loading of pollutants from six plants were as follows:

Production	184 kkg
Flow	37.8 cu m/day (0.01 MGD)
BOD	2950 mg/l; 0.49 kg/kkg (0.98 lb/ton)
COD	5850 mg/l; 1.38 kg/kkg (2.76 lb/ton)
SS	900 mg/l; 0.19 kg/kkg (0.38 lb/ton)
O&G	920 mg/l; 0.20 kg/kkg (0.40 lb/ton)
BOD/COD	0.42
pH Range	5.5 to 11.9

Table 21 presents a summary table of means, minimums, maximums, sample size, standard deviations and coefficients of covariance for tank car cleaning operations from six edible oil refining operations. Table 22 presents a summary table of tank car cleaning wastewater characteristics for each of the six plants investigated during this study.

Storage and Transfer

Another typical unit process waste load associated with all edible oil refinery Subcategories A 5 through A 12 is that of wastewaters generated during cleanup from storage, handling, and transfer areas within the refining plant. Waste loads from these areas are highly variable and are dependent on general daily cleanup necessitated by accidental spills, leakage, or pump failures. Averaged waste load data from three plants resulted in the following pollutant concentrations.

Production	314 kkg
Flow	75.7 cu m/day (0.02 MGD)
BOD	8,000 mg/l; 1.4 kg/kkg (2.7 lb/ton)
COD	21,000 mg/l; 3.8 kg/kkg (7.7 lb/ton)
SS	5,400 mg/l; 0.87 kg/kkg (1.7 lb/ton)
O&G	4,200 mg/l; 0.69 kg/kkg (1.4 lb/ton)
BOD/COD	0.51
pH Range	2.5 to 11.1

Table 23 presents a statistical description of the data compiled for this study including mean, standard deviations, minimum, maximum, sample size, and coefficients of covariance for the three plants investigated.

Refinery Floor Wash

Pollutant waste loadings result from general floor washing operations necessitated by accidental oil spills and pump seal leakages. In general these cleanup procedures are intermittent and represent a relatively minor contribution to the total waste load of Subcategory A 5 plants.

TABLE 21

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR EDIBLE OIL REFINERY TANK CAR CLEANING OPERATIONS

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	36	0.010124	0.008411	0.0001	0.000800	0.048000	83.077
Prod. (ton/day)	36	183.552778	123.245906	15189.5534	75.000000	750.000000	67.145
BOD (mg/l)	30	2968.033333	4626.352162	21961896.5851	70.000000	18275.000000	158.565
SS (mg/l)	35	902.828571	941.755629	886903.6039	8.000000	3920.000000	104.358
COD (mg/l)	36	5848.156667	7338.445060	53852834.6000	60.000000	31510.000000	125.483
*FOG (mg/l)	36	923.111111	1164.397006	1355820.3873	3.000000	4846.000000	126.138
BOD (lb/day)	30	129.987984	159.110827	25317.5281	6.717725	643.980312	122.407
COD (lb/day)	36	405.489276	656.521801	431019.8776	5.758050	3552.967200	161.508
SS (lb/day)	35	66.914197	129.190111	16690.0848	0.767740	752.385200	193.068
FOG (lb/day)	36	67.941879	119.049493	14172.7817	0.287903	536.249700	175.223
Lb/Ton-BOD	30	0.983145	1.678639	2.8178	0.029857	8.528404	170.742
Kg/kkg-BOD	30	0.491573	0.839317	0.7045	0.014928	4.293202	170.742
Lb/Ton-COD	36	2.758311	4.820171	23.2341	0.025551	25.378337	174.738
Kg/kkg-COD	36	1.379256	2.410086	5.8085	0.012796	12.689169	174.738
Lb/Ton-SS	35	0.380021	0.494842	0.2449	0.003412	2.351204	130.214
Kg/kkg-SS	35	0.190011	0.247421	0.0612	0.001706	1.175602	130.210
Lb/Ton-FOG	36	0.406728	0.611730	0.3742	0.001280	2.800913	150.396
Kg/kkg-FOG	36	0.203364	0.305852	0.0935	0.000640	1.400457	150.396
BOD/COD Ratio	30	0.423683	0.247794	0.0614	0.027057	1.166667	58.486
BOD/FOG Ratio	30	4.355555	4.870536	23.7219	0.362538	23.333333	111.823
Flow Ratio	36	57.627483	52.679299	2775.1065	10.666667	342.857143	91.097

* FOG = Fats, Oils, and greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

TABLE 22

POLLUTANT WASTE LOADINGS FOR EDIBLE OIL REFINERY TANK CAR CLEANING

DRAFT

Edible Oil Refinery by Process Code	Production (kkg/day)	Volume of Wastewater Discharged (cu m/day)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	Oil & Grease (mg/l)
75T05	68	85.4	1.6	2.7	0.26	0.27
75T06	170	21.2	0.37	0.79	0.09	0.16
75T08	191	44.0	0.40	1.28	0.36	0.38
75T09	127	124.9	0.31	8.07	0.21	0.68
75T10	187	37.9	0.13	0.32	0.10	0.03

DRAFT

TABLE 23

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR EDIBLE OIL REFINERY STORAGE AND HANDLING OPERATIONS

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	21	0.021924	0.041975	0.00	0.004800	0.173000	191.458
Prod. (ton/day)	21	314.738695	87.556213	7666.09	140.000000	498.000000	27.819
BOD (mg/l)	19	8173.888211	22709.529317	515722721.78	70.000000	99000.000000	277.837
SS (mg/l)	20	5428.300000	13955.541929	194757150.54	40.000000	55600.000000	257.089
COD (mg/l)	18	21806.111111	76049.302459	5783350390.69	130.000000	326000.000000	348.748
*FOG (mg/l)	19	4223.473684	12911.602032	166709487.04	10.000000	56705.000000	305.710
BOD (lb/day)	19	943.536452	3389.270853	11426231.44	24.630440	14870.750000	358.256
COD (lb/day)	18	2952.337377	11485.845408	131920844.73	37.772808	48968.460000	389.042
SS (lb/day)	20	544.060240	1863.214956	3471569.97	8.002855	8351.676800	342.465
FOG (lb/day)	19	511.752952	1940.916493	3767156.63	1.251750	8517.658050	379.268
Lb/Ton-BOD	19	2.717597	8.650179	74.89	0.096730	37.839160	318.450
kg/kkg-BOD	19	1.358799	4.327090	18.72	0.048365	18.919580	318.450
Lb/Ton-COD	18	7.661584	29.190865	852.11	0.180025	120.601679	381.003
kg/kkg-COD	18	3.830792	14.595433	213.03	0.090003	62.300840	381.003
Lb/Ton-SS	20	1.743992	5.772839	25.73	0.027483	21.251084	290.875
kg/kkg-SS	20	0.871996	2.536419	6.43	0.013741	10.625542	290.875
Lb/Ton-FOG	19	1.390295	4.932987	24.33	0.004622	21.673030	354.816
kg/kkg-FOG	19	0.695147	2.466493	6.08	0.002411	10.836715	354.816
BOD/COD Ratio	17	0.506325	0.114849	0.01	0.292560	0.675676	22.683
BOD/FOG Ratio	17	53.885382	201.794436	40720.99	0.307523	836.666667	374.488
Flow Ratio	21	62.437146	103.963429	10808.39	14.201183	397.701149	166.509

* FOG = Fats, Oils, and greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

Total Processing Effluent

On a daily basis the total waste load from the Subcategory A 5 plants may be quite variable due to 1) differences in the raw materials processed; 2) the numbers of tank cars washed; and 3) the general cleanup procedures utilized to clean up accidental oil spills. Data compiled for caustic refining, tank car cleaning, and storage and handling indicate that flows and BOD concentrations vary greatly from day to day as is indicated in the large standard deviations calculated for these parameters in Table 17.

Model Plant

Based upon the data compiled for this study, a hypothetical model plant for a caustic refinery operation was formulated. The following assumptions were made for Subcategory A 5 plants:

1. The model plant is assumed to have a production of 454 kkg (500 ton) per day.

2. The model plant has separate discharge of process waters and non-contact cooling water.

3. The model plant has approximately five tank cars washed per day. Each tank car has a capacity of 68 kkg (75 ton).

4. The model plant has a waste load generated from storage and handling areas based upon a 454 kkg (500 ton) per day production.

The following pollutant parameter waste loads were calculated for Subcategory A 5 plants by assuming a linear relationship between production and wasteload generation. For example, the average waste loading for caustic refinery from the compiled data base was as follows:

Production (kkg)	Flow (cu m/day)	BOD (kg/kkg)	COD (kg/kkg)	Suspended Solids (kg/kkg)	Oil and Grease (kg/kkg)
320	71.9	1.01	1.81	0.51	0.61

The waste load for a caustic refining operation with a production of 454 kkg (500 ton) per day was then calculated by multiplying each waste load by a factor of 1.42 (i.e., 454 kkg/320 kkg = 1.42). Thus, the model plant was assumed to have the following waste load characteristics for caustic refining:

Production (kkg)	Flow (cu m/day)	BOD (kg/kkg)	COD (kg/kkg)	Suspended Solids (kg/kkg)	Oil and Grease (kg/kkg)
454	102	1.43	2.57	0.72	0.86

Historical and verification survey data compiled for storage and handling was also converted to a production of 454 kkg (500 ton) per day by multiplying by a factor of 1.59.

In addition, the model plant was assumed to wash five tank cars daily. Therefore, tank car cleaning data was converted to a production of 320 kkg (375 ton) per day by multiplying by a factor of 2.05.

The total waste load characteristics for establishments engaged in the caustic refining of edible oils was then calculated as indicated in Table 24. Therefore, the wastewater characteristics for the hypothetical model plant Subcategory A 5 are as follows:

Production:	454 kkg (500 ton) per day
Flow	314 cu m per day (0.083 MGD)
BOD	6,600 mg/l
COD	16,600 mg/l
SS	3,600 mg/l
O&G	3,500
pH	5.5 to 11.0
BOD Ratio	4.59 kg/kkg (9.18 lb/ton)
COD Ratio	11.49 kg/kkg (22.98 lb/ton)
SS Ratio	2.49 kg/kkg (4.98 lb/ton)
O&G Ratio	2.39 kg/kkg (4.78 lb/ton)

SUBCATEGORY A 6 - PROCESSING OF EDIBLE OILS BY THE USE OF CAUSTIC REFINING AND ACIDULATION METHODS

The major process waste streams associated with Subcategory A 6 plants are the same as those for Subcategory A 5 with the addition of acidulation.

Acidulation

The major waste loading unit process for the edible oil refinery industry results from the acidulation process for the recovery of fatty acides from the soapstock generated by caustic refining. Data collected from four plants found average pollutant concentrations and waste loadings for the acidulation process to be:

Production	486 kkg
Flow	223 cu m/day (0.059 MGD)
BOD	12,000 mg/l; 4.70 kg/kkg (9.39 lb/ton)
COD	22,000 mg/l; 14.97 kg/kkg (29.94 lb/ton)
SS	3,800 mg/l; 1.66 kg/kkg (3.[illegible] lb/ton)
O&G	2,500 mg/l; 1.20 kg/kkg (2.40 lb/ton)
BOD/COD	0.57
pH range	0.6 to 3.0

Table 25 presents a statistical description of the data collected from four refining operations. Table 26 provides a summary of average wasteload values calculated for each plant investigated.

TABLE 24

SAMPLE CALCULATIONS FOR DETERMINING TOTAL WASTE LOADINGS FOR SUBCATEGORY A 5 PLANTS

Unit Process	Flow (cu m/day)	BOD (kg/kkg)	COD (kg/kkg)	SS (kg/kkg)	O & G (kg/kkg)
Caustic Refining	102.2	1.43	2.57	0.72	0.87
Storage and Handling	132.5	2.16	2.83	0.39	0.41
Tankcar Cleaning	79.5	1.00	6.09	1.38	1.11
Total subcategory A5 Plant wasteload	314.2	4.59	11.49	2.49	2.39

DRAFT

TABLE 25

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR THE EDIBLE OIL REFINERY SOAPSTOCK ACIDULATION PROCESS

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	43	0.059156	0.039224	0.002	0.008800	0.228000	65.971
Prod. (ton/day)	43	[illegible]	526.130398	[illegible]	144.000000	1666.000000	94.355
BOD (mg/l)	33	[illegible]	13917.169952	193914162.731	746.000000	62100.000000	114.422
SS (mg/l)	42	[illegible]	10049.563189	100993720.265	18.000000	56988.000000	260.679
COD (mg/l)	35	[illegible]	25933.371775	[illegible]	2730.000000	121000.000000	119.278
*FOG (mg/l)	42	[illegible]	6437.980083	41447587.552	5.000000	34570.000000	256.605
[illegible]	33	[illegible]	[illegible]	[illegible]	224.113320	39325.062000	132.957
[illegible]	35	[illegible]	[illegible]	[illegible]	[illegible]	78256.405200	139.560
[illegible]	40	[illegible]	[illegible]	42765545.591	[illegible]	36142.929360	259.605
[illegible]	42	[illegible]	[illegible]	[illegible]	1.752450	21924.965400	257.036
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35.595625	108.130
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19.297813	108.130
[illegible]	33	[illegible]	[illegible]	[illegible]	[illegible]	203.792723	156.590
[illegible]	34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	156.594
[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	39.977766	231.023
[illegible]	40	[illegible]	[illegible]	[illegible]	0.009038	19.988883	231.023
[illegible]	42	[illegible]	[illegible]	37.431	[illegible]	34.318813	254.550
[illegible]	42	[illegible]	[illegible]	9.358	0.002511	17.159436	254.550
BOD/COD Ratio	25	[illegible]	0.204302	0.042	0.204341	0.948200	35.331
BOD/FOG Ratio	29	[illegible]	[illegible]	[illegible]	0.831289	673.333333	197.654
Flow Ratio	43	[illegible]	[illegible]	11598.927	38.406420	593.750000	71.626

* FOG = Fats, Oils, and greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

DRAFT

TABLE 26

POLLUTANT WASTE LOADINGS FOR THE EDIBLE OIL REFINERY ACIDULATION PROCESS

Edible Oil Refinery by Process Code	Production (kkg/day)	Volume of Wastewater Discharged (cu m/day)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	Oil & Grease (mg/l)
75A10	279	147.6	1.29	3.09	0.25	0.23
75A15	337	518.5	18.43	59.4	6.34	5.31
75A09	346	170.7	7.05	11.07	0.45	0.04
75A08	[illegible]	263.8	6.06	10.72	2.91	1.86

DRAFT

Model Plant

The hypothetical model plant described for Subcategory A 6 is assumed to have a production of 454 kkg (500 ton) per day; to wash five tank cars per day; and to have a separate discharge of process wastewater and non-contact water. It is essentially the same plant described in Subcategory A 5 with the addition of the unit process of acidulation. By converting the acidulation data base to a 454 kkg (500 ton) per day plant and adding this value to the model plant waste loads calculated for Subcategory A 5 refineries, the following wastewater characteristics were derived for Subcategory A 6 refineries.

Production	454 kkg (500 ton) per day
Flow	534 cu m/day (0.141 MGD)
BOD	7,600 mg/l
COD	21,600 mg/l
SS	3,400 mg/l
O&G	3,000 mg/l
pH range	0.6 to 3.0
BOD ratio	8.95 kg/kkg (17.90 lb/ton)
COD ratio	25.41 kg/kkg (50.82 lb/ton)
SS ratio	4.03 kg/kkg (8.06 lb/ton)
O&G ratio	3.51 kg/kkg ([illegible] lb/ton)

SUBCATEGORY A 7 - PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING, ACIDULATION, OIL PROCESSING, AND DEODORIZATION

The individual unit processes and assumptions for the hypothetical Subcategory A 7 refinery are identical to Subcategory A 6 plants with the addition of the unit processes of deodorization and oil processing.

Deodorization

The contact cooling water blowdown generated from deodorization barometric condenser units represents a major contribution to the [illegible] waste load of an edible oil refinery. Average concentrations of pollutants from six refining operations were a BOD of [illegible] mg/l, a COD of [illegible] mg/l, a suspended solids of [illegible] mg/l, and oil and grease of [illegible] range was from 3.3 to 7.3. The average waste loadings were as follows:

BOD	2.21 kg/kkg ([illegible] lb/ton)
SS	0.[illegible] kg/kkg ([illegible] lb/ton)
O&G	0.30 kg/kkg ([illegible] lb/ton)
BOD/COD	[illegible]

Table [illegible] presents a statistical [illegible] of the data compiled for contact cooling tower blowdown from the six plants investigated.

Oil Processing

Oil processing includes the floor washing and general cleanup wastewater discharges from the hydrogenation, winterization, bleaching,

DRAFT

TABLE 27

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR EDIBLE OIL REFINERY CONTACT COOLING TOWER BLOWDOWN FROM BAROMETRIC CONDENSERS

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	44	0.0[illegible]7044	0.035721	0.0013	0.004320	0.173000	75.532
Prod. (ton/day)	44	383.936818	291.499943	84972.2151	96.500000	1194.000000	75.930
BOD (mg/l)	38	4061.648421	5341.475771	28531363.4147	60.000000	26700.000000	131.503
SS (mg/l)	43	731.325581	1267.467222	1606455.4153	15.000000	7960.000000	172.837
COD (mg/l)	39	7895.549744	8771.247567	76934783.8799	150.000000	44520.000000	111.090
*FOG (mg/l)	44	758.598727	986.107676	972408.3483	20.000000	3653.000000	130.004
BOD (lb/day)	38	1051.815527	1157.773150	1340438.6658	15.662176	5793.099000	110.074
COD (lb/day)	39	2288.022442	2060.657355	4247116.5517	33.877376	9655.504400	90.071
SS (lb/day)	43	[illegible]	[illegible]	[illegible]2.6496	4.506300	1129.245[illegible]00	115.562
FOG (lb/day)	44	255.[illegible]	432.449137	187012.2563	15.321420	2494.771130	169.123
[illegible]	35	[illegible]	7.019663	49.2167	0.038872	40.035238	158.737
[illegible]	34	[illegible]	3.507732	12.3042	0.019439	20.017619	158.737
[illegible]	39	[illegible]	11.469081	131.5398	0.063057	66.735386	135.162
[illegible]	39	[illegible]	5.734540	32.8850	0.041529	33.377693	135.162
[illegible]	43	[illegible]	0.734637	0.5397	0.018902	3.[illegible]8324	116.575
[illegible]	43	[illegible]	0.367319	0.1349	0.009451	1.839162	116.575
[illegible]	44	[illegible]	0.653684	0.4270	0.049039	3.158095	113.938
[illegible]	44	[illegible]	0.341923	0.1169	0.024520	1.579047	113.938
[illegible] Ratio	33	[illegible]	0.164917	0.0272	0.191964	0.860210	31.341
[illegible] Ratio	38	[illegible]	25.785414	664.8876	0.776952	100.754717	162.059
Flow Ratio	44	[illegible]	100.222196	10056.5189	10.588235	607.017544	67.722

* FOG = Fats, Oils, and Greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

and deodorization unit process operations. The wastewaters discharged from these operations represent a relatively minor waste loading in comparison to the other unit processes previously identified. The average flow was 26.5 cu m/day (0.007 MGD). Average pollutant concentrations were calculated as follows:

BOD	1800 mg/l
COD	5000 mg/l
SS	1100 mg/l
O&G	1300 mg/l
pH	7.3 to 13.0

Average waste loadings from oil processing were as follows:

BOD	0.09 kg/kkg (0.18 lb/ton)
COD	0.22 kg/kkg (0.45 lb/ton)
O&G	0.024 kg/kkg (0.48 lb/ton)

The BOD/COD ratio was 0.49. Table 28 presents a statistical description of the compiled data base from six plants.

Model Plant

Deodorization and oil processing data were converted to a 454 kkg (500 ton) per day plant by the factors 1.32 and 1.16, respectively. The waste loads from these unit processes were then added to the total wasteload of the 454 kkg (500 ton) per day plant described for Subcategory A 6 refineries. The following data represents the wastewater characteristics of a Subcategory A 7 refining operation consisting of the unit operations of caustic refining, acidulation, deodorization, and oil processing:

Production	454 kkg
Flow	1147 cu m/da. (0.303 MGD)
BOD	6,400 mg/l
COD	15,000 mg/l
SS	3,100 mg/l
O&G	1,500 mg/l
pH range	7.3 to 13.0
BOD ratio	16.09 kg/kkg (32.18 lb/ton)
COD ratio	36.41 kg/kkg (72.82 lb/ton)
SS ratio	7.84 kg/kkg (15.68 lb/ton)
O&G ratio	3.93 kg/kkg (7.86 lb/ton)

SUBCATEGORY A 8 - PROCESSING OF EDIBLE OILS UTILIZING CAUSTIC REFINING, OIL PROCESSING, AND DEODORIZATION

Subcategory A 8 is essentially the same as Subcategory A 7 with the deletion of the unit process of acidulation. As a result, the model

TABLE 28

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR EDIBLE OIL REFINERY OIL PROCESSING**

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	14	0.006681	0.005754	0.0000	0.000330	0.013000	86.122
Prod. (ton/day)	14	429.171429	234.008594	54760.0222	238.400000	960.600000	54.526
BOD (mg/l)	12	1793.083333	3831.751806	14682321.9015	105.000000	13600.000000	213.696
SS (mg/l)	13	1089.615385	1704.931550	2906791.5897	35.000000	5720.000000	156.471
COD (mg/l)	13	5073.[illegible]	8219.576185	67561432.6667	140.000000	28400.000000	162.026
*FOG (mg/l)	14	1335.[illegible]	1699.344181	2887770.5769	2.000000	6000.000000	126.559
BOD (lb/day)	12	67.[illegible]	175.612274	30839.6709	1.518793	624.206000	260.469
COD (lb/day)	13	168.[illegible]	364.281552	132686.4779	13.791782	1303.489000	216.757
SS (lb/day)	13	34.[illegible]	61.722045	3809.6109	0.841176	151.386920	177.094
[illegible] (lb/day)	14	19.[illegible]	29.357574	863.6233	0.216970	102.810400	153.292
[illegible]	14	[illegible]	0.455253	0.2073	0.002075	1.625536	245.826
[illegible]	12	[illegible]	0.227632	0.0518	0.001038	0.812768	245.826
lb/Ton-[illegible]	13	0.[illegible]	0.945456	0.8943	0.018846	3.394503	211.589
kg/kkg-[illegible]	13	0.[illegible]	0.472829	0.2236	0.009423	1.697251	211.589
lb/Ton-[illegible]	13	[illegible]	0.160112	0.0256	0.001149	0.472362	171.106
kg/kkg-SS	13	[illegible]	0.080056	0.0064	0.000575	0.236181	171.106
lb/Ton-FOG	14	[illegible]	0.077120	0.0059	0.000910	0.267735	161.513
kg/kkg-FOG	14	[illegible]	0.038560	0.0015	0.000455	0.133868	161.513
BOD/COD Ratio	12	[illegible]	0.226269	0.0512	0.110123	0.690909	46.584
BOD/FOG Ratio	12	13.991234	34.332618	1178.7266	0.351937	122.500000	275.387
Flow Ratio	14	25.[illegible]	24.822636	616.1632	0.728711	54.530201	99.049

* FOG = Fats, Oils, and greases.

N = Number of data points

** Includes floorwashing and general cleanup for the following unit processes. hydrogenation, deodorization, bleaching, and winterization.

Note: Computer calculations for this table show no ragard for significant figures.

plant for Subcategory A 8 will have a lower waste loading and flow then Subcategory A 7 plants.

Model Plant

Assuming the same production rates and assumptions made for Subcategory A 7 refineries, the model plant for Subcategory A 8 was calculated to have the following concentrations and waste loading:

Production	454 kkg
Flow	927 cu m/day (0.245 MGD)
BOD	5,750 mg/l
COD	11,300 mg/l
SS	3,100 mg/l
O&G	1,400 mg/l
pH range	6 to 9
BOD ratio	11.73 kg/kkg (23.46 lb/ton)
COD ratio	22.99 kg/kkg (45.98 lb/ton)
SS ratio	6.30 kg/kkg (12.60 lb/ton)
O&G ratio	2.81 kg/kkg (5.62 lb/ton)

SUBCATEGORY A 9 - PROCESSING OF EDIBLE OILS BY THE USE OF CAUSTIC REFINING, ACIDULATION, OIL PROCESSING, DEODORIZATION AND, THE PRODUCTION OF SHORTENING AND TABLE OILS

Subcategory A 9 is identical to Subcategory A 7 with the addition of the plasticizing and packaging operations associated with a shortening and table oils processing

Shortening and Table Oil Production

Wastewater resulting from shortening and table oils plasticizing and/or packaging operations are primarily generated from floor washing and periodic equipment cleanup procedures. Wastewaters generated from these operations represent a relatively insignificant waste loading to the total refinery effluent. Average pollutant waste loads for the production of shortening and table oils are discussed in detail in Subcategory A 14.

Total Processing Effluent

Although the model plant for Subcategory A 9 has an additional unit process waste stream its total waste load is observed to be less concentrated than Subcategory A 7 due to the dilution effect attributable to the relatively low waste load contributed by shortening and table oil processing.

Model Plant

The Subcategory A 9 model plant is assumed to be identical to the Subcategory A 7 model plant with the addition of plasticizing and packaging of shortening and table oils (i.e., Subcategory A 14). The shortening and table oils packaging waste loads were converted to a 454 kkg (500 ton) per day operation and were added to the total waste load for Subcategory A 9. The wastewater characteristics for Subcategory A 9 plants are as follows:

Production	454 kkg
Flow	1320 cu m/day (0.349 MGD)
BOD	5,900 mg/l
COD	13,500 mg/l
SS	3,000 mg/l
O&G	1,500 mg/l
pH range	3 to 9
BOD ratio	17.12 kg/kkg (34.24 lb/ton)
COD ratio	39.15 kg/kkg (78.30 lb/ton)
SS ratio	8.68 kg/kkg (17.36 lb/ton)
O&G ratio	4.35 kg/kkg (8.70 lb/ton)

SUBCATEGORY A 10 - PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING, OIL PROCESSING, DEODORIZATION, AND THE PLASTICIZING AND PACKAGING OF SHORTENING AND TABLE OILS

The model plant developed for Subcategory A 10 is principally the same as Subcategory A 9 with the deletion of the unit process of acidulation.

Total Process Effluent

As a result of the deletion of acidulation, the total processing effluent from Subcategory A 10 plants will be significantly reduced.

Model Plant

The model plant for Subcategory A 10 is identical to the Subcategory A 9 model plant with the deletion of acidulation. The model plant assumes a 454 kkg (500 ton) per day production for both the refining operations and the filling and packaging of shortening and table oils. The wastewater characteristics of Subcategory A 10 plants are as follows:

Production	454 kkg
Flow	1101 cu m/day (0.291 MGD)
BOD	5,250 mg/l
COD	10,400 mg/l
SS	3,000 mg/l
O&G	1,300 mg/l

pH range	6 to 9
BOD ratio	12.76 kg/kkg (25.52 lb/ton)
COD ratio	25.23 kg/kkg (50.46 lb/ton)
SS ratio	7.14 kg/kkg (14.28 lb/ton)
O&G ratio	3.23 kg/kkg (6.46 lb/ton)

SUBCATEGORY A 11 - PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING, ACIDULATION, OIL PROCESSING, DEODORIZATION, AND THE PLASTICIZING AND PACKAGING OF SHORTENING, TABLE OILS, AND MARGARINE

Subcategory A 11 is a combination of Subcategory A 7 (i.e., edible oil caustic refining, acidulation, oil processing and deodorization) with the addition of shortening, table oils, and margarine processing waste load data presented in Subcategories A 13 and A 14. It is assumed that the refining unit processes operate at a 454 kkg per day level. Subcategory A 11 also assumes that the two additional unit processes (i.e., shortening, table oils packaging, and margarine packaging) operate each at 227 kkg (250 ton) per day.

Total Processing Effluent

The total process effluent from Subcategory A 11 refineries represents the highest pollutant wasteloading calculated for all the edible oil refining model plants developed for this report.

Model Plant

It is assumed that the Subcategory A 11 plant has the same waste load characteristics of Subcategory A 7, with the addition of: 1) a shortening, table oils plasticizing and/or packaging room and 2) a margarine plasticizing and packaging room. Each packaging operation is assumed to operate at a production rate of 227 kkg (250 ton) per day. The wastewater characteristics of Subcategory A 11 plants are as follows:

Production	454 kkg
Flow	1574 cu m/day (0.416 MGD)
BOD	5,900 mg/l
COD	13,500 mg/l
SS	3,200 mg/l
O&G	2,800 mg/l
pH range	3 to 9
BOD ratio	20.57 kg/kkg (41.14 lb/ton)
COD ratio	46.60 kg/kkg (93.2 lb/ton)
SS ratio	10.98 kg/kkg (21.96 lb/ton)
O&G ratio	9.95 kg/kkg (19.90 lb/ton)

DRAFT

SUBCATEGORY A 12 - PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING, OIL PROCESSING, DEODORIZATION, AND THE PLASTICIZING AND PACKAGING OF SHORTENING, TABLE OILS, AND MARGARINE

Subcategory A 12 is identical to Subcategory A 11 with the deletion of the unit process of acidulation. As a result, the final discharge from the Subcategory A 12 plant will have a significantly higher pH and lower pollutant waste load than Subcategory A 11.

Model Plant

The hypothetical Subcategory A 12 model plant is assumed to have the same daily production rates, assumptions, and waste loadings per unit process as the Subcategory A 11 model plant with the deletion of the unit process for acidulation. The wastewater characteristics of Subcategory A 12 edible oil refineries are as follows:

BOD	5,400 mg/l
COD	10,9[illegible] mg/l
SS	3,200 mg/l
O&G	3,200 mg/l
pH range	6 to 9
BOD ratio	16.20 kg/kkg (32.40 lb/ton)
COD ratio	32.68 kg/kkg (65.36 lb/ton)
SS ratio	9.44 kg/kkg (18.88 lb/ton)
O&G ratio	8.83 kg/kkg (17.66 lb/ton)

SUBCATEGORY A 13 - PLASTICIZING AND PACKAGING OF MARGARINE

Historical data submitted by the National Association of Margarine Manufacturers (NAMM) for four plants with supporting verification sampling represents the data base compiled for Subcategory A 13 margarine processing plants.

There are principally three sources of wastewater generated from margarine plasticizing and packaging operations: 1) wastewater discharged from margarine reclamation rooms; 2) wastewater discharged from general floor washing operations containing detergents and chlorine; and 3) the daily cleanup of CIP (clean-in-place) equipment utilizing the following cleaning cycles: hot rinse, caustic wash, chlorine rinse, final rinse, sanitation, and air drying. The amounts of wastewater generated from these operations is primarily dependent upon the cleanliness and efficiency of the above three operations. Margarine production requires considerably more sanitation procedures than other edible oil finished product packaging operations due to its ability to provide a growth medium for pathogenic bacteria. As a result, cleanup operations of CIP equipment and floor washing procedures require relatively larger volumes of water. Average pollutant concentrations, flow, and production for the four plants investigated were as follows:

DRAFT

Production	112 kkg
Flow	170 cu m/day (0.045 MGD)
BOD	1440 mg/l
COD	4470 mg/l
SS	900 mg/l
O&G	1760 mg/l
pH	6 to 8
BOD ratio	1.93 kg/kkg (3.86 lb/ton)
COD ratio	4.22 kg/kkg (8.45 lb/ton)
SS ratio	1.34 kg/kkg (2.69 lb/ton)
O&G ratio	2.36 kg/kkg (5.72 lb/ton)
BOD/COD ratio	0.53

Table 29 presents a statistical description of the data base collected indicating mean, standard deviations, and minimum and maximum values. Table 30 presents the calculated averaged data for each of the three plants investigated.

Total Processing Effluent

The total waste load resulting from a margarine processing operation in combination with an edible oils refinery represents a significant waste load to the total processing effluent. Based upon the data provided by the [illegible], it is evident that the wastewater characteristics for margarine processing is highly variable from plant to plant with higher waste loads being correlated with larger production rates.

Model Plant

The hypothetical margarine processing plant for Subcategory A 13 was assumed to operate at a production rate of 227 kkg/day (250 ton/day). The wastewater characteristics for Subcategory A 13 plants are as follows:

Production	227 kkg
Flow	340 cu m/day (0.09 MGD)
BOD	2000 mg/l
COD	5700 mg/l
SS	1600 mg/l
O&G	3900 mg/l
pH range	6 to 8
BOD ratio	[illegible] lb/ton)
COD ratio	[illegible] lb/ton)
SS	2.72 [illegible] lb/ton)
O&G	5.61 kg/kkg (11.[illegible] lb/ton)

SUBCATEGORY A 14 - PLASTICIZING AND PACKAGING OF SHORTENING AND TABLE OILS

The plasticizing and packaging of shortening and table oils represents a relative insignificant waste load in comparison to Subcategory A 13, margarine processing. In general, shortening and table oils processing

TABLE 29

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS
FOR MARGARINE PROCESSING

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	32	0.044551	0.036737	0.0013	0.008000	0.111400	82.443
Prod. (ton/day)	32	123.1[illegible]	66.597688	4475.3006	30.000000	251.500000	54.344
BOD (mg/l)	25	1437.[illegible]	2175.024452	4730992.3733	135.000000	11433.000000	151.262
SS (mg/l)	31	904.[illegible]	1273.862963	1622728.8495	24.000000	4476.000000	140.894
COD (mg/l)	19	4447.[illegible]	7270.[illegible]	52861753.8869	930.000000	32554.000000	162.763
*FOG (mg/l)	31	1742.[illegible]	2654.526167	7099599.6966	22.000000	11907.000000	151.342
BOD (lb/day)	25	693.57[illegible]	2091.200180	4373116.1409	22.761850	10628.494069	319.766
COD (lb/day)	19	1352.279216	2815.[illegible]	7926533.1378	119.592195	11033.814077	208.208
SS (lb/day)	31	422.1[illegible]	988.[illegible]	977527.0368	3.972230	3702.926850	205.044
FOG (lb/day)	32	972.3[illegible]	2284.817528	5220391.1341	4.836762	10592.193339	234.971
[illegible]	25	3.4[illegible]	8.123545	65.9920	0.399981	42.260414	210.450
[illegible]	25	1.93[illegible]	4.061772	16.4980	0.199991	21.130207	210.450
[illegible]	19	8.45[illegible]	11.268122	126.9706	1.161289	43.672024	133.256
[illegible]	19	4.2[illegible]	5.634061	31.7426	0.580645	21.936012	133.256
[illegible]	31	2.5[illegible]	4.816516	23.2181	0.054639	19.235984	179.169
[illegible]	31	1.3[illegible]	2.409258	5.8045	0.027320	9.617992	179.169
[illegible]-FOG	32	5.72[illegible]	11.221218	125.9155	0.026416	51.795566	196.008
[illegible]-FOG	32	2.862[illegible]	5.610624	31.4789	0.013208	25.897783	196.008
[illegible] Ratio	17	[illegible]	0.225[illegible]	0.0506	0.288925	0.976744	42.741
[illegible] Ratio	25	[illegible]	4.285584	18.4005	0.367647	20.434783	103.528
Flow Ratio	32	329.4[illegible]866	139.962332	19589.4544	118.518519	615.384615	42.478

* FOG = Fats, Oils, and greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

DRAFT

TABLE 30

POLLUTANT WASTE LOADINGS FOR THE PROCESSING OF MARGARINE

Edible Oil Refinery by Process Code	Production (kkg/day)	Volume of Wastewater Discharged (cu m/day)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	Oil & Grease (mg/l)
79M03	134.0	219.5	4.05	7.01	2.65	6.58
79M06	119.4	176.7	0.95	0.74	0.33	0.19
79M05	63.9	59.4	1.36	2.38	0.51	0.42

DRAFT

employs strictly mechanical treatment of oils for the conversion of bulk quantities of hardened oil into consumer sized packaging. The wastewaters generated from these operations are principally from general sanitation of filling and packaging equipment and general floor washing procedures. The volume of water generated from the process is significantly less than that for margarine processing due to the fact that the finished products do not support bacterial growth and therefore require less rigorous sanitation procedures The average pollutant concentrations furnished by the Institute of Shortening and Edible Oils (ISEO) from five plants were:

Production	195 kkg (215 ton/day)
Flow	74.9 cu m/day (0.0198 MGD)
BOD	1600 mg/l
COD	4000 mg/l
SS	750 mg/l
O&G	770 mg/l
pH	6 to 8
BOD	0.48 kg/kkg (0.96 lb/ton)
COD	0.19 kg/kkg (0.37 lb/ton)
SS	0.18 kg/kkg (0.36 lb/ton)
O&G	0.19 kg/kkg (0.36 lb/ton)
BOD/COD ratio	0.52

Table 31 presents a statistical description of the means, standard deviations, and minimum and maximum values calculated from the five plants investigated and sampled. Table 32 presents a description of the shortening data collected at each plant.

Model Plant

The hypothetical shortening and table oil processing model plant was assumed to operate at a production level of 227 kkg (250 ton) per day. The data base collected was converted to a daily production rate of 227 kkg by multiplying by a factor of 1.16 (i.e., 227 kkg / 195 kkg = 1.16). The wastewater [illegible] as follows:

Production	227 kkg
Flow	87 cu m/day [illegible]
BOD	1500 mg/l
COD	3000 mg/l [illegible]
SS	[illegible]
O&G	550 mg/l
BOD ratio	0.56 [illegible]
COD ratio	1.12 [illegible]
SS ratio	0.42 [illegible]
O&G ratio	0.21 (0.42 lb/ton)
BOD/COD ratio	0.5[illegible]

TABLE 31

A STATISTICAL DESCRIPTION OF THE WASTEWATER CHARACTERISTICS FOR SHORTENING AND TABLE OIL PACKAGING OPERATIONS

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF COVARIENCE (%)
Flow (MGD)	24	0.019747	0.029776	0.0009	0.000700	0.090900	150.838
Prod (ton/day)	24	214.987500	114.096810	13018.5385	38.700000	455.500000	53.072
BOD (mg/l)	22	1594.158368	2205.237171	4863070.9805	470.000000	11290.000000	138.330
SS (mg/l)	23	747.782609	873.458158	762981.6324	106.000000	4246.000000	116.810
COD (mg/l)	15	[illegible]	6429.411554	41337333.3167	942.000000	27800.000000	160.040
FOG (mg/l)*	24	765.433333	807.152319	651462.5757	23.000000	3300.000000	105.393
BOD (lb/day)	22	168.801818	273.432769	74765.4458	8.178100	842.002155	161.985
COD (lb/day)	16	66.137775	56.003200	3136.3584	15.576777	231.591000	84.677
SS (lb/day)	23	65.[illegible]	89.113543	7941.2377	1.503769	317.694150	136.246
FOG (lb/day)	24	92.[illegible]	265.740977	70618.6666	2.142162	1321.646000	287.543
[illegible] BOD	22	[illegible]	1.507346	2.2722	0.032303	4.595592	156.361
[illegible]	22	[illegible]	0.753693	0.5681	0.016152	2.299296	156.361
[illegible]	16	[illegible]	0.308416	0.0951	0.059433	1.321649	82.841
[illegible]	16	[illegible]	0.154208	0.0238	0.029716	0.660924	82.841
[illegible]	23	[illegible]	0.486227	0.2364	0.009283	1.735085	136.536
[illegible]	23	[illegible]	0.244113	0.0596	0.004641	0.867543	136.536
lb/ton-FOG	24	[illegible]	0.760704	0.5787	0.007420	3.734034	202.840
kg/kkg-FOG	24	[illegible]	0.380352	0.1447	0.003710	1.867017	202.840
BOD/COD Ratio	16	[illegible]	0.104451	0.0109	0.307423	0.669528	20.251
BOD/FOG Ratio	22	[illegible]	6.677769	44.5929	0.500872	27.876543	131.480
Flow Ratio	24	[illegible]	163.075792	26593.7160	2.195393	496.450027	150.655

* FOG = Fats, Oils, and greases.

N = Number of data points

Note: Computer calculations for this table show no regard for significant figures.

DRAFT

TABLE 32

POLLUTANT WASTE LOADINGS FOR SHORTENING AND TABLE OIL PROCESSING

Edible Oil Refinery by Process Code	Production (kkg/day)	Volume of Wastewater Discharged (cu m/day)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	Oil & Grease (mg/l)
79905	142	12.9	0.13	0.22	0.052	0.056
79908	250	7.19	0.046	0.12	0.041	0.052
79909	26[illegible]	17.9	0.11	0.24	0.12	0.067
79[illegible]	[illegible]	235.4	1.51	----	1.03	0.28
[illegible]17	[illegible]	181.7	----	----	----	1.87

DRAFT

SUBCATEGORY A 15 - OLIVE OIL REFINING

The refining of olive oil is similar to the refining of other edible oils except that it is done on a much smaller scale. The only wastewater generated is from caustic refining wash water with the following characteristics:

Flow	1.13 cu m/day (0.003 MGD)
BOD	5700 mg/l
SS	296 mg/l
FOG	195 mg/l

Model Plant

Plant 79102 is the only olive oil refiner in the country using caustic refining. Thus, the model plant is Plant 79102 and is illustrated in Figure 111. The plant will have wastewater characteristics as listed above.

BEVERAGES

SUBCATEGORY A 16 - NEW LARGE MALT BEVERAGE BREWERIES

In order to determine the wastewater characteristics of the malt beverage industry, information was collected from several sources. The United States Brewers Association (USBA) circulated one of two types of survey to all known breweries. They then produced a report entitled "1974 Brewery Effluent Wastewater Characteristics" (56). Eleven breweries were visited during the study and four breweries were sampled. An extensive literature search was made to locate any existing historical data.

Process Waste Streams

As was noted in Section III, the sources of brewery waste can be identified but the methods of disposal vary for each individual brewery. Further, individual breweries may vary their methods of disposal based upon [illegible] or environmental factors. For these reasons there can be no fixed [illegible] of the strengths of waste streams for the entire industry, however several generalizations can be made.

Spent Grain Liquor - This is one of the most significant sources of [illegible] in the brewing process. It is [illegible], carbohydrate material, [illegible] BOD and suspended solids and low in pH. According to LeSeelleur (57), average concentrations of BOD and suspended solids in spent grain liquor are 15,000 mg/l and 20,000 mg/l, respectively. At these concentrations spent grain liquor, if discharged, can be expected to comprise 30 to [illegible] percent of the total plant load. As reported by Stein (58), spent grain liquor from Plant 82B081P9 represented 43.5 percent of the total pounds of BOD and 60.3 percent of the total pounds of suspended solids. Most the breweries in subcategory A 16 do not discharge spent grain liquor.

Feed Recovery - These systems are [illegible] by breweries not selling wet spent grains or not disposing of spent grain liquor to sewers. As explained in Section III, the major wastewater discharge from feed recovery

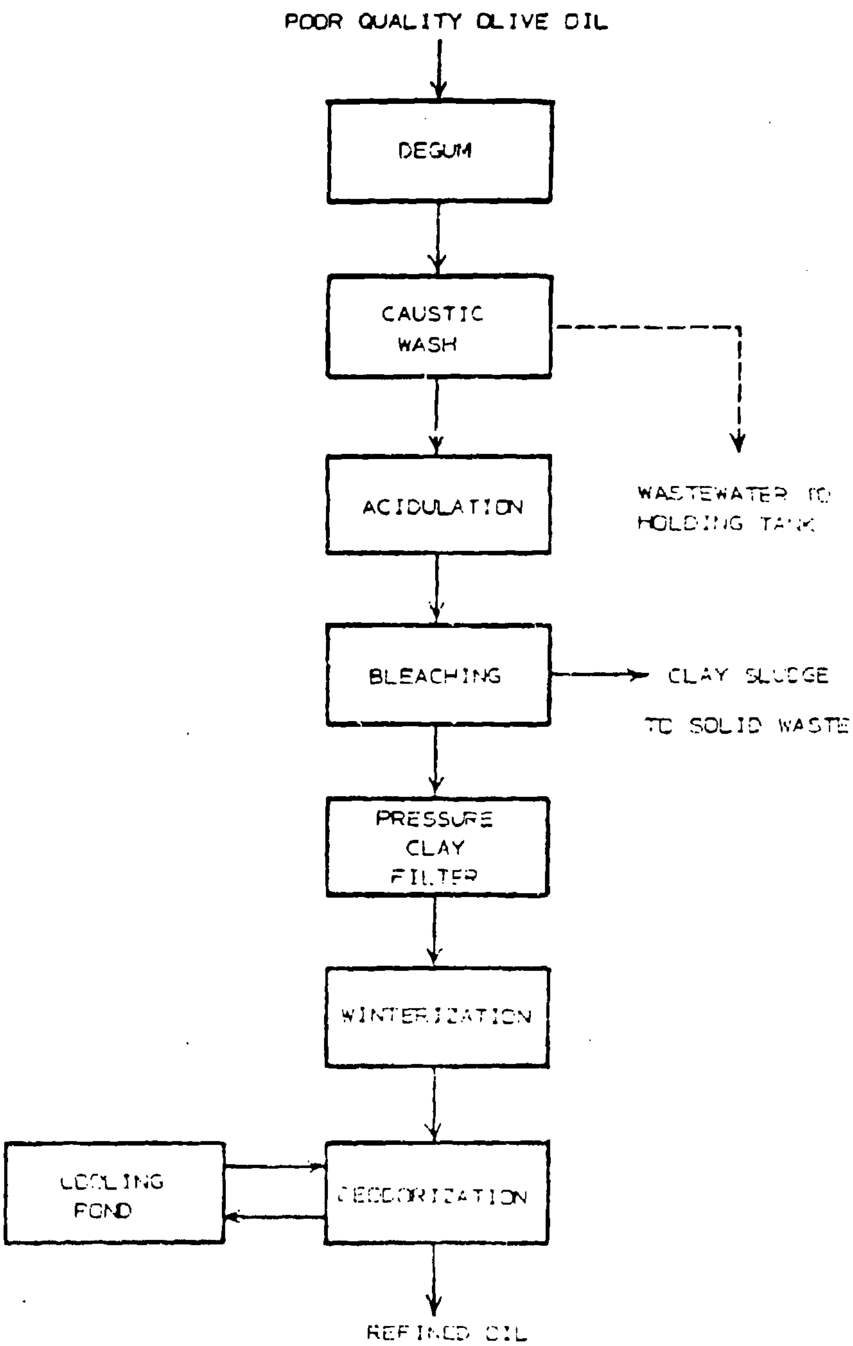


FIGURE III

SUBCATEGORY A 15
OLIVE OIL CAUSTIC REFINING PROCESS
MODEL PLANT

is the evaporator condensate. This is a high volume effluent with little or no suspended solids and up to 300 mg/l BOD. The concentration varies from plant to plant depending on whether yeast, lost beer, or other wastes are evaporated along with spent grain liquor. Wet scrubbers, if utilized, comprise a minor part of total feed recovery wasteload. Some plants utilize cyclones, thus eliminating wet scrubber discharge. More than half of the breweries in Subcategory A 16 operate feed recovery systems.

Lost Beer - This may represent from four to eight percent of beer produced. Lost beer is primarily derived from packaging, fermentation, and finishing. Since beer has a BOD concentration of approximately 125,000 mg/l, this can account for a considerable part of the total plant load. Plant 82A02IP9, for example, estimated beer loss at 40 percent of the total pounds of BOD discharged per day. Assuming no recovery, a four percent beer loss would amount to a BOD load of 5.02 kg/cu m (1.3 lb/barrel). Four of the breweries in Subcategory A 16 practice some form of beer recovery.

Spent Hops, Trub, and Yeast - These are grouped together simply because their method of disposal may be similar. They are all suitable for addition to spent grains since they contain only carbohydrates, protein materials, yeast, and beer residues. None of the plants in Subcategory A 16 discharge hops, trub, or yeast to sewers.

Filter Aid - This must either be hauled away to land disposal or sewered. Considerable suspended solids would result were this waste to be discharged, hence all but one of the plants in Subcategory A 16 recover filter aid by decant tanks, vacuum, or pressure filters.

Alkaline Wastes - These are generated from vessel cleanup and bottle washers. Residue from vessel walls is combined with caustic during vessel cleanup. Paper labels, sodium aluminate from aluminum labels, and glue are combined with caustic discharges from bottle washers. Although alkaline wastes may be readjusted and reused, they are eventually sewered. Several plants in Subcategory A 16 meter caustic into sewers from holding tanks.

Combined Process Flow

Data from 77 breweries were catalogued in the USBA wastewater characteristics report. These brewers represented 87 percent of total sales for the industry in 1973. Each brewery reported the ratio of flow (barrels), BOD (lb), and suspended solids (lb), to production (barrels) for a full-capacity day. A full-capacity day was defined as the maximum output which could be sustained for a number of consecutive days. Each brewery was assigned a reliability number based on the amount of accumulated data and on sampling technique. Reliability numbers ranged from 0 to 10, with the higher numbers corresponding to those breweries with more accurate data. Breweries with reliability ratings of 8 to 10 were characterized by continuous metering with short interval flow proportional sampling on a daily basis for six or more months. Breweries with reliability ratings of zero had no data or data which would have an extremely high probability of yielding misleading results. The year of initial construction and last major expansion was presented for as many brewers as possible.

Based on the survey data, the arithmetic mean for all brewers was as follows:

Flow Ratio	7420 l/cu m (7.42 lb/bbl)
BOD Ratio	9.43 kg/cu m (2.44 lb/bbl)
SS Ratio	3.83 kg/cu m (0.99 lb/bbl)

Data for breweries in Subcategory A 16 are itemized and summarized in Table 33. Scatter diagrams of flow, BOD, and suspended solids ratios versus production for Subcategory A 16 are illustrated in Figures 112, 113 and 114.

Log normal probability plots of flow, BOD, and suspended solids ratios are illustrated in Figures 115, 116, and 117.

Other significant parameters for combined process flow are pH, nitrogen, and phosphorus. Several studies have documented the fact that pH may vary widely over a 24 hour period. In fact, fluctuations of pH from 2 to 12 can be expected due to the batch nature of the brewing process. In general, the pH of breweries in Subcategory A 16 can be expected to remain between 5 and 11 due to the large number of compensating operations taking place simultaneously. Metering of caustic from holding tanks can be expected to further buffer variations. Brewery waste is known to be deficient in nitrogen. O'Rourke and Tomlinson (59) defined an average BOD/N ratio of 43.2. Tests at Plant 82K32MP9 (60) established a BOD/N ratio of 50.7. These appear to be representative of the industry as a whole. Based on treatment systems in operation the waste appears to contain adequate phosphorus.

In order to demonstrate the daily variability of brewery waste, the flow, BOD, and suspended solids ratios for Plant 82A43 have been plotted for a [illegible] month period as shown in Figures 118, 119, and 120. The means and standard deviations are also given. It is obvious from these figures that treatment system design and effluent limitations must take into account the highly variable nature of brewery waste.

Model Plant

The raw waste loads for the model plant for Subcategory A 16 are based on the mean ratios presented in Table 33. It should be noted that these means were calculated by excluding the data from Plant 82A16. This plant has demonstrated superior in-house waste reduction procedures. It was felt, however, that the raw waste loads for this plant were not necessarily economically achievable for the other brewers in this subcategory in their present configurations. For treatment system design purposes, an average production for this subcategory was calculated to be 1500 cu m (12,800

DRAFT

TABLE 33

WASTEWATER CHARACTERISTICS
SUBCATEGORY A16
(NEW LARGE BREWERIES)

Plant	Flow Ratio (l/cum)	BOD Ratio (kg cu m)	SS Ratio (kg/cu m)	Reliability Number
82A01	4640	9.62	3.48	10
82A02	5200	7.88	3.40	8
82A05	7020	10.40	2.40	8
82B07	6850	12.90	4.41	7
82B08	9860	17.40	8.35	5
82A09	4970	7.38	5.05	8
82A16	1620	1.74	1.08	10
82B35	3550	9.00	2.24	5
82A43	4520	8.8[illegible]	2.98	10
82B56	4600	11.00	3.94	7
82A58	5870	15.00	4.68	8
82A61	4860	8.58	2.78	10
[illegible]	4660	11.[illegible]	3.59	9
82A63	3730	7.[illegible]	2.94	[illegible]
Mean*	5410 (5.41 bbl/bbl)	10.[illegible] (2.72 [illegible])	3.86 (1.00 lbs/bbl)	

*Calculated without data from plant 82A16

DRAFT

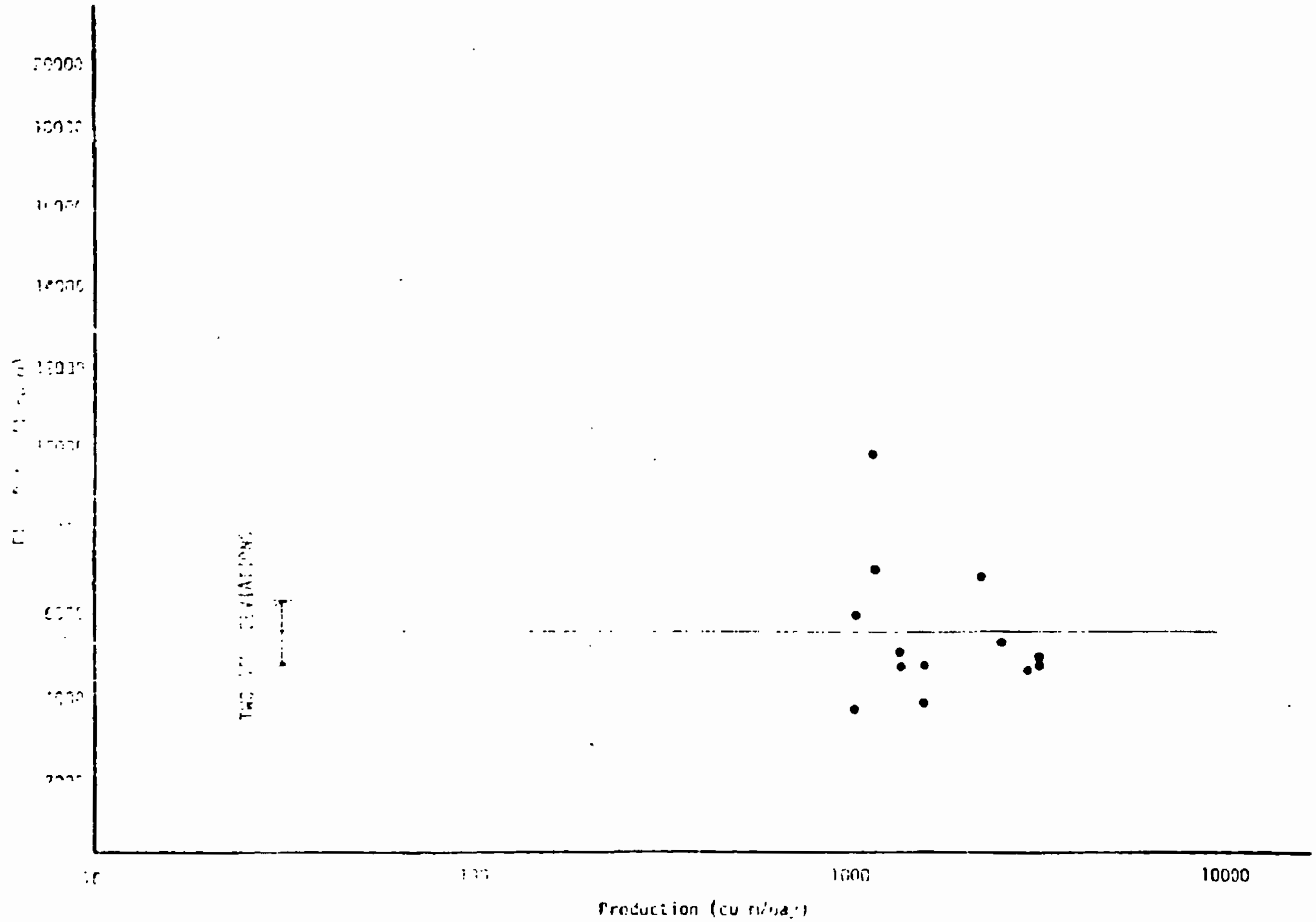


FIGURE 112

SUBCATEGORY A 16
FLOW VS. CAPACITY

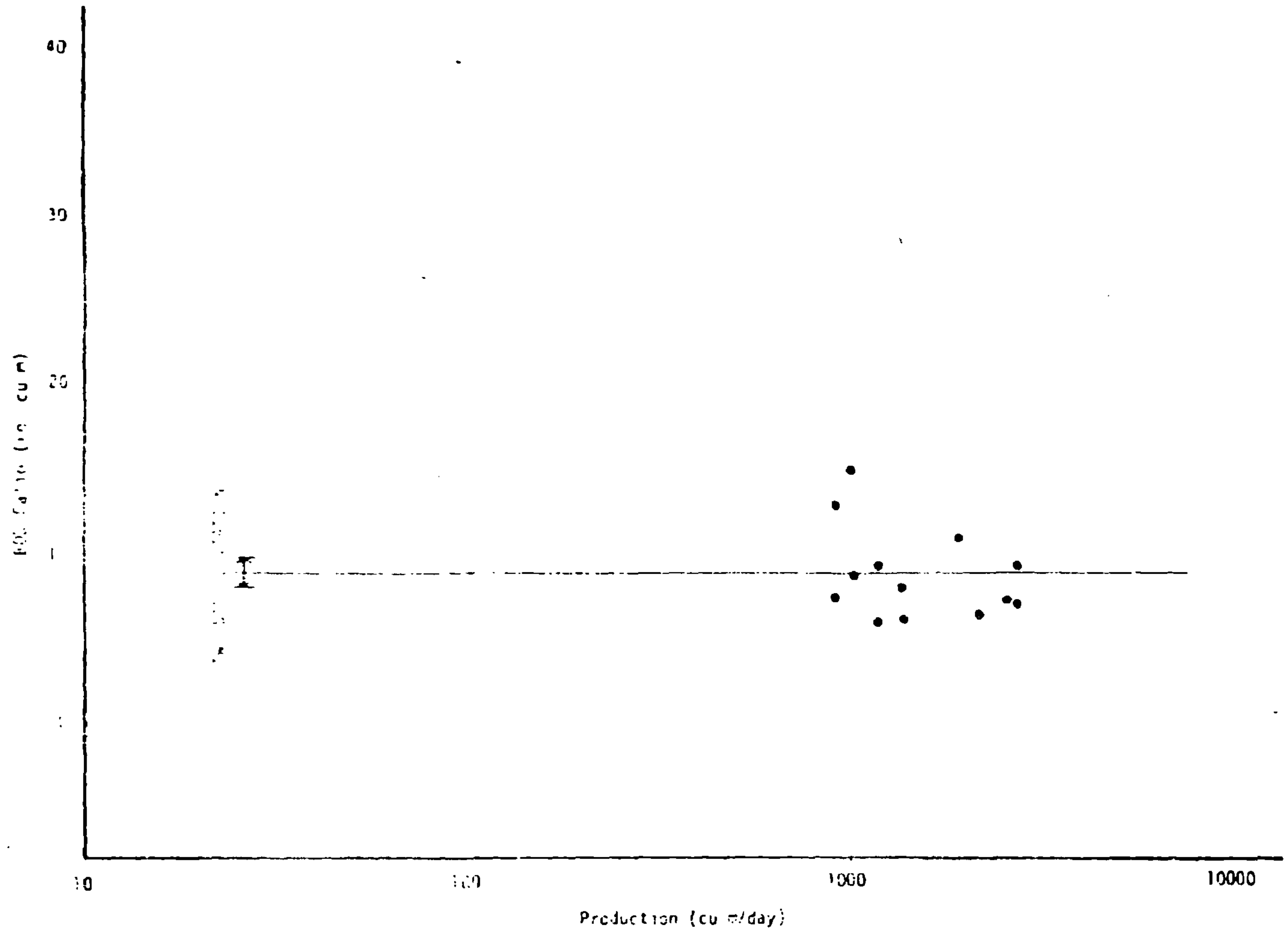


FIGURE 113

SUBCATEGORY A 16
DESIGN CAPACITY

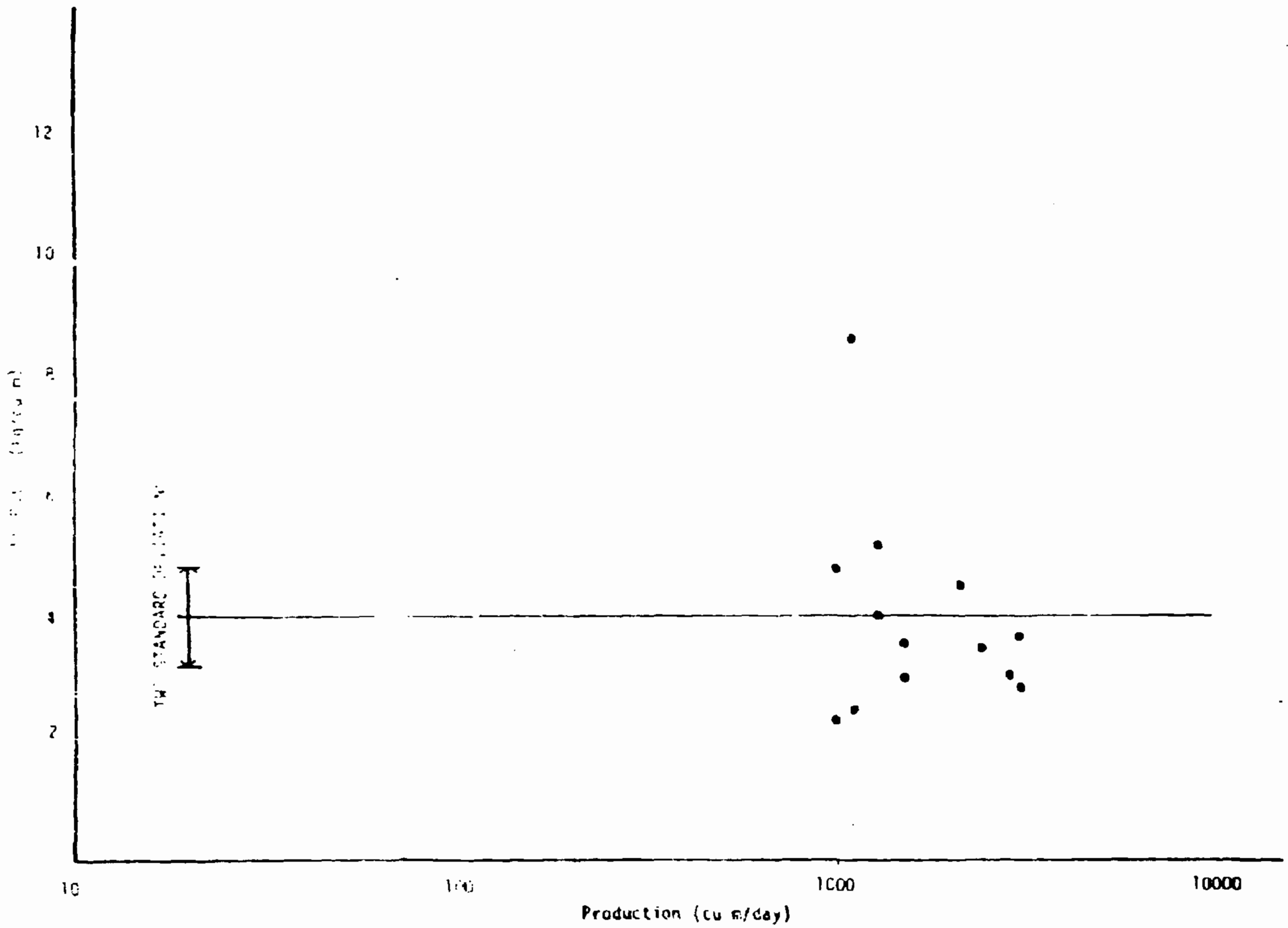


FIGURE 114

SUBCATEGORY A 16
SUSPENDED SOLIDS VS CAPACITY

DRAFT

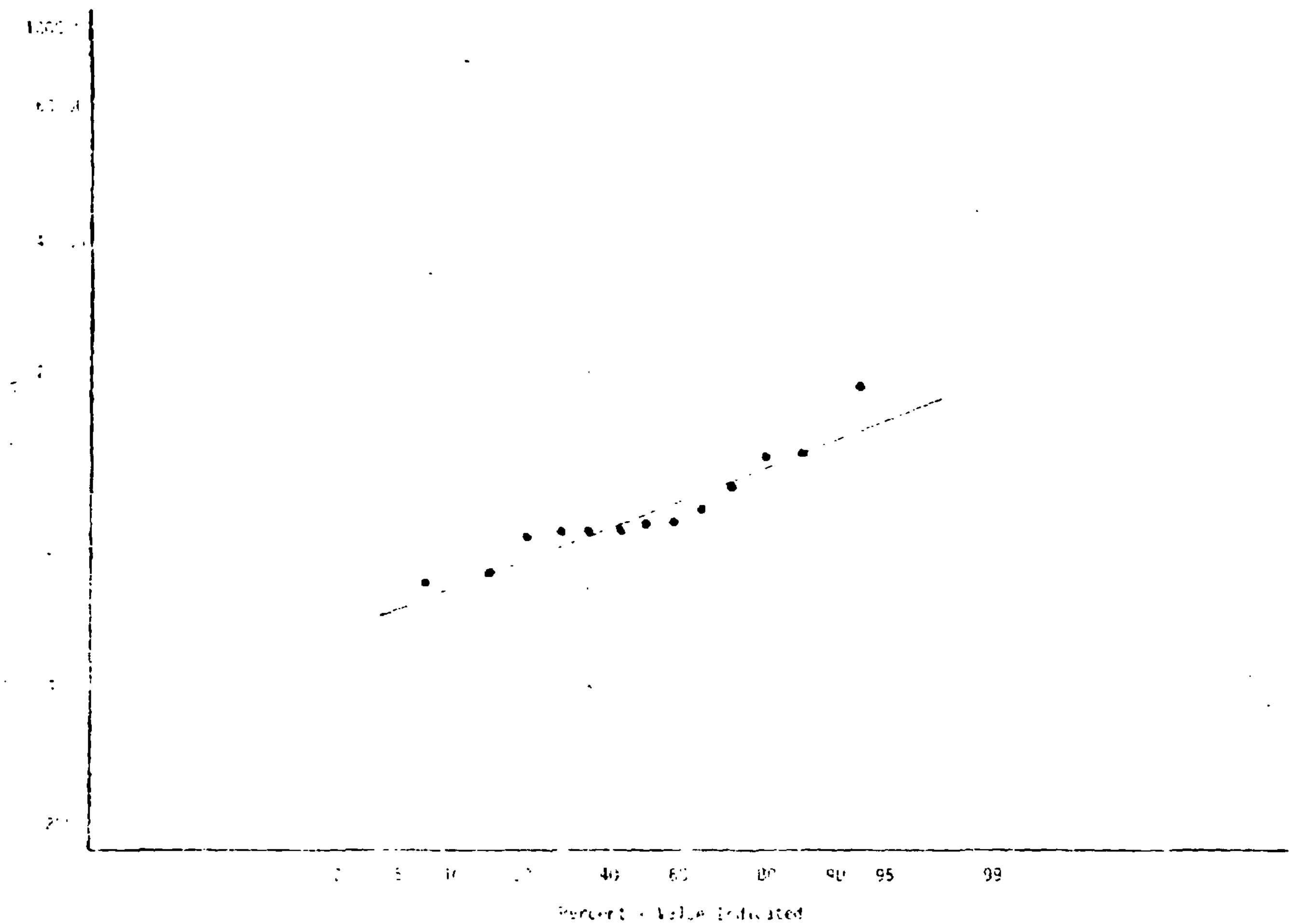
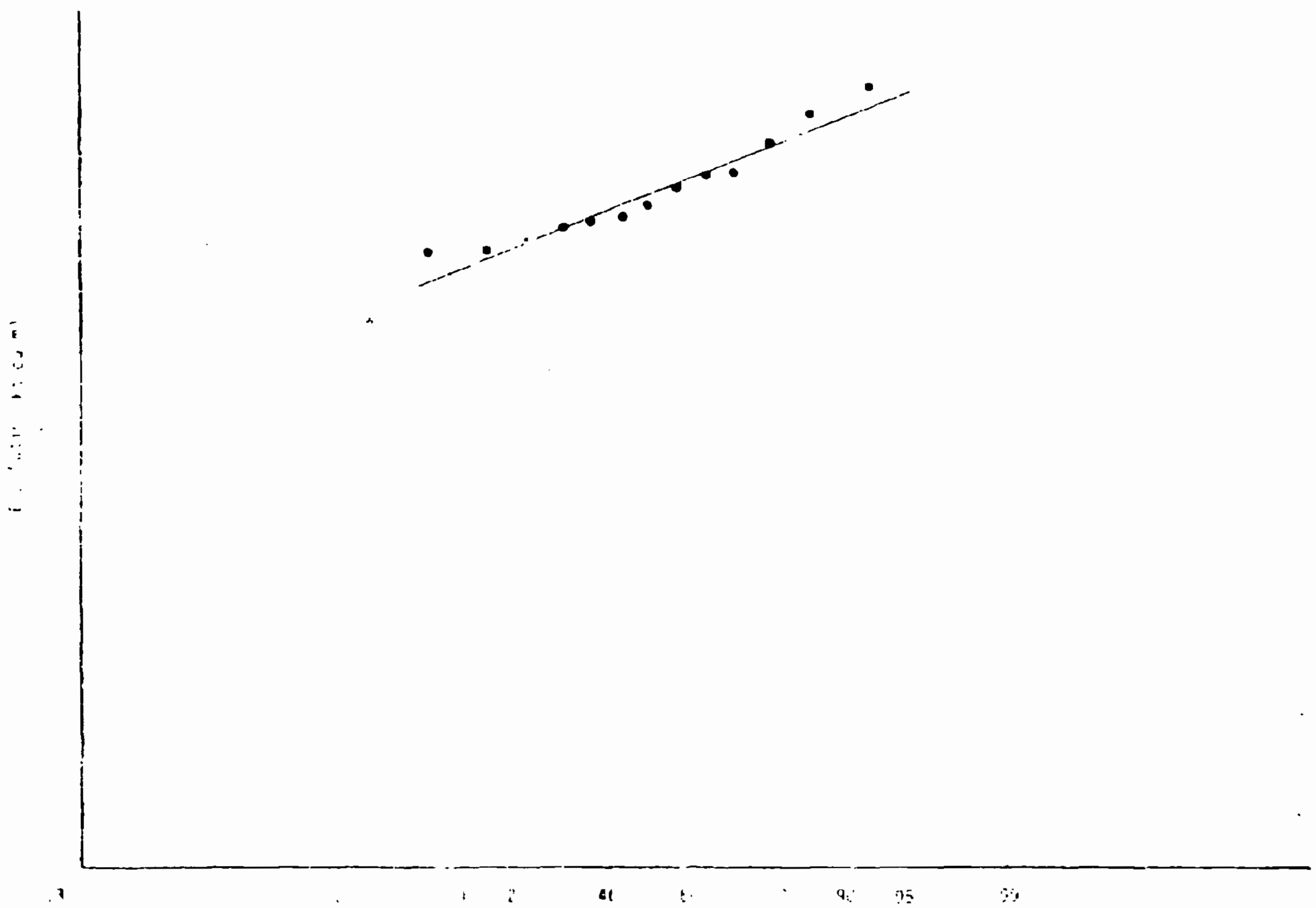


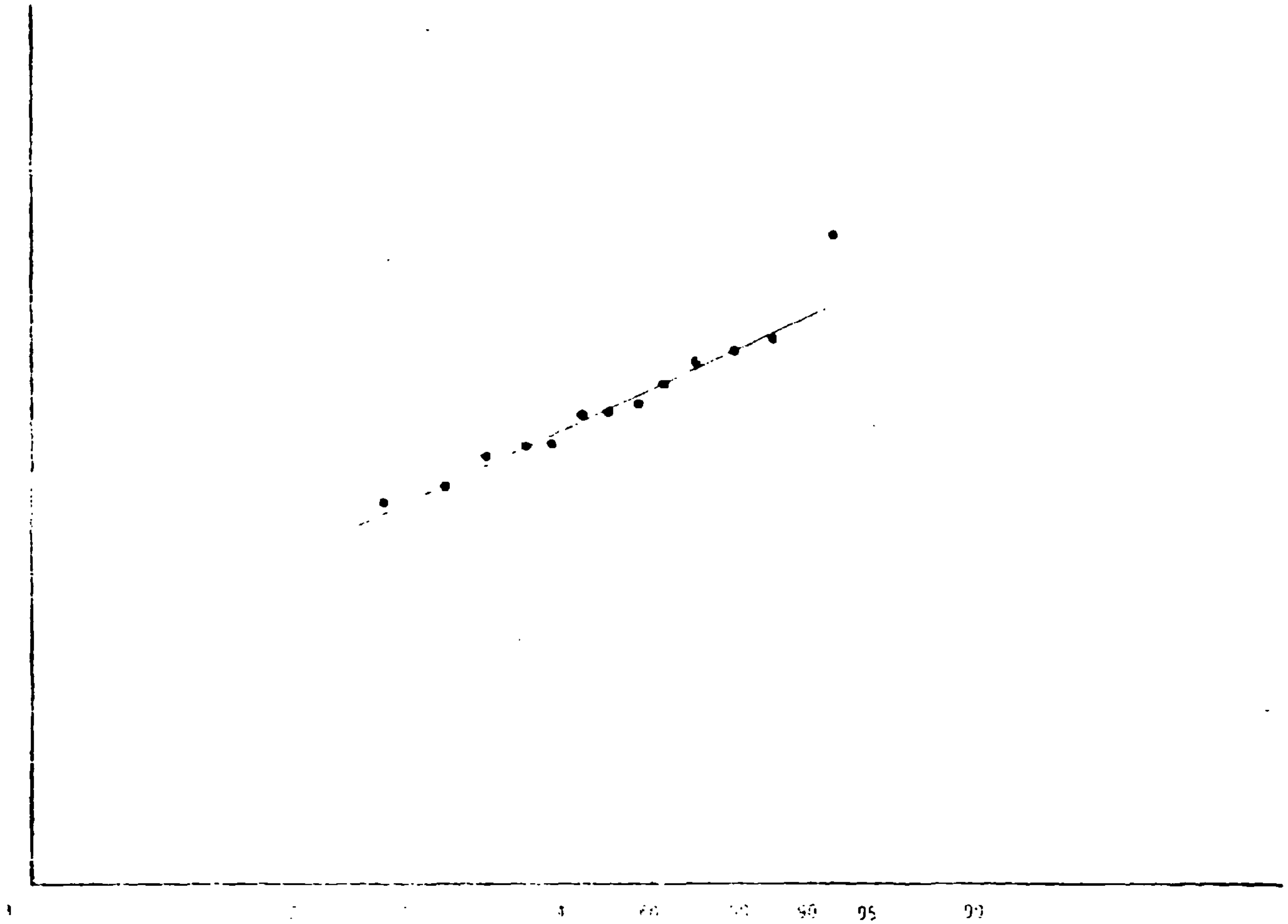
FIGURE 115

[illegible]
[illegible] PROBABILITY DIAGRAM

DRAFT



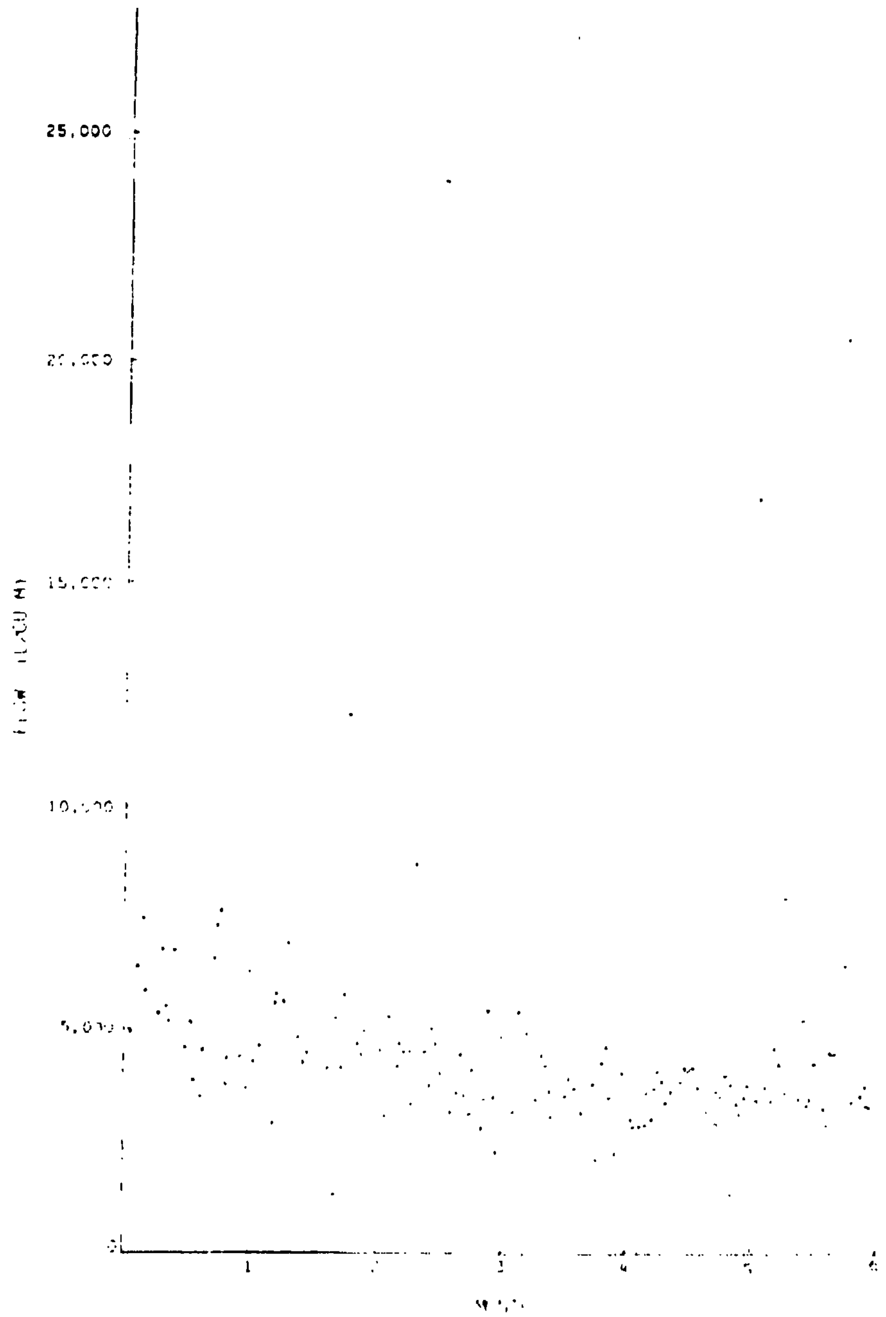
[illegible]



[illegible]

FIGURE 117

[illegible]
[illegible] ILITY DIAGRAM



F[illegible]

DAILY [illegible]ILITY
PLANT [illegible]

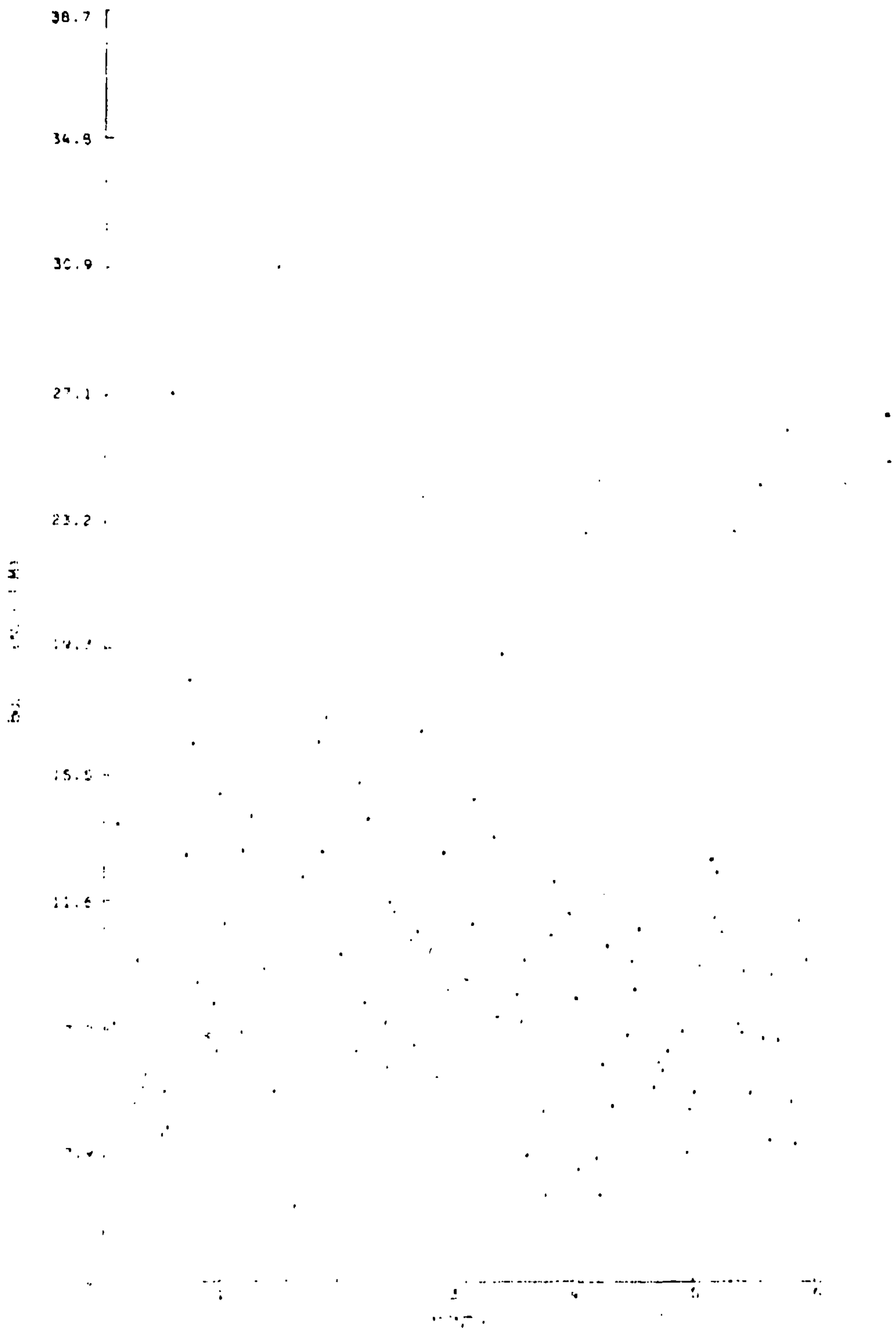


FIGURE 119

DAILY BOD VARIABILITY

FIGURE [illegible]

DAILY SUSPENDED SOLIDS VARIABILITY

DRAFT

barrels) per day. Process waste and non-contact water are assumed to be separated. Based on these assumptions, the model plant is defined as follows:

Flow (MGD)	2.2
BOD (mg/l)	1900
SS (mg/l)	700
Total KN	40
pH	2 to 12

SUBCATEGORY A 17 - OLD LARGE MALT BEVERAGE BREWERIES

The methodology for determining wastewater characteristics for this subcategory was the same as for Subcategory 16.

Process Waste Streams

Management questionnaires were available for three of the four brewers in this subcategory. From the questionnaire responses and from plant visits the following generalizations can be made. Due to the original design of breweries in this subcategory there is a tendency for spent wet grains to be sold and for spent grain liquor to be sewered instead of evaporated. Spent hops, trub, and yeast are generally added to the wet spent grains, while lost beer, filter aid, and caustic are usually sewered.

Combined Process Flow

Data for breweries in this subcategory are itemized and summarized in Table 35. Scatter diagrams of flow, BOD, and suspended solids ratios versus production are plotted in Figures 121, 122, and 123. Log normal probability plots of flow, BOD, and suspended solids ratios are illustrated in Figures 124, 125, and 126. Age of facilities and efficiency of operation result in higher raw wasteloads for this subcategory. Smaller tankage is common, thus causing more water to be used in cleaning operations. Collection and disposition of wastes is made more difficult by old and intricate piping.

Model Plant

The raw waste load for this [illegible] are based on the mean values presented in Table 35. The [illegible] was calculated to be 2600 cu m (2,[illegible] barrels) per [illegible]. Process waste and non-contact [illegible] are assumed to be separated. [illegible] on these assumptions the model [illegible] is defined as follows:

Flow [illegible]	[illegible].5
[illegible]	1[illegible]00
SS (mg[illegible]	[illegible]
Total [illegible]	[illegible]
pH	2 to 12

DRAFT

TABLE 35

WASTEWATER CHARACTERISTICS SUBCATEGORY A17 (OLD LARGE BREWERIES)

Plant	Flow Ratio (l/cu m)	BOD Ratio (kg/cu m)	SS Ratio (kg/cu m)	Reliability Number
82F04	14,700	18.9	9.62	5
82H36	9380	-	-	0
82G46	9870	20.9	7.85	2
82G64	10,200	16.7	4.64	2
Mean	11,000 (11.0 bbl/bbl)	18.8 (4.87 lbs/bbl)	7.34 ([illegible].90 lbs/bbl)	

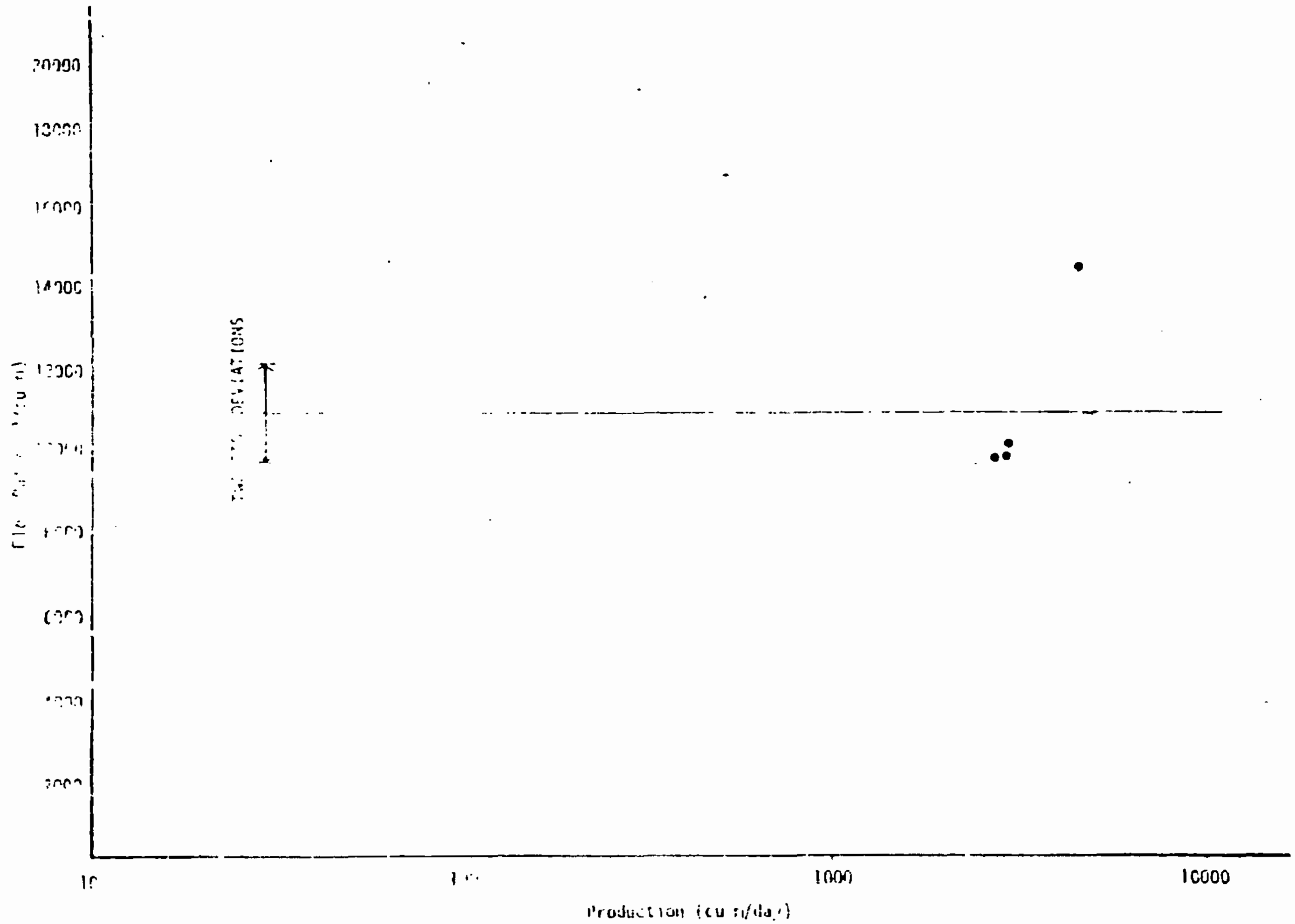


FIGURE 121

SUBCATEGORY A 17
FLOW VS CAPACITY

DRAFT

FIGURE 122

SUBCATEGORY A 17
[illegible]

DRAFT

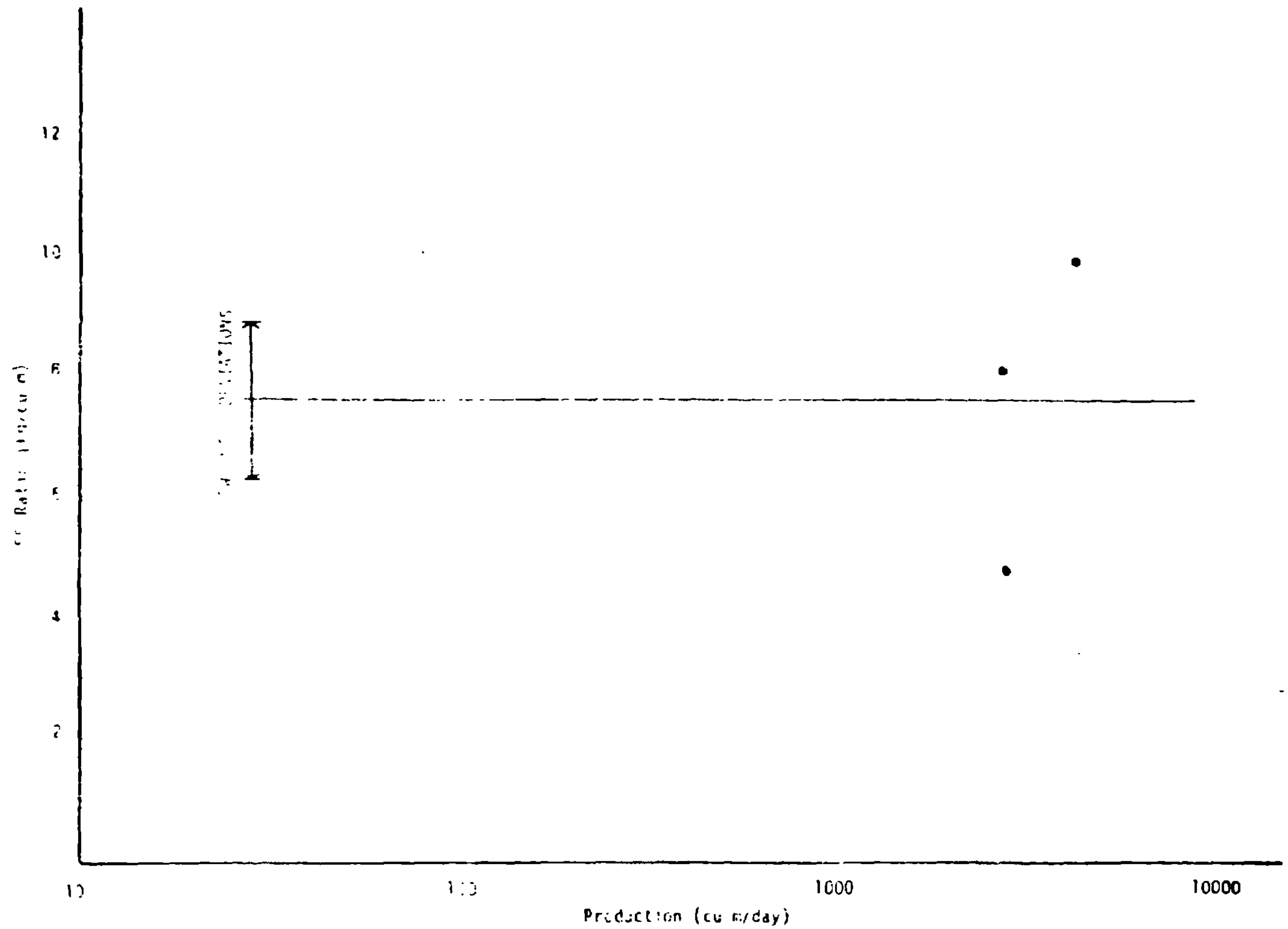


FIGURE 123

SUBCATEGORY A 17
SUSPENDED SOLIDS VS CAPACITY

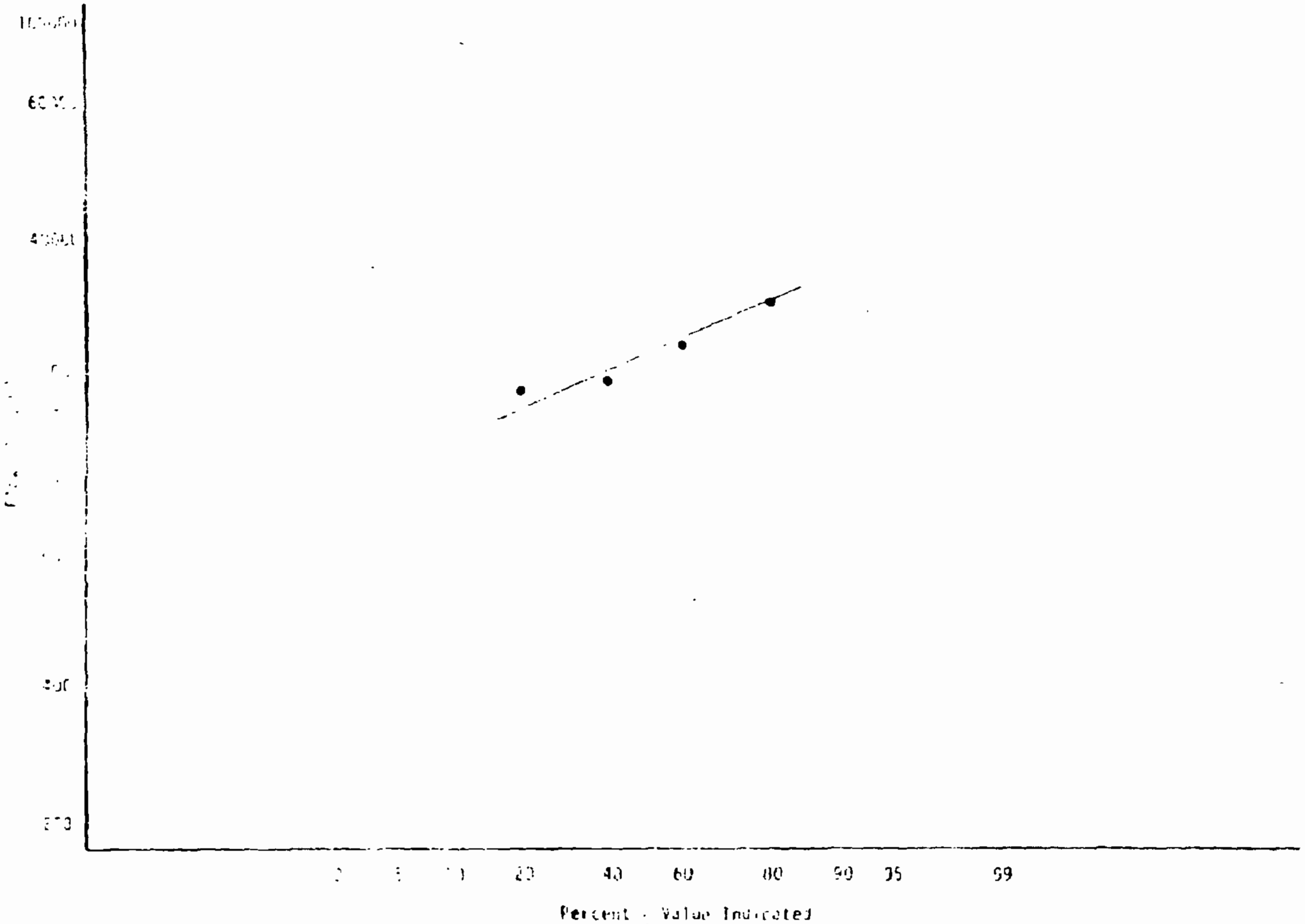


FIGURE 124

SUBCATEGORY A 17
FLOW PROBABILITY DIAGRAM

DRAFT

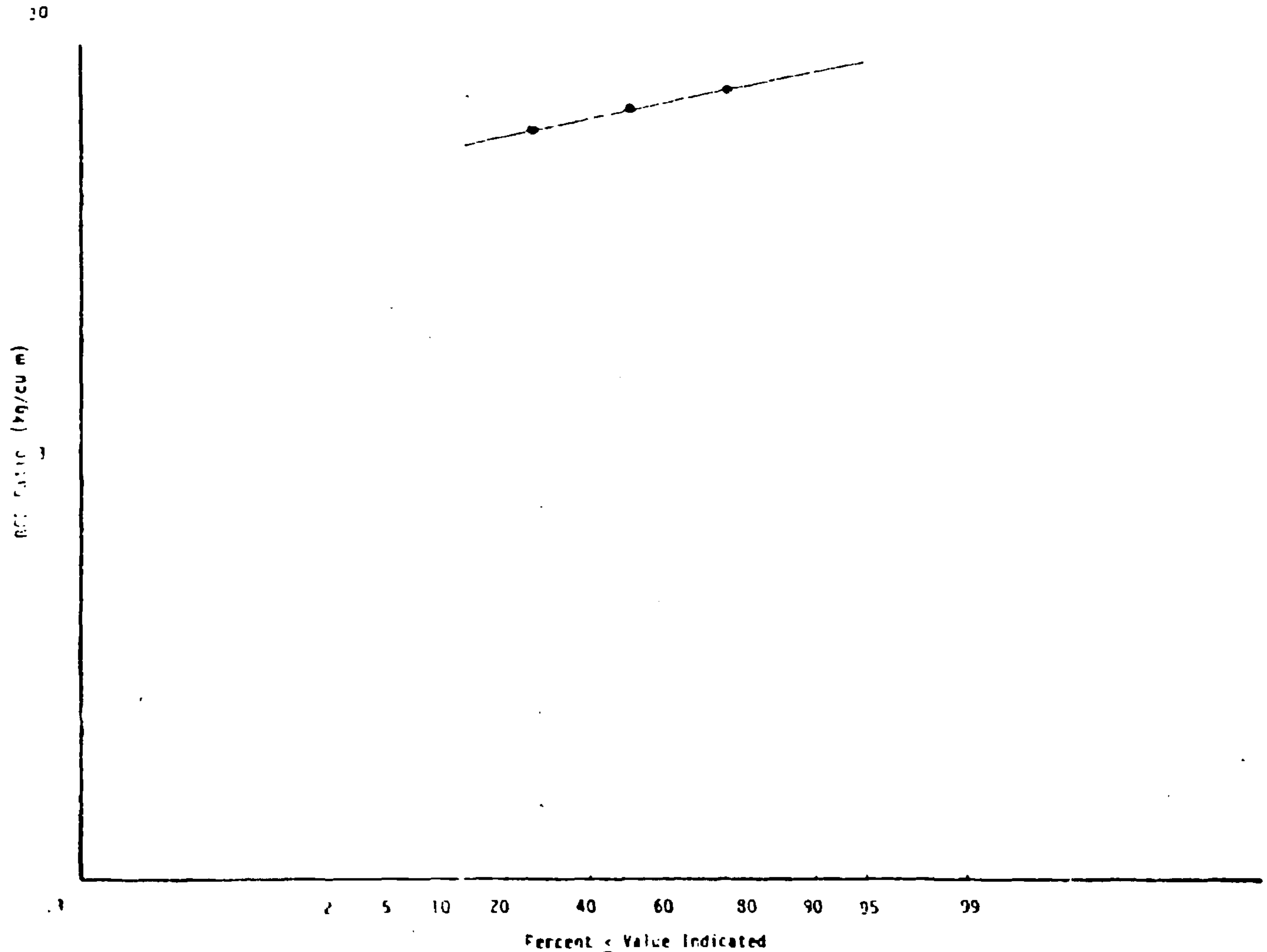


FIGURE 125

SUBCATEGORY A 17
BCD PROBABILITY DIAGRAM

DRAFT

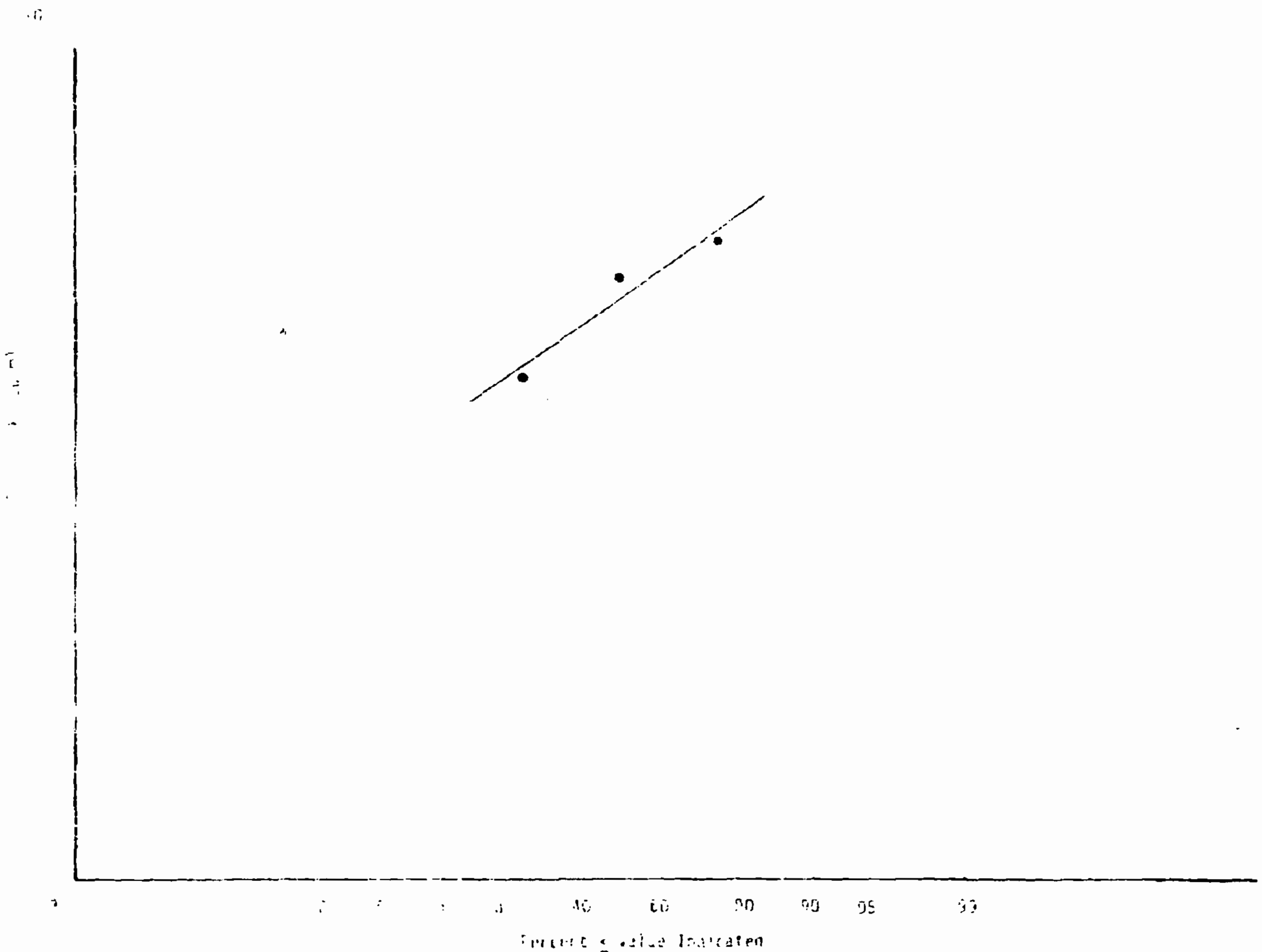


FIGURE 126

SUBCATEGORY A 12
[illegible] SOLIDS PROBABILITY DIAGRAM

DRAFT

SUBCATEGORY A 18 - ALL OTHER MALT BEVERAGE BREWERIES

The methodology for determining wastewater characteristics for this subcategory was the same as for Subcategory A 16 and A 17.

Process Waste Streams

Management questionnaires were not completed by all breweries in this subcategory hence no comprehensive analysis of methods of disposal is possible. The constituency of the process streams remains identical to that described in Subcategory A 17.

Combined Process Flow

Eighty-five breweries are included in this subcategory. The 27 plants not responding to the USBA survey form part of this group. Twenty-five plants responding, but reporting no data, are also included in this group. Data for those breweries responding is itemized and summarized in Table 36. Only six of these breweries have a reliability rating of four or higher. The standard deviation for the group is quite high, indicating the lack of a definitive data base. Scatter diagrams of flow, BOD, and suspended solids ratios verus production are plotted in Figures 127, 128, and 129. Log normal probability plots of flow, BOD and suspended solids ratios are illustrated in Figures 130, 131, and 132.

Model Plant

The raw waste loads for the model plant are based on the 80 percent values for this subcategory as presented in Table 36. This assumption took into account the statistical variance of the group in addition to the fact that those six plants with reliable data tended to exceed the mean in several cases. The average production for this subcategory was calculated to be 470 cu m (4000 barrels) per day. Process waste and non-contact water are assumed to be separated. Based on these assumptions the model plant is defined as follows:

Flow (MGD)	1.2
BOD (mg/l)	14[illegible]
SS (mg/l)	[illegible]
Total N	30
pH	[illegible] to 12

SUBCATEGORY A 19 - MALT

In order to determine the wastewater characteristics of this industry a survey was conducted of all known maltsters. Three plants were visited, two plants were sampled, and a search was made for any existing historical data.

Process Waste Streams

As far back as 1935 Ruf (61) identified steeping and germinating as the primary and secondary waste sources, respectively, from a malt house.

DRAFT

TABLE 36

WASTEWATER CHARACTERISTICS
SUBCATEGORY A 18

PLANT	FLOW RATIO (l/cu m)	BOD RATIO (kg/cu m)	SS RATIO (kg/cu m)	RELIABILITY NUMBER
82J59	4300	9.05	1.62	8
82K32	920	2.20	0.27	6
82K44	6810	9.82	6.26	7
82K50	3710	7.50	1.93	7
82K55	4100	7.42	2.55	6
82L03	9700	15.08	5.03	1
82L10	4630	1.66	1.04	1
82L14	2820	6.88	2.94	1
82L17	12900	19.34	9.40	1
82L20	8990	1.66	0.19	1
82L21	5380	28.35	0.89	1
82L23	3110	10.71	4.95	4
82L24	3720	8.62	2.98	2
82L25	7190	5.99	1.47	1
82L26	760	5.76	1.24	2
82L27	18060	8.97	5.68	1
82L28	66020	2.55	1.66	1
82L29	1030	5.41	1.55	1
82L33	4160	1.70	1.01	1
82L40	1660	1.66	0.54	1
82L42	4690	14.93	4.76	2
82L45	6450	14.31	6.36	1
82L47	4810	4.10	-.81	2
82L48	6500	0.66	0.39	1
82L57	11730	5.88	15.82	1
82L60	21510	15.47	6.46	1
82L65	7650	5.45	[illegible]	3
82L68	2470	3.40	0.65	1
82L74	10860	10.32	4.[illegible]	3
82M12	3910	----	----	0
82M13	10750	----	----	0
82M15	5960	----	----	0
82M18	3010	----	----	0
82M19	1130	----	----	0
82M22	----	----	----	0
82M30	7460	0.04	[illegible]	0
82M31	1090	----	----	0
82M34	810	2.32	3.[illegible]	0
82M37	----	----	----	0
82M38	----	----	----	0
82M39	----	----	----	0

DRAFT

TABLE 36 (CONT'D)

PLANT	FLOW RATIO (l/cu m)	BOD RATIO (kg/cu m)	SS RATIO (kg/cu m)	RELIABILITY NUMBER
82M41	11750	-----	-----	0
82M49	-----	-----	-----	0
82M51	-----	-----	-----	0
82M52	6620	-----	-----	0
82M53	5280	-----	-----	0
82M54	-----	-----	-----	0
82M65	4900	-----	-----	0
82M67	8310	-----	-----	0
82M69	-----	-----	-----	0
82M70	9160	5.41	2.44	0
82M71	190	0.50	0.04	0
82M72	9220	6.61	3.33	0
82M73	-----	-----	-----	0
82M75	12900	-----	-----	0
82M76	15240	-----	-----	0
82M77	3440	-----	-----	0
MEAN	(7710 l/bbl)	(8.47 l/bbl)	(3.64 l/bbl)	
80 Percent Value	10000	13.53	6.19	
	(10.0bbl/bbl)	(3.5bbl/bbl)	(1.00bbl/bbl)	

DRAFT

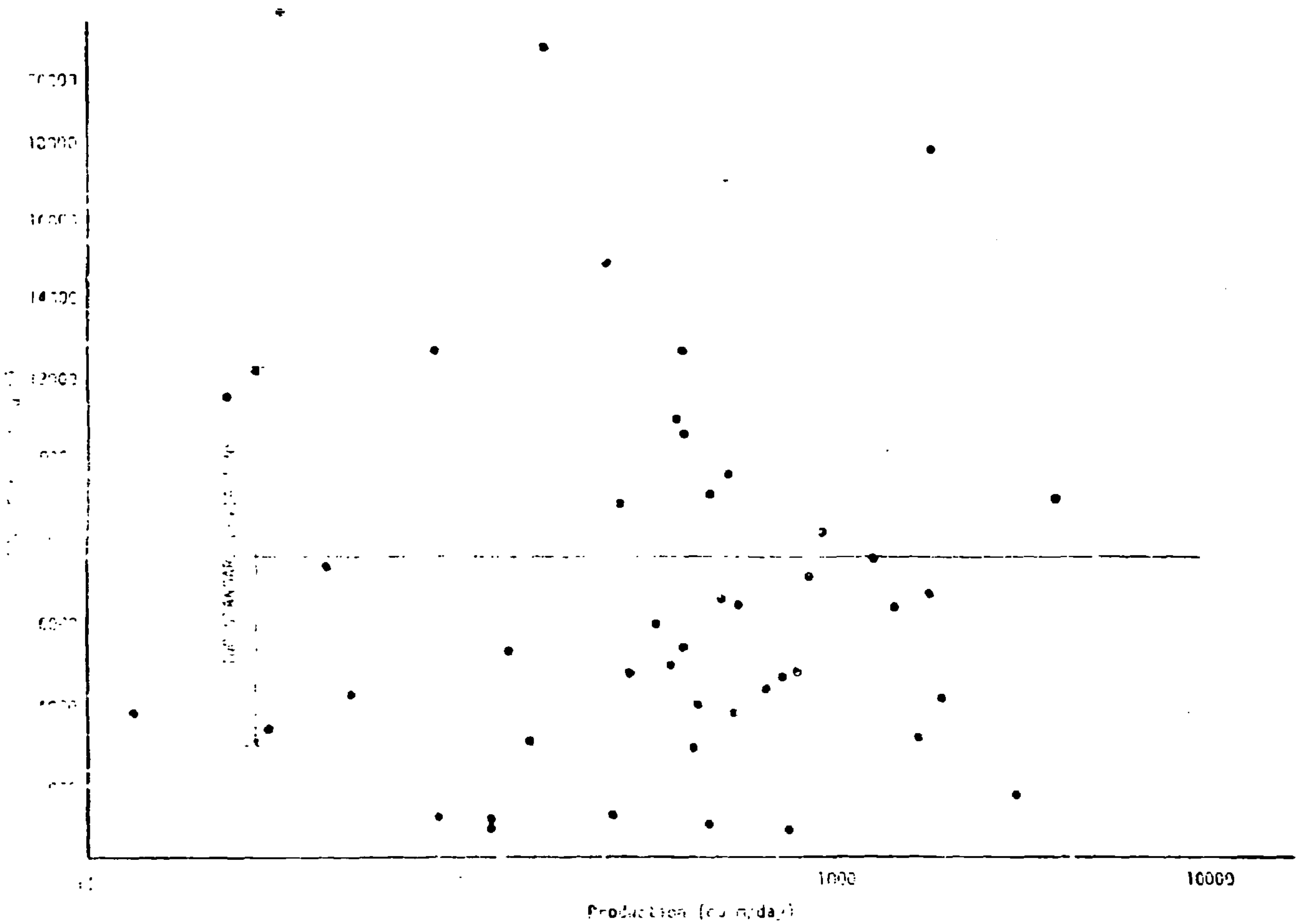


FIGURE 127

[illegible]
[illegible]

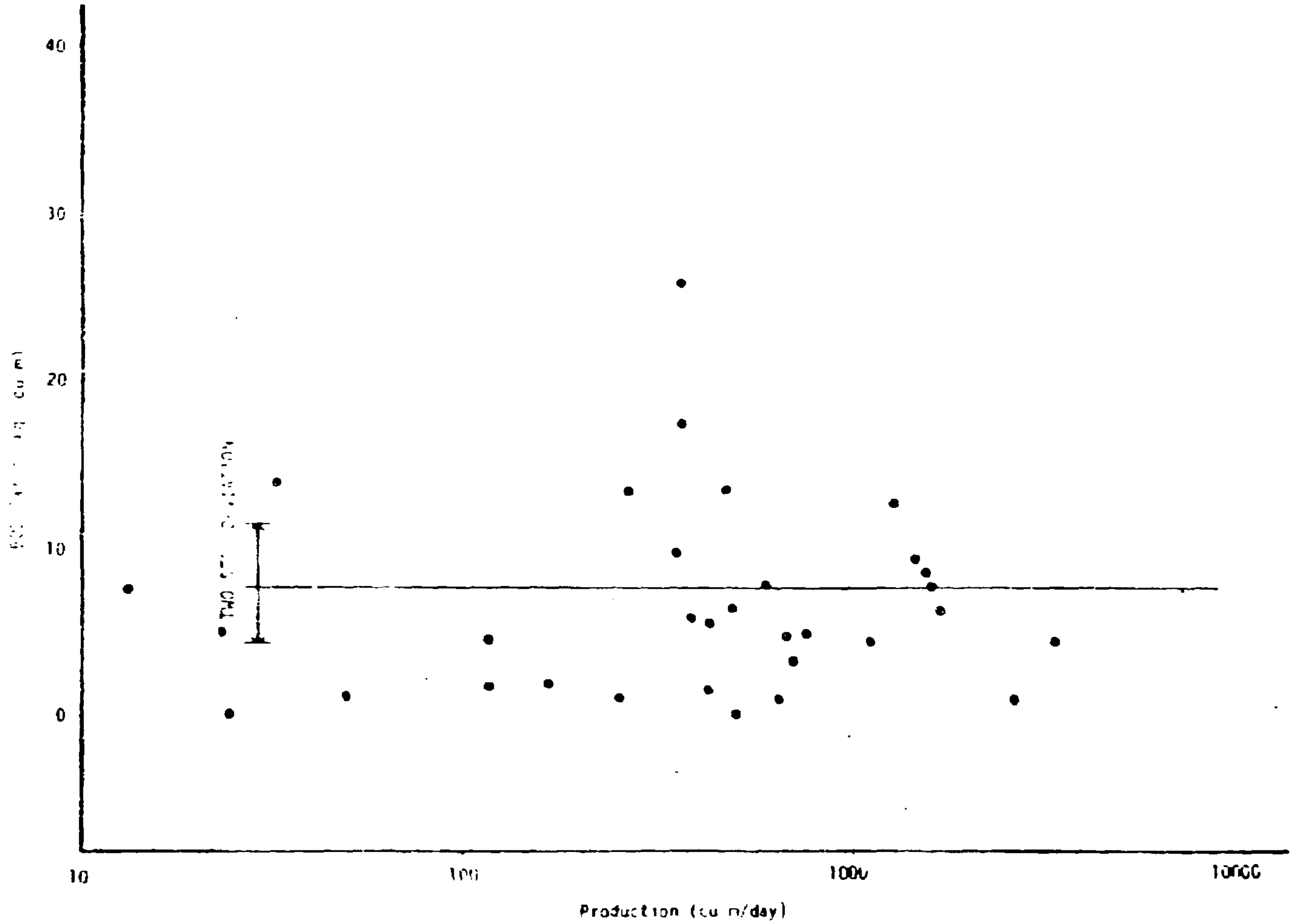


FIGURE 128

SUBCATEGORY A 18
BOD VS CAPACITY

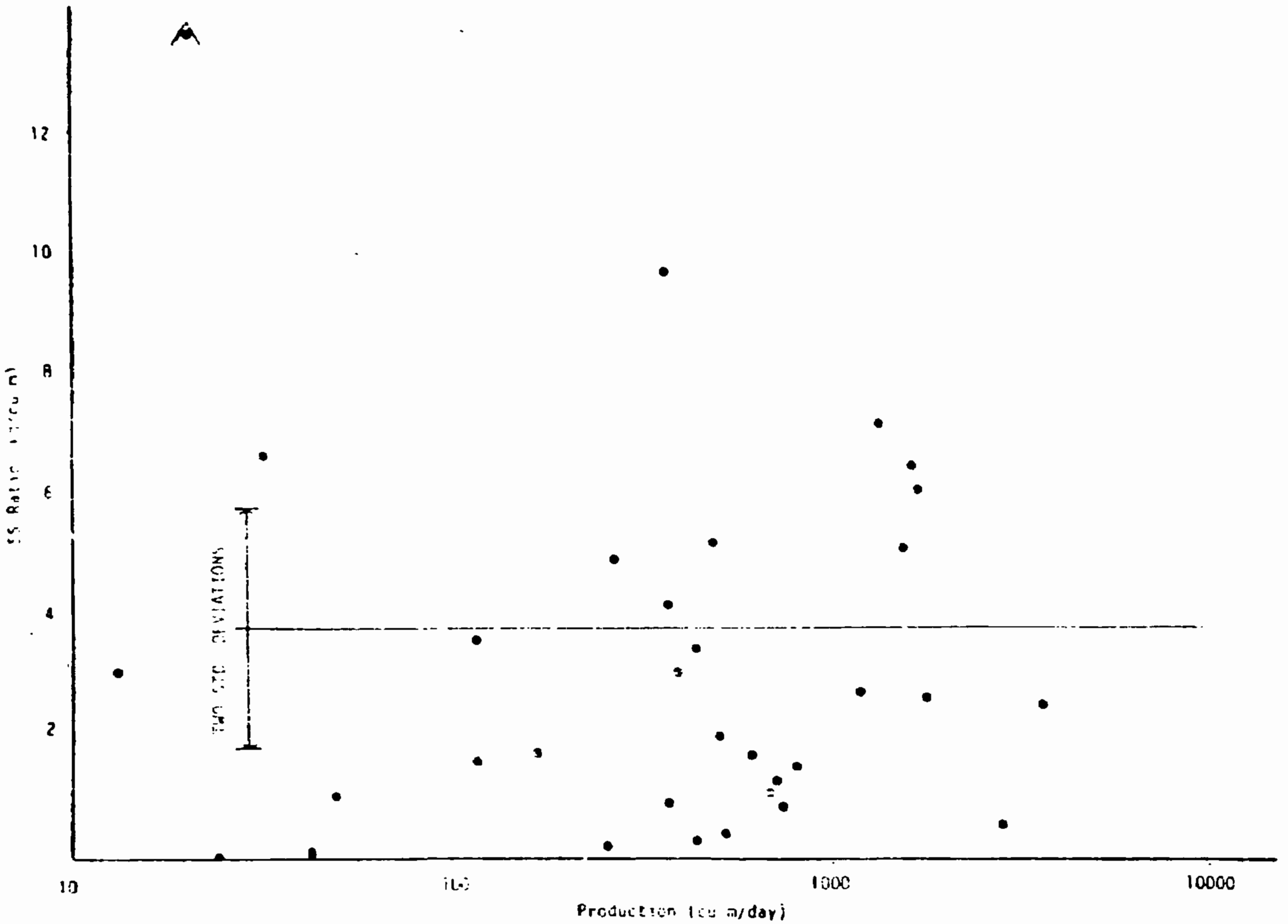


FIGURE 129

SUBCATEGORY A 18
[illegible] CAPACITY

DRAFT

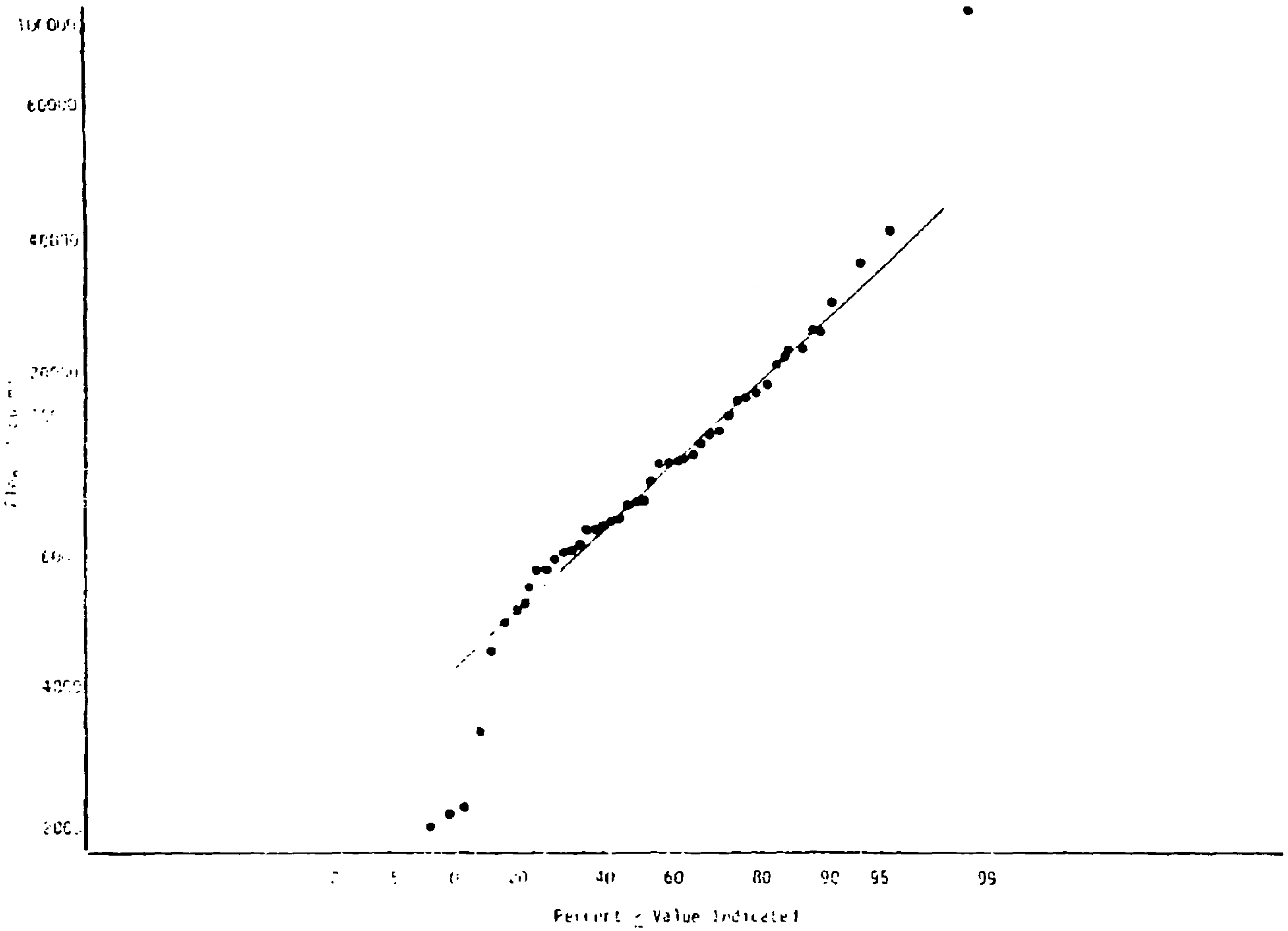


FIGURE 130

SUBCATEGORY A 18
FLOW PROBABILITY DIAGRAM

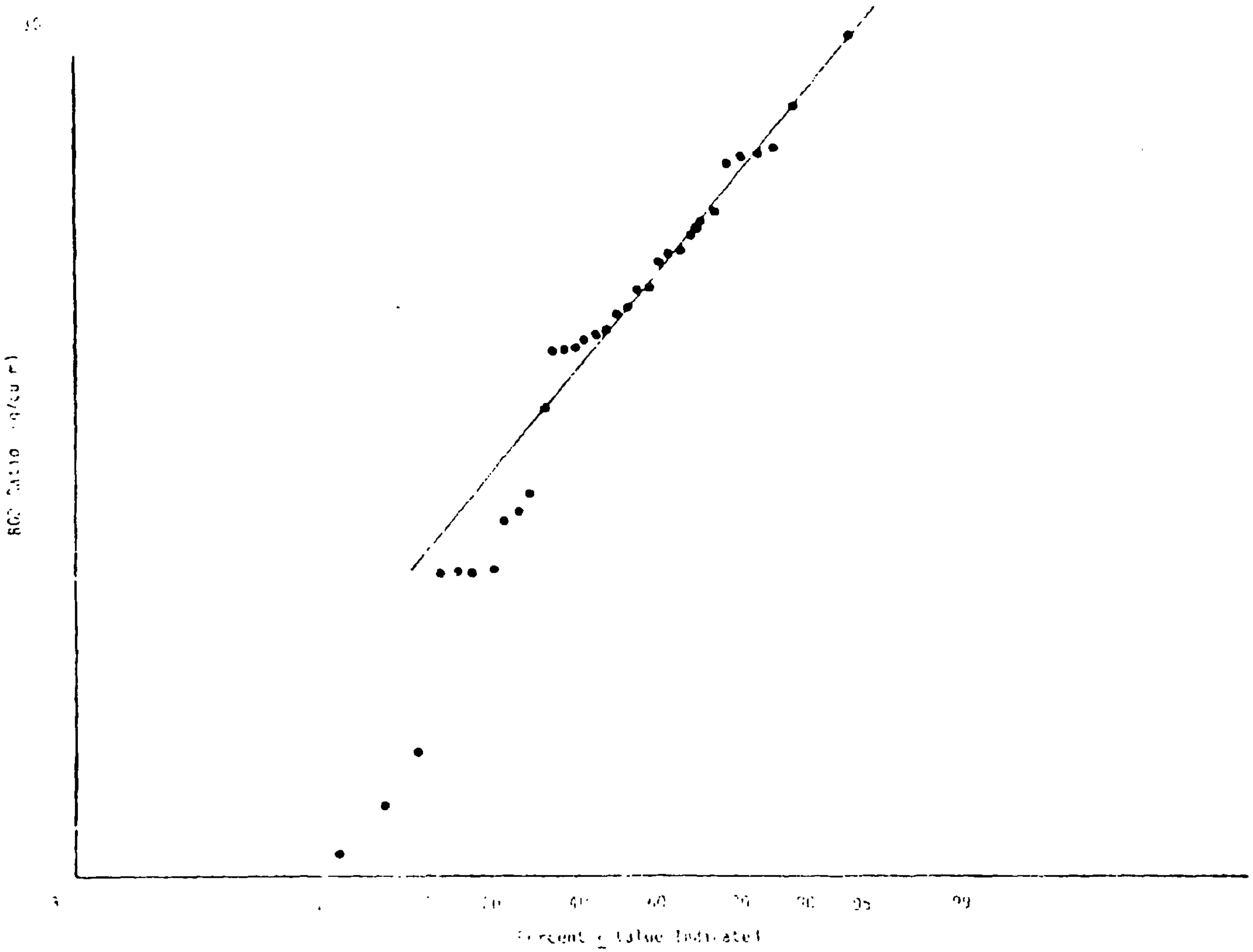


FIGURE 131

SUBLATERAL A 18
BOD PROBABILITY DIAGRAM

DRAFT

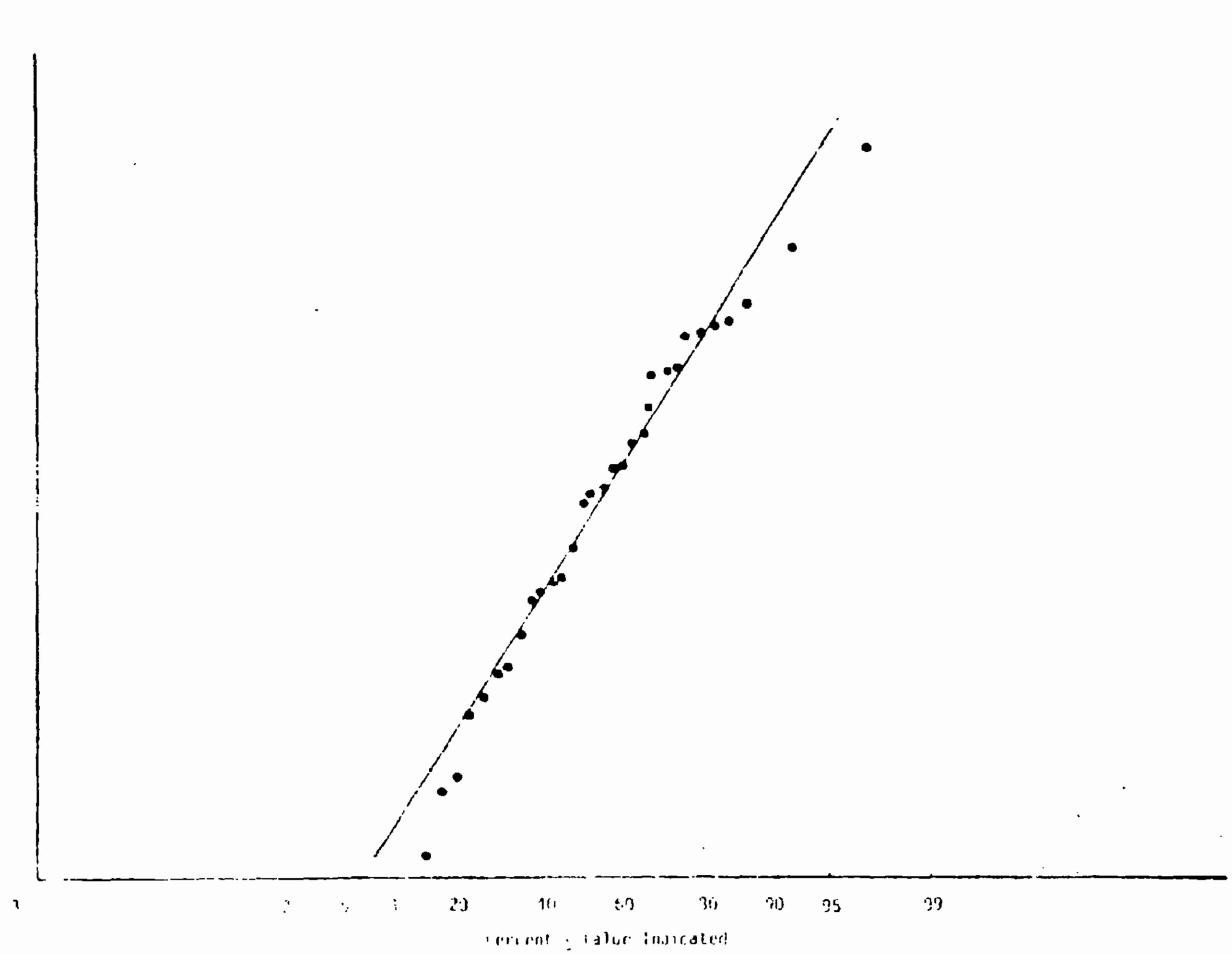


FIGURE 132

SUBCATEGORY A 18
SUSPENDED SOLIDS PROBABILITY DIAGRAM

DRAFT

According to Isaac (62) the steep liquor is a strong, deeply colored, putrescible liquid which may contain high levels of suspended solids. The quantity and quality of steep liquor varies according to the number of steep water changes and according to the contact time for each change. In general, the strength of the waste (as measured by BOD) decreases approximately 75 percent from the first to the last steep. This is illustrated by data from Isaac (62) and Simpson (63) presented in Table 37.

Wastes from germination are known to be smaller in volume and concentration than those from steeping, although insufficient data is available to establish a specific proportion between the two.

Combined Process Flow

The significant parameters for this industry are flow, BOD, and suspended solids. The ratios of these parameters to the number of barley bushels processed were calculated for each of the 18 plants which responded to the industry survey. These responses are itemized and summarized in Table 38. In addition, a reliability number was assigned to each plant based on the method and duration of sampling as follows:

Reliability 1 - 24 hour flow proportional sampling for 5 consecutive days or more.

Reliability 2 - 24 hour flow proportional sampling for less than 5 consecutive days.

Reliability 3 - Flow metered, grab samples.

Reliability 4 - Flow estimated, grab samples.

A separate arithmetic mean was calculated for those plants with reliability numbers 1 and 2. A log mean was calculated to check the distribution of the data.

In order to demonstrate the variability of malt waste, one plant was selected which had conducted several periods of five-day, 24-hour, flow proportional sampling. Table 39 gives the results of those tests with the standard deviation for each measured parameter.

Malting effluents can be characterized as consisting of highly soluble organic materials. Based on the even distribution of high reliability plants throughout the spectrum of production in the industry, it is felt that the following levels are typical.

BOD Ratio	4.55 kg/kkg (0.218 lb/bu)
SS Ratio	0.770 kg/kkg (0.0369 lb/bu)
Flow Ratio	7410 l/kkg (42.6 gal/bu)

The pH of the waste varies between 6.0 and 8.0 as reported by Isaac (62). The waste is deficient in nitrogen, a fact which was confirmed by wet sampling at plant 83A13.

DRAFT

TABLE 37

ANALYSES OF MALTING STEEP WATER WASTES

BOD CONCENTRATION (mg/l)

Plant Designation	A	B	C	D	E	F
1st Steep	960	1100	750	2800	1900	2750
2nd Steep	920	900	890	2250	1630	1300
3rd Steep	185	700	400	1900	1890	1800
4th Steep	254	140	50	490	450	870

DRAFT

TABLE 38

RESULTS OF MALT INDUSTRY WASTEWATER SURVEY

PLANT	FLOWR	BODR	SSR	RELIABILITY
83A02IS9	11,800	7.29	0.446	2
83A07IP9	8,780	4.41	1.45	4
83A08IP9	682	0.459	0.0914	4
83A09IS9	7,080	6.05	0.892	3
83A12IP9	6,240	3.74	0.543	4
83A13IS9	6,960	5.29	0.586	2
83A15IP9	6,240	2.72	0.713	3
83A19IS9	4,430	3.43	0.625	2
83A22IP9	6,180	3.52	0.506	4
83A25IP9	9,700	4.03	0.928	1
83A27IS9	10,800	14.59	5.52	4
83A28IS9	31,100	3.66	1.80	2
83A29IP9	11,300	5.44	1.14	2
83A30IP9	5,690	3.16	0.171	2
83A31IP9	4,580	2.93	0.458	2
83A32IP9	4,190	2.92	0.477	4
83A33IP9	5,570	3.37	0.885	4
83A34IP9	5,210	4.84	0.836	2
MEAN (ALL)	8,140 l/kkg 46.8 gal/bu	4.60 kg/kkg 0.221 lb/bu	1.00 kg/kkg 0.048 lb/bu	
MEAN (1,2)	*7410 l/kkg 42.6 gal/bu	4.55 kg/kkg 0.218 lb/bu	0.770 kg/kkg 0.036 lb/bu	
LOG-MEAN (ALL)	6460 l/kkg 37.1 gal/bu	3.70 kg/kkg 0.177 lb/bu	0.682 kg/kkg 0.033 lb/bu	

* Calculated without Plant 83A28 which had combined process and cooling water.

DRAFT

TABLE 39

DAILY VARIABILITY OF MALT WASTE

DAY	FLOW (MGD)	FLOWR (l/kkg)	BOD (MG/l)	BODR (kg/kkg)	SS (MG/l)	SSR (kg/kkg)
1	0.365	9,210	485	4.43	92	0.843
2	0.373	9,420	475	4.44	59	0.552
3	0.365	9,210	300	2.74	125	1.14
4	0.378	9,560	370	3.51	90	0.850
5	0.444	11,200	451	5.01	113	1.26
MEAN	0.385	9,700	416	4.03	95.8	0.928
STD. DEVIATION	0.0334		79.1		25.3	

Model Malt Plant

For the purpose of developing control and treatment technology and for conducting cost analyses a model plant has been designed. The model plant for Subcategory A 19 operates 24 hours per day, 365 days per year. It processes 350 kkg (16,000 bu) of barley per day based on the mean production of those plants surveyed. Suspended solids in the waste, consisting mostly of grain and sprouts, are assumed to be removed by screening prior to discharge. Non-contact and process water are assumed to be separated. Based on the above ratios the model plant has the following wastewater characteristics:

Flow (MGD)	0.625
BOD (mg/l)	615
SS (mg/l)	104
Total KN (mg/l)	17
Total P (mg/l)	7
pH	6 to 9

SUBCATEGORY A 20 - WINERIES WITHOUT STILLS

In order to determine the wastewater characteristics for the wine industry (Subcategories A 20 and A 21) 11 wineries were visited, 5 wineries were sampled, and an extensive literature search was conducted.

A short discussion of the methodology to be used in this section is required. Basically, a building block approach will be used. First, wineries without stills will be described. Since many wineries in New York discharge to navigable waters and since wineries in California do not, the raw waste and effluent monitoring in New York were understandably more extensive. For this reason wastewater characteristics for wineries without stills rely heavily on New York data. Second, wineries with stills will be described. These wineries are all located in California. They produce the same wastewater as wineries without stills plus wastewater associated with stillage. Since the characteristics of stillage are fairly well defined, the total effluent for wineries with stills during crushing will be the sum of the wastewater produced by distilling added to the wastewater produced by wineries without stills. During the processing season all wineries will be assumed to operate with the same wastewater characteristics except as noted.

Process Waste Streams

The percentage of wastewater that each unit process contributes to the total winery effluent has not been well documented. As identified in Section III the sources of wastewater during processing are as follows: lees, or washdown of filter presses or centrifuges with lees and filter aid residue; fermenter washdown; finishing tank washdown; aging tank washdown; transfer hose, pipeline, and pump washdown; boiler and cooling tower blowdown; water conditioning and regeneration rinses; and general winery sanitation. During crushing, wastewater may be generated from all of the above plus crusher/stemmer and pomace press washdown.

Combined Process Flow

It is recognized that wastewater characteristics differ during the crushing and processing season. For that reason waste loading has been separately correlated to kkg (tons) of grapes crushed and to cu m (gallons) of wine produced. The ratio of flow, BOD, and suspended solids to grapes crushed for four New York wineries is presented in Table 40. Three of these four wineries have 24 hour flow proportional sampling with daily COD and weekly BOD analyses. Based on the weighted mean for these wineries, it is felt that the following ratios are typical for a winery without stills during crushing:

Flow Ratio (l/kkg)	BOD Ratio (kg/kkg)	SS Ratio (kg/kkg)
1528 (365 gal/ton)	3.57 (7.14 lb/ton)	1.16 (2.32 lb/ton)

It is noted that although these values are derived from New York wineries they apply equally well to California wineries which are estimated to produce wastewater during crushing at 2.1 kg/kkg (4.2 lb/ton) (64).

Wastewater generated during processing has been correlated to finished wine produced. The flow, BOD, and suspended solids to wine produced ratios are presented in Table 41. Based on the weighted mean for these wineries it is felt that the following ratios are typical for a winery without stills during processing.

Flow Ratio (l/cu m)	BOD Ratio (kg/cu m)	SS Ratio (kg/cu m)
5510 (5510 gal/1000 gal)	6.63 (55.3 lb/1000 gal)	2.33 (19.4 lb/1000 gal)

Here again the values correlate to estimates from California wineries of 2.96 kg/cu m BOD and 0.6 kg/cu m suspended solids, since the product of the New York wineries has been increased by amelioration and blending.

Other parameters which are significant for treatment system design are pH, nitrogen, and phosphorus. In general the pH varies annually from 4.0 to 10.0 with a daily average of 7.9. Based on over 100 samples from plants 84*02 and 84*03 the waste can be characterized as deficient in both nitrogen and phosphorus. BOD/N ratios vary from 78:1 to 690:1 with those during crushing being somewhat higher than those during processing. BOD/P ratios remain fairly consistent between 152:1 and 208:1.

DRAFT

TABLE 40

RAW WASTE CHARACTERISTICS DURING CRUSHING WINERIES WITHOUT STILLS

Plant	Flow Ratio (l/kkg)	BOD Ratio (kg/kkg)	SS Ratio (kg/kkg)	Number of Samples
84E01	1,970	3.42	1.47	12
84E02	7,290	4.96	1.57	16
84E03	1,087	2.88	0.44	16
84E04	1,090	3.03	0.32	5
Mean	1,380*	3.57	0.95	
Log Mean	2,000	3.64	0.76	
Weighted** Mean	1,528	3.57	1.16	
	(365 gal/ton)	(7.14 lb/ton)	(2.32 lb/ton)	

* Calculated without plant 84E02 which has combined process and cooling water.

** Excludes FLOWR and SSR for plant [illegible] due to method of sampling.

DRAFT

TABLE 41

RAW WASTE CHARACTERISTICS DURING PROCESSING
WINERIES WITHOUT STILLS

Plant	Flow Ratio (l/cu m)	BOD Ratio (kg/cu m)	SS Ratio (kg/cu m)	Number of Samples
84A01	7,280	14.1	4.70	36
84A02	12,400	6.35	1.52	47
84A03	2,940	6.91	0.79	65
84A04	1,290	30.4	4.05	5
Mean	3,840*	14.4	2.76	
Log Mean	4,300	11.7	2.19	
Weighted** Mean	5,510	6.63	2.33	
	(5,510 gal / 1,000 gal)	(55.3 lb / 1,000 gal)	(19.4 lb / 1,000 gal)	

* Calculated without plant 84E02 which has combined process and cooling water.

** Calculated without plant 84A04 due to size and method of sampling. Labor calculated without plant 84A01 due to in-plant reduction required (See Section VII).

DRAFT

Model Plant

For the purposes of control and treatment technology and cost analysis a model plant has been designed. The production for wineries without stills during crushing is 180 kkg (200 tons) per day based on average operating levels for New York and California wineries. The production during processing is 41 cu m (10,800 gal) of finished wine based on the average for New York wineries. It is recognized that this figure may be a little higher than California wineries without stills due to the practice of New York wineries to blend in up to 25 percent of California wines; i.e., a typical California production during a 70 day season would be 25 cu m (6,730 gal). Based on this production level the raw waste loads for the model plant are as follows:

	Crushing	Processing
Flow (MGD)	0.0730	0.060
BOD (mg/l)	2300	1200
SS (mg/l)	760	420
Total KN mg/l)	7	4
Total P (mg/l)	13	7
pH	4 to 10	4 to 10

The following process operations are assumed:

1) Stems are considered a solid waste to be spread on vineyard property.

2) Pressed pomace may be used for distilling material, may be spread on vineyard property, or recovered as a by-product.

3) Diatomaceous earth (filter aid) is considered a solid waste to be spread on vineyard property.

4) No distilling takes place on premises.

5) Final effluent is screened to remove solids.

SUBCATEGORY A 21 - WINERIES WITH STILLS

As previously described, the wastewater for wineries in this subcategory will be the same as that for wineries without stills, plus the wastewater associated with stillage.

Process Waste Streams

As explained in Section III the raw material for distillation may be [illegible], pomace, or wine. Although stillage characteristics will vary with the source of distilling material, it can generally be classified as a high-strength organic waste with low pH. Typical values for different types of stillage are reported in Table 42 (65).

In order to determine the wastewater effluent due to stillage an average volume and concentration must be defined which will apply equitably to the wineries with stills. In order to calculate the average flow, data from 19 California wineries with stills was obtained to determine the average amount of distilling material produced per ton of grapes crushed.

This data is itemized in Table 43 (66). Based on this average of 746 l/kkg (179 gal/ton) the total quantity of stillage produced would be the amount of distilling material increased by 15 percent due to steam introduced in the still. The average volume of stillage per unit of grapes crushed, therefore, is 853 l/kkg (206 gal/ton). As acknowledged, the concentration of stillage varies depending on the type of distilling material used. Table 44 presents data from Skofis (67) and wet sampling at plant 84020 which has been used to verify the ranges of values expected. In both cases 24 hour flow proportional samples were taken for five or more days. Based on these data and that presented in the literature (68, 69) it is felt that typical values for stillage are as follows:

BOD (mg/l)	12,000
SS (mg/l)	14,000

By combining these values with the flow volume of 858 l/kkg (206 gal/ton) the ratios (pounds of pollutant to tons of grapes crushed) contributed by stillage are:

BOD	10.3 kg/kkg (20.6 lb/ton)
SS	12.0 kg/kkg (24.0 lb/ton)

Combined Process Flow

The total effluent during crushing for a winery with stills, then, is a combination of stillage and crushing wastes as shown below:

Due to Crushing	Due to Stillage	Total
Flow 1528 l/kkg (365 gal/ton)	859 l/kkg (206 gal/ton)	2390 l/kkg (571 gal/ton)
BOD 3.57 kg/kkg (7.14 lb/ton)	10.3 kg/kkg (20.6 lb/ton)	13.9 kg/kkg (27.7 lb/ton)
SS 1.16 kg/kkg (2.32 lb/ton)	12.0 kg/kkg (24.0 lb/ton)	13.6 kg/kkg (27.3 lb/ton)

As evidenced by these calculations, stillage contributes 36 percent of the flow and 74 percent of the BOD and suspended solids in winery waste during

DRAFT

TABLE 42

STILLAGE CHARACTERISTICS

	Conventional Stillage (mg/l)	Lees Stillage (mg/l)	Pomace Stillage (mg/l)
Total Solids	20,100	68,000	13,180
Volatile Solids	87.4	86.5	77.0
Suspended Solids	3,120	59,000	18,700
BOD	11,000	20,000	2,400
Total Acidity ($CaCO_3$)	3,170	9,870	1,220
pH	4.7	3.8	3.7-6.8
Total N	271	1,532	330
Total P	11,150	4,284	1,310

DRAFT

TABLE 43

DISTILLING MATERIAL PRODUCED PER TON OF GRAPES CRUSHED

Plant	Tons of Grapes Received	Gallons Distilling Material Produced	Gallons Distilling Material Per Ton of Grapes
(A)	79,633	21,659,432	270.968
(B)	58,448	22,532,405	385.500
(C)	53,514	7,898,299	147.592
(D)	34,187	6,768,076	197.99
(E)	50,488	14,292,949	283.00
(F)	39,769	10,334,742	259.868
(G)	24,480	7,460,034	304.74
(H)	208,603	12,271,927	58.828
(I)	45,909	10,275,021	223.812
(J)	17,846	2,620,889	146.86
(K)	131,381	33,995,334	258.754
(L)	27,822	5,061,980	181.93
(M)	113,050	7,323,023	64.776
(N)	34,520	8,148,219	236.043
(O)	28,869	4,207,161	145.732
(P)	26,800	[illegible]	77.620
(Q)	25,920	[illegible]	113.082
(R)	6,296	1,701,137	270.193
(S)	24,762	3,164,583	127.793
TOTAL	1,032,297	184,727,132	

$\frac{184,727,132}{1,032,297}$ = 17[illegible] [illegible] Gallons Distilling Material per Ton of Grapes Received

DRAFT

TABLE 44

STILLAGE CHARACTERISTICS

PLANT 84C80

Day	BOD (mg/l)	SS (mg/l)	N (mg/l)	P (mg/l)	pH
1	6,650	23,100	369	321	3.8
2	14,400	11,400	380	321	3.8
3	9,620	10,200	184	204	3.8
4	11,100	10,700	185	273	3.9
5	10,300	4,060	192	242	3.8
6	12,000	13,400	268	308	3.8
7	18,300	33,200	203	425	3.9
8	7,650	10,300	231	209	3.9
Average	11,300	14,500	250	288	3.8

DATA FROM SKOFIS

Day	BOD (mg/l)	SS (mg/l)	pH
1	12,008	5,289	3.98
2	14,211	3,784	3.92
3	9,926	6,384	3.89
4	13,864	2,096	3.82
5	13,650	2,916	3.95
Average	12,732	4,033	3.91

crushing. A winery with stills is assumed to have the same wastewater loads during processing as a winery without stills.

Model Plant

For the purposes of control and treatment technology and cost analysis a model plant has been designed. The production for wineries with stills during crushing is 700 kkg (776 tons) per day based on the average of the 19 wineries itemized in Table 43 over 70 days in 1974. The production per day during a 70 day processing season is estimated to be 91 cu m (23,900 gal).

Based on these production levels the raw waste loads for the model plant are as follows:

	Crushing	Processing
Flow (MGD)	0.422	0.132
BOD (mg/l)	5830	1210
SS (mg/l)	5750	424
Total KN (mg/l)	103	4
Total P (mg/l)	494	7
pH	3.5 to 6	4 to 10

SUBCATEGORY A 22 - GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS

In order to determine the wastewater characteristics for the distilled spirits industry (Subcategories A 22, A 23, A 24 and A 25) 39 plants were contacted to obtain existing historical data, 13 plants were visited, 3 plants were sampled, and a complete literature search was conducted.

Process Waste Streams

Extensive unit process research has been conducted in distilled spirits plants since the 1930's. As a result of this research, process waste streams can be defined quite accurately. Table 45 illustrates the percent of total plant wasteload attributable to each unit process as reported by plants 85A01 and 85A13 (70 and 71). These figures are reported merely to establish a general hierarchy of waste loading that is felt to be representative of the industry. Additional waste reduction measures employed by these plants since testing are reported in Section VII.

Feed Recovery - The major source of wastewater within the feed recovery plant is evaporator condensate. Evaporator condensate flows will vary based on mash concentration in the fermenters, percent of "backset," and beer still dilution. By reducing beer gallonage toward 110 l (29 gal) per bushel, the liquid load to the evaporators is reduced. By increasing the percent of "backset," less water must be added to obtain a given beer

TABLE 45

PROCESS WASTE STREAMS
GRAIN DISTILLERS WITH STILLAGE RECOVERY

Subcategory A 22

	Percent of Total Waste Load	
	Plant 85A01	Plant 85A13
Feed Recovery	79	75
Cooking-Mashing	12	11
Rectifying-Bottling	4	8
Distilling	1	2
Fermenting	1	1
Power House	2	2
Domestic	1	1
TOTAL	100	100

gallonage. By using a reboiler, either internal or external to the still, the amount of liquid added to spent stillage is reduced in comparison with liquid added by sparging live steam. The flow for evaporator condensate might vary between 97 l (15 gal) and 79 l (21 gal) per bushel. The concentration of the condensate (as measured by BOD in mg/l) varies mainly according to the design and operation of the evaporator. Data presented by Rullman in Table 46 (72) illustrates the range of values that might be expected. As reported by Hurst (73) Plant 35A04 has achieved BOD concentrations of 300 mg/l using a mechanical recompression evaporator. Results of other tests (74 and 75) indicate that BOD concentrations of from 600 to 300 mg/l are generally representative of the industry. An analysis of evaporator condensate from Plant 35A01 is shown in Table 47. The main constituents of the condensate are free organic acids, volatile with steam at reduced pressure and, hence, not included in total solids figures.

Both barometric and surface condensers are being used on evaporators in the industry. Flows for these discharges might vary between 380 and 570 l (100 and 150 gal) per bushel. BOD concentrations for barometric discharges are generally quite low depending on the quality of the intake water. The temperature of these discharges as they leave the plant might range from 83° to 99°C (180° to 210°F).

Barometric discharges are currently separated from process wastestreams and routed to surface waters. Wet scrubber discharge containing particulate from drum and/or grain dryers may constitute the secondary wasteload from feed recovery operations. Before their elimination, Plant 35A17 estimated these discharges at 27 percent (70) of the population equivalent for feed recovery. Several plants have installed cyclones to recover particulate for addition to feeds, thereby eliminating the wasteload.

Mashing - Cooking - Mash pressure cooking in batch cookers with vacuum cooling to malting temperature will produce approximately 7.6 l (2 gal) of condensate per bushel of grain mashed. Analyses at Plant 35A22 (72) indicate this condensate may average 900 mg/l BOD. The flow from continuous cookers would be some what higher. Here again, both barometric and surface condensers are employed in the industry. As indicated in Section III, cooling may be by shell and tube heat exchanger, thus reducing the wasteload.

Cooking vessel cleanup must also be taken into account. In most plants the mash will simply be washed to the following cook, then cleaned with caustic during the weekend. Unpumpable mash which is low in volume but high in BOD and suspended solids concentration will inevitably be sewered.

Rectifying - Bottling - As described in Section III, the potential wastes generated from rectifying are fusel oil column tails and rectifying column tails. A balance sheet for Plant 35A22 operating at 200 kkg (7200 bushels) per day with a grain neutral spirits unit

TABLE 46

VARIABILITY IN BOD CONCENTRATION OF GRAIN DISTILLERY EVAPORATOR CONDENSATE

SUBCATEGORY A 22

	Type of Evaporator	Remarks	BOD (mg/l)
A.	Standard short tube vertical type, triple effect and finishing pan, natrual circulation, basket type separators.	Operated at maximum capacity. Automatic level controls.	675
B.	Same as above.	Operated at 3/4 capacity	570
C.	Same as above.	Operated at 1/2 capacity	510
D.	Same as above.	Operated at 1/2 capacity, manual level controls.	300
E.	Standard vertical, quadruple effect and finishing pan. Forced circulation in 4th effect and finishing pan. Centrifugal separators.	1/2 capacity. Automatic level controls.	650
F.	Standard vertical, short tube, triple effect and finishing pan, natural circulation. Baffle type separators.	Full capacity. Manual controls.	1580
G.	Vertical long tube, outside colandria, triple effect and finisning pan. Natural circulation.	3/4 capacity. Semi-Auto level controls.	3210
H.	Same as above, after larger vapor bodies and basket type separators and automatic level controls installed.	3/4 capacity. Automatic level controls.	520

TABLE 47

ANALYSIS OF GRAIN DISTILLERY EVAPORATOR CONDENSATE

SUBCATEGORY A 22

Biochemical Oxygen Demand (BOD)	1,100
Total Solids (8.0 gms/100 l)	80
Ethyl Alcohol (0.04 Proof)	135
Aldehydes	Trace
Esters	Trace
Organic Acids, calc. as acetic	550
Fusel Oil, AOAC	Less than 10
Nessler Nitrogen	12
pH	3.6

consisting of aldehyde, rectifying, fusel oil, and vacuum columns is presented in Table 48 (72). As noted, discharges at the plant from the fusel oil column amount to approximately 7.6 l (2 gal) per bushel at 35 to 40 mg/l BOD, and discharges from the rectifying column approximately 38 l (10 gal) per bushel at 300 mg/l BOD. It should be noted that at these rates the waste load from rectifying would comprise more than four percent of the total plant load. Sobolov (76) indicates that gin process residues would be higher due to the presence of spent botanicals.

Bottling wastes, consisting of glue, paper, and alcohol, appear to be negligible.

Distilling - As noted in Section III, possible sources of waste from distilling are doubler discharge and beer still cleanup. If the doubler discharge is sewered then the approximate flow for a doubler raising proof from 115° to 130° would be calculated as follows (72):

One Bushel Mashed = Five Proof Gallon (Yield)
Five Proof Gallon = 4.35 Wine Gallons at 115 Proof
= 3.85 Wine Gallons at 130 Proof

One Bushel Mashed = 0.5 Gallons to Sewer

At these rates BOD concentration may be from 5000 to 6000 mg/l.

Beer still cleanup discharges will of course vary throughout the industry. Plant 35A01 has estimated 30,300 l (8000 gal) at 1500 mg/l BOD for a weekly water and caustic wash. Plant 35A30 (77) reports 38,000 l (10,000 gal) at 2500 mg/l BOD once per week.

Fermenting - Steam and water are normally employed to wash the mash into the still during processing. Weekend cleanups here again will comprise the major discharge. Plant 35A01 (74) has estimated fermenter wash at 3000 l (1000 gal) and 1000 to 2000 mg/l BOD.

Cleanup - Wastes from weekend cleanups are normally estimated and averaged on a daily basis to determine total plant discharges. In order to establish the general nature and magnitude of weekend cleanups, data is presented in Table 49 (74). These loads would vary from plant to plant according to operating procedure, numbers and types of equipment, and plant design.

Combined Process Flow

The significant parameters for this industry are flow, BOD, and suspended solids. The ratios of these parameters to bushels mashed were calculated for 16 plants. In addition, a reliability number was assigned to each plant based on plant visits and the method and duration of raw waste sampling as follows:

DRAFT

TABLE 48

BALANCE SHEET FOR GRAIN NEUTRAL SPIRITS UNIT
GRAIN DISTILLERY

SUBCATEGORY A 22

In	Wine Gallons (Per/Hour)
High Wine Feed (115° Proof)	1285
Aldehyde Column Steam (5,000 #)	600
Rectifying Column Steam (13,000 #)	1560
Fusel Oil Column Steam (3,000 #)	360
Fusel Oil Column Dilution Water	125
	3930
Out	
Concentrating Column Heads	70
Rectifying Column Product (190° Proof)	700
Fusel Oil Column Tails to Sewer (35 to 40 ppm BOD)	527
Rectifying Column Tails to Sewer (300 ppm BOD)	2633
	3930

DRAFT

TABLE 49

POLLUTION LOAD FROM WEEK-END CLEANUPS
GRAIN DISTILLERY

SUBCATEGORY A 22

Source	Flow (gal)	BOD (mg/l)	SS (mg/l)
Unpumpable mash	80	20,000	10,000
Venturi fermenter wash	1,000	1,100	450
Beer still caustic	8,000	1,500	1,600
Gin still drop	3,500	5,300	-----
Mash line caustic	9,000	3,200	1,500
Evaporator water wash	20,000	1,600	600
Conveyor water wash	300	1,600	27,000
Centrifuge water wash	3,000	900	700

Reliability 1 - 24 hour flow proportional sampling for three or more months.
Reliability 2 - 24 hour flow proportional sampling for at least one week.
Reliability 3 - Flow metered, grab samples.
Reliability 4 - Flow estimates, grab samples.
Reliability 5 - Plant estimates.

This data is itemized and summarized in Table (50). A separate arithmetic mean was calculated for those plants with reliability numbers 1 and 2. As reported in Table (50) the means are as follows:

	Flow Ratio (l/kkg)	BOD Ratio (kg/kkg)	SS Ratio (kg/kkg)
All Plants	5572 (37.5 gal/bu)	3.95 (0.221 lb/bu)	2.57 (0.144 lb/bu)
Plants (1,2)	6582 (44.3 gal/bu)	6.01 (0.376 lb/bu)	4.23 (0.237 lb/bu)

Table 51 demonstrates the daily variability in distillery waste as presented by Clower (77), 24 hour flow proportional composites were taken for ten consecutive days in a large size plant with combined process and cooling water.

Other parameters significant for treatment system design are pH, nitrogen, and phosphorous. pH can be expected to fluctuate between 5 and 11 over a 24 hour period. The waste is deficient in nitrogen and phosphorous. Based on tests conducted at Plant 85A01, (78) probable levels of nitrogen and phosphorous are 1.59 kg (3.5 lb) and 0.136 kg (0.3 lb) per 45.5 kg (100 lb) of BOD.

Model Plant

For the purpose of developing control and treatment technology and for conducting cost analysis a model plant must be designed. Based on the even distribution of plants with reliability numbers 1 and 2 throughout the spectrum of the industry, it is felt that the following raw waste ratios are typical:

Flowr	6500 l/kkg (43.7 gal/bu)
BODR	6.00 kg/kkg (0.33 lb/bu)
SSR	4.23 kg/kkg (0.237 lb/bu)

Since the range of production in the industry is large, two model plants have been designed on the above ratios. Production for the two plants was set at 380kkg (15,000 bushels) and 90 kkg (3500 bushels)

DRAFT

TABLE 50

WASTEWATER CHARACTERISTICS
GRAIN DISTILLERY

SUBCATEGORY A 22

Plant	Flowr (l/kkg)	BODR (kg/kkg)	SSR (kg/kkg)	Reliability
85A01	8120	7.88	3.52	1
" 02	3680	1.79	.545	3
04	6770	4.07	1.44	4
" 05	3480	1.08	.463	4
" 07	3450	1.17	.711	3
" 08	3550	6.25	.592	5
" 13	3690	6.97	6.18	2
" 15	5730	1.72	----	4
" 17	7230	2.64	3.56	4
" 19	7360	2.22	3.53	4
" 22	4050	3.97	1.43	3
" 23	70,500	2.16	----	3
" 26	7560	6.14	5.77	2
" 27	6120	2.99	.536	2
" 29	7420	5.63	----	2
" 30	77,100	6.49	5.16	2
MEAN	5572* (37.5 gal/bu)	3.95 (0.221 lb/bu)	2.57 (0.144 lb/bu)	
MEAN (1,2)	6582* (44.3 gal/bu)	6.01 (0.336 lb/bu)	4.23 (0.237 lb/bu)	

* Averaged without 85A23 and 85A30 which have combined process & cooling water

DRAFT

TABLE 51

DAILY VARIATIONS IN RAW WASTE GRAIN DISTILLERY

SUBCATEGORY A 22

	Flow (MGD)	SS (mg/l)	SS (lb/bu)	BOD (mg/l)	BOD (lb/bu)
	7.90	120	0.504	40	0.168
	8.10	100	0.480	109	0.521
	7.84	84	0.349	53	0.221
	7.53	31	0.138	121	0.539
	7.63	21	0.082	124	0.502
	7.79	138	0.573	100	0.415
	7.77	54	0.248	58	0.267
	8.58	35	0.159	43	0.218
	7.64	41	0.184	91	0.369
	[illegible]	45	0.168	100	0.373
MEAN	7.92	67	0.309 5.5 kg/kkg	84	0.359 6.4 kg/kkg
STANDARD DEVIATION			0.179		0.136

DRAFT

per day. Screening is assumed to remove grain solids prior to discharge. Based on these assumptions the raw waste loads for the model plants are as follows:

	380 kkg	90 kkg
Flow (MGD)	0.650	0.150
BOD (mg/l)	930	950
SS (mg/l)	650	670
Total KN (mg/l)	33	33
Total P (mg/l)	3	3
pH	5 to 11	5 to 11

SUBCATEGORY A 23 - GRAIN DISTILLERS NOT OPERATING STILLAGE RECOVERY SYSTEMS

The methodology for determining the wastewater characteristics for this subcategory was the same as for Subcategory A 22.

Process Waste Streams

Process streams are assumed to have the same characteristics as those in Subcategory A 22 with the following exceptions:

Feed Recovery - Distilleries in this subcategory may operate in one of two modes: 1) wet spent stillage may be collected in holding tanks and sold as cattle feed; 2) wet spent stillage may be screened, with solids recovered by drying, and thin stillage collected in holding tanks for sale as cattle feed. Since the load from evaporator condensate is non-existent, the wastewater discharge is greatly reduced compared to distilleries in Subcategory A 24.

Rectifying-Bottling - Many distillers in this subcategory may produce only straight whiskey. Wastes associated with multi-column operation would therefore be eliminated, but doubler discharge would remain the same. Also, whiskey may be shipped in bulk after maturation, thus eliminating bottling discharges.

Combined Process Flow

Less data exists for these distilleries due to the fact that many either sell to farmers or discharge their wastes to sewers. Data obtained from three plants is presented below:

Plant	Flow Ratio (l/kkg)	BOD Ratio (kg/kkg)	SS Ratio (kg/kkg)
35B04	1530	0.629	0.736
85D28	1830	0.593	0.523
85D29	1975	1.62	0.101
Mean	1780	0.947	0.634

DRAFT

The mean for the suspended solids ratio was calculated without data from plant 85B29 due to sampling error.

As expected, these ratios are approximately 70 percent less than the ratios for distilleries with complete feed recovery systems.

Model Plant

For the purpose of developing control and treatment technology and for conducting cost analysis, a model plant has been designed. The daily production for the subcategory was set at 50 kkg (2000 bushels). Based on these assumptions the raw waste loads for the model plant are as follows:

Flow	90.8 cu m/day (0.024 MGD)
BOD (mg/l)	210
SS (mg/l)	100
Total N	7
Total P	1
pH	5 to 11

SUBCATEGORY A 24 - MOLASSES DISTILLERS

In order to determine the wastewater characteristics for this subcategory all known rum distillers were contacted. Two plants were visited and a complete search of the literature was conducted.

Process Streams

Areas of wastewater generation in the rum distilling process are 1) spent molasses stillage, 2) boiler and cooling waters and fermenter washdowns, 3) barrel washings and analytical laboratory wastewaters, and 4) bottling wastes. Table 52 outlines the wastewater generated per proof gallon produced as well as the percent contribution by type of waste stream (79).

Spent Stillage

This stream accounts for approximately 66 percent of the waste flow, over 98 percent of the BOD and COD, and over 90 percent of the solids generated. The chemical constituents can fluctuate depending on the variability of ash and sugar contents of the molasses feed and the degree of acidification prior to fermentation. Table 53 demonstrates the variability of spent stillage based on the type of molasses used. Such variations appear to have only minor effects on waste treatability. In addition, both cane and citrus molasses are used by distillers in the United States. According to plants 85C43 and 85C44 (78, 79) these raw materials also produce no noticeable difference in wastewater effluent. Typical chemical analyses and ionic concentrations of rum slops are presented in Tables 54 and 55 respectively (79). It should also be noted that the temperature of this waste stream ranges from [illegible] to [illegible] C (165 to 220° F) with a dark brown color of approximately 100,000 units.

TABLE 52

MOLASSES DISTILLERY WASTE STREAMS

Waste Parameter or Constituent	Total Facility Waste Generation per Proof Gallon	% Contribution by Type of Waste Stream			
		Slops Stream	Boiler/Cooling Water & Fermenter Washdown	Barrel Washings	Water Treatment & Analytical Lab. Wastewaters
Volume	55.6 l (14.7 gal)	66%	26%	5%	3%
COD	3.0 kg (6.6 lb)	98%	1%	1%	---
BOD	1.0 kg (2.3 lb)	99%	1%	---	---
Total Solids	4.2 kg (9.2 lb)	91%	9%	---	---
Total Dissolved Solids	3.9 kg (8.6 lb)	91%	9%	---	---
Total Suspended Solids	0.25 kg (0.56 lb)	97%	3%	---	---
Total Kjehldahl Nitrogen	0.06 kg (0.14 lb)	100%	---	---	---
Total Phosphate	0.003 kg (0.007 lb)	100%	---	---	---

DRAFT

TABLE 53

VARIABILITY OF MOLASSES STILLAGE

Type of Molasses	Cuban High Test	Cuban Low Test
pH	3.5	4.2
Total Solids %	2.81	7.12
Insoluble solids %	0.25	0.68
Ash %	0.42	2.3
Total nitrogen %	----	0.13
Reducing substances (as invert sugar) %	----	1.0
Ca %	0.06	0.26
Sulphate (as SO_4) %	0.13	0.52
5-day BOD p.p. 100,000	870	1,950

DRAFT

TABLE 54

CHEMICAL CHARACTERISTICS OF MOLASSES STILLAGE

Parameter	Mean	Range
Soluble COD (mg/l)	72,000 92,000	67,100 - 75,700 81,100 - 106,300
Total COD (mg/l)	74,800 99,800	71,500 - 78,900 83,800 - 115,500
Soluble BOD (mg/l)	26,500 47,400	17,600 - 32,300 40,600 - 57,500
Total BOD (mg/l)	32,900 54,300	19,800 - 41,900 46,200 - 67,000
Alkalinity (mg/l as $CACO_3$)	912	806 - 1,320
Volatile Acids (mg/l as HAc)	4,920	3,610 - 5,920
pH	4.36	4.28 - 4.45
Solids (mg/l)		
Total	83,500	70,200 - 95,800
. total fixed	20,500	19,400 - 22,200
. total volatile	63,000	50,700 - 73,600
Total dissolved	77,700	77,400 - 85,600
. fixed dissolved	19,800	17,900 - 21,500
. volatile dissolved	57,900	45,600 - 64,000
Total suspended	6,[illegible]	2,540 - 10,280
. fixed suspended	800	40 - [illegible]
. volatile suspended	5,400	2,500 - [illegible]
Nitrogen (mg/l as N)		
. total Kjehldahl	1,140	790 - 1,450
. organic	1,060	770 - 1,280
Total Orthophosphate (mg/l as PO_4	93	59 - 96

TABLE 55

IONIC COMPOSITION OF MOLASSES STILLAGE

(Units of mg/l)

Constituent	Mean	Range	Observations
Zn	9.89	2.38 - 19.93	4
Cd	0.18	0.09 - 0.32	4
Pb	1.10	0.77 - 1.60	4
Fe	81.0	42.0 - 150.0	5
Na	372	209 - 523	5
Cu	32.8	2.0 - 124	5
Co	0.60	0.19 - 0.76	4
Mn	10.6	2.38 - 15.6	4
Ca	2088	1850 - 2476	4
Mg	824	391 - 1728	5
Cr	0.30	0.25 - 0.33	4
K	4259	4011 - 4845	5
Al	0.38	0.10 - 0.58	4
Cl	2110	1330 - 4400	4
SO_4	4120	3500 - 4800	3

The amount of mixing water added to the raw molasses can affect the strength of the stillage. When the water to molasses ratio is decreased, a smaller volume of stillage results. Therefore, in order to minimize cost, most rum distillers maintain a low water to molasses ratio.

The addition of NH_4 and PO_4 nutrients appears to have little effect on the wastewater characteristics. It is assumed that nearly 100 percent of the nutrients added are utilized by the yeast cells during fermentation.

The use of indirect heat rather than live steam in the still also results in a lower volume of stillage. The total pollutant load remains the same. The use of direct heat would result in a 15 to 30 percent reduction in water usage. Only one rum distiller is currently in the process of converting from live steam to indirect heating.

The unique solubility properties of calcium sulfate (gypsum), one of the major components of rum stillage, has an impact on the treatability of the slops stream. Unlike most compounds, gypsum becomes less soluble with increased temperatures. Therefore, the formation of scale is an important consideration, especially for evaporation.

Boiling/Cooling Water and Miscellaneous Washes - Boiling/cooling waters can represent 20 to 25 percent of the total flow from a rum distillery. Most of the wasteload is in the form of suspended and dissolved solids (less than 10 percent of the RWL) resulting from solubility changes due to the temperature fluctuations. Cooling water is used on a non-contact basis to decrease the temperature of the molasses prior to fermentation. Boiling water is used in pasteurization of the molasses prior to cooling and fermentation. Such water is non-contact and usually recycled, thus explaining the minor role in pollutant loadings. Further uses of boiling/cooling waters are similar to those of the grain distillation processes.

Washdown of fermenters usually is sent to the still with the 'wort.' Some plants may follow with a caustic wash cycle which is then either discharged or regenerated for future washings. Other plants use a detergent wash cycle which is directly sewered. The initial holding tanks for molasses seldom require washing since they are rarely empty. A rinse once a year would be an exceptional case.

Barreling Operations - These operations involve a minimum of water usage (approximately 1.3 gallons of water/gallon of rum). Since alcohol laws for rum production permit the use of used oak barrels for aging, the barrels are washed after usage. The resultant wasteloads are small amounts of dissolved materials which have migrated to the inside surface of the barrel during maturation. These wastes are washed off the barrels at the barreling site and disposed of directly. Further reuse of such wastes has not yet been explored.

DRAFT

Bottling - Due to the similarities in bottling operations between grain distillers and rum manufacturers, the resulting waste loads are assumed identical.

Combined Process Flow

All known existing data was collected in order to determine combined process flows. The ratios were calculated for flow, BOD, and suspended solids to proof gallons produced and are presented in Table (56). Other parameters requiring consideration are pH and temperature. pH averages 4.8 and temperature 100° C (212° F) due to the high percentage of stillage in the waste.

Model Plant

The production of the model plant is 30,000 proof gallons per day, based on the mean of those plants in Table 56. It is assumed that stillage is discharged without treatment and that process and cooling water are separated. Based on these assumptions the raw waste loads for the model plant are as follows.

Flow (MGD)	0.216
BOD (mg/l)	35,600
SS (mg/l)	6,720
Total KN	1,110
Total P	56.3
Temperature	212° C
pH	4.8
Color	100,000 units

SUBCATEGORY A 25 - BOTTLING AND BLENDING OF BEVERAGE ALCOHOL

Plants in this subcategory exist as an adjunct to those beverage alcohol producers described in Subcategories A 20, A 21, A 22, A 23, and A 24. The methodology for determining wastewater characteristics for bottlers, therefore, was an extension of that used for the abovementioned subcategories.

Process Waste Streams

As described in Section III, these plants may only bottle beverage alcohol produced in wineries and distilleries, or they may additionally redistill and rectify purchased liquors in order to manufacture such products as cocktails and cordials. The wastes involved are those from redistilling, rectifying, and bottling. In order to demonstrate the general nature of these wastes, data will be presented from plant 85D1C, a large rectifier bottler. Although this is not intended to represent the typical wastes for the entire spectrum of the industry, it does identify unit process wastes that may be common to other bottler/rectifiers.

Redistilling - Both vodka and gin are products which may be redistilled. The residue from redistillation constitutes the major waste associated with this segment of the process. Heads from continuous column distillation and bottoms from batch distillation are collected in a holding tank.

DRAFT

TABLE 56

RAW WASTE CHARACTERISTICS
RUM DISTILLERS

Plant	Flow Ratio (l/proof gal)	BOD Ratio (kg/proof gal)	SS Ratio (kg/proof gal)
85C34	25.7	0.997	0.149
85C38	23.8	0.922	0.206
85C39	255.0	1.40	0.265
85C45	378.0	0.557	0.110
MEAN	27.3	0.969	0.183
	(7.22 gal/pg)	(2.136 lb/pg)	(0.392 lb/pg)

*Excludes Plants 85C39 and 85C45 which reported process and cooling water combined.

On an average of once per month 3000 l (800 gal) of this liquid must be discharged. The approximate BOD is 245,000 mg/l, the suspended solids only 6.3 mg/l, and the pH 5.6. If discharged at once, this would represent a shock load of 7400 kg (16,300 lb) of BOD. The residue from redistillation can amount to one percent of the input to the still, but this waste does not necessarily relate to total plant production since some alcohol used is not redistilled. A correlation may be possible if linked to the vodka and gin production for each plant.

Rectifying - The types and volumes of wastes from rectifying for plant 85D10 are listed below.

Type	Volume l/day
Frame Filter Rinse	5700 (1500 gal/day)
Product Chiller Rinse	600 (160 gal/day)
Vodka Column Rinse	2500 (650 gal/day)
Product Tank, Filter, Line and Pump Rinse	7200 (1900 gal/day)
Bonded Warehouse Rinse	4000 (1000 gal/day)
Winery Rinse	950 (250 gal/day)
Demineralizer Regeneration	1900 (500 gal/day)

These wastes generally contain only dilute portions of alcohol that have adhered to surfaces during processing, except for demineralizer regeneration. Periodically, the demineralizing resins must be recharged by washing with caustic and acid. These are presently collected and neutralized before discharge.

Bottling - These wastes consist mainly of filler cleanup and miscellaneous floor washing. Filler discharge will obviously vary depending on the number of fillers, number of product changes, and volume used. Glue and paper labels may also contribute to the load.

Bad Product - A small quantity of bad product is destroyed periodically due to the product not meeting quality standards or being discontinued. These are crushed in bottles with the liquid being sewered. This may amount to as much as 10,000 wine gallons per year, however it may vary greatly depending upon the amount of new product activity or package changes that occur.

Combined Process Flow

The combined process flow consists of biodegradable liquids with little or no suspended solids. The flow may vary from 1900 l (500 gal) per day, for those small plants only bottling, up to 40,000 l (10,000 gal) per day for large rectifier/bottlers. For the most part these flows will be low in BOD concentration due to dilution factors. Heads from redistillation and bad product discharges may, however, be quite concentrated depending on the method of disposal. There is no existing data available concerning combined process flow.

It should be noted that considerable non-contact water may be used in large rectifying/bottling plants. Compressor and redistillation column cooling water comprises the vast majority of this flow. Plant 95D10 gave the following breakdown of water usage:

	Percent
Sanitary Waste	5.9
Industrial Waste	5.7
Non-Contact Discharge	67.6
Boiler Water	3.9
In Product	16.9
Total	100.0

Model Plant

For purposes of cost analysis and treatment system design a model plant must be designed. The following assumptions have been made:

1. Residue from redistillation may amount to one percent of the input to the still. For plants with redistillation this waste is assumed to be collected in holding tanks.

2. Bad product may accrue and periodically require disposal. This product is assumed to be collected and held prior to disposal.

3. Demineralizers may be used, requiring periodic regeneration. This is assumed to be collected in holding tanks and neutralized.

4. All other process wastes are assumed to be separated from non-contact water. The process wastes are assumed to result from washdowns previously itemized and to be biodegradable with low concentrations of BOD and suspended solids.

Based on these assumptions two model plants have been designed. Plant A is assumed only to bottle. Plant B is assumed to rectify and bottle. The raw wasteloads are as follows:

	A	B
Flow (cu m/day)	4	40
(MGD)	0.001	0.010

SUBCATEGORY A 26 - SOFT DRINK CANNERS

In order to determine the wastewater characteristics for the soft drink industry (Subcategory A26 and A27) 74 plants were contacted by phone, eight plants were visited, and five plants were sampled. In addition, a complete literature search was conducted.

DRAFT

Process Waste Streams

The major waste streams associated with soft drink canners are filler spillage, mixing tank washing, and fill tank and line washings.

Filler Spillage - Due to the type of container and the speed of the line there is considerable spillage involved in canning operations. This product waste may be characterized as high in BOD, total solids, and acidity, and low in suspended solids and pH. Expected ranges are as follows:

BOD (mg/l)	60,000-80,000
Total Solids (mg/l)	100,000-120,000
Suspended Solids (mg/l)	50-200
Acidity (mg/l)	1,200-3,200
pH	2-3.5

Mixing Tank Washing - Mixing room wastes originate from the small residue of syrup dumped during flavor changes and the water required to wash the mixing tanks. Syrup used for carbonated beverages may be as high as 800,000 mg/l BOD. When diluted with wash water this waste has the same character as filler spillage, but it is lower in concentration and higher in pH.

Fill Tank and Line Washings - These wastes, again, correlate closely to the number of flavor changes. A small amount of syrup, and water to flush the filling lines, is the source of waste. The character of the waste is the same as that from the mixing tanks.

Other Wastes - Additional waste may be created by washing bulk containers, periodic washing of syrup storage tanks, water treatment and filtration backwash, and plant cleanup. These are considered to be minor process discharges. Boiler and compressor cooling water comprise the majority of the non-contact water.

Combined Process Flow

In order to demonstrate the combined waste characteristics from soft drink canners, one plant has been selected which conducted twenty-four hour sampling over a period of more than five days. The results are presented in Table 57. As expected the BOD concentrations were high, but the ratio of pounds of BOD to gallons produced was quite low. This is explained by the low flow discharged in conjunction with a high volume of production. The pH of the waste was below six, indicating the presence of low pH product in the waste.

Based on the average of all canners surveyed it is felt that the following ratios are typical.

TABLE 57

DAILY WASTE CHARACTERISTICS
SOFT DRINK CANNING PLANT
Plant 86A27

Day	Flow (MGD)	Flow Ratio (gal/1,000 gal)	BOD (mgl)	BOD Ratio (lb/1,000 gal)	SS (mgl)	SS (lb/1,000 gal)	pH
1	0.033	281	1650	3.86	154	0.36	5.9
2	0.031	277	960	2.22	177	0.42	4.3
3	0.036	305	1140	2.89	118	0.30	3.5
4	0.035	280	1160	2.70	192	0.45	2.9
5	0.037	296	790	1.94	219	0.54	4.6
6	0.031	253	1480	3.13	376	0.79	3.5
Average	0.034	282	1197	2.79	206	0.48	
		(282 l/cu m)		(.335 kg/cu m)		(0.057 kg/cu m)	

DRAFT

Flow = 741 l/cu m (741 gal/1000 gal)

BOD = 1.02 kg/cu m (8.51 lb/1000 gal)

SS = 0.123 kg/cu m (1.03 lb/1000 gal)

The pH is expected to vary between 3 and 7 except during periods of cleanup when alkaline wastes will be discharged. Based on sampling at Plants 86A32 and 86A29 the effluent appears to be somewhat deficient in nitrogen but adequate in phosphorus for purposes of treatment. BOD:N ratios averaged 60:1, while BOD:P ratios were 110:1.

Model Plant

For the purposes of control and treatment technology and cost analysis a model plant has been designed. The production was set at 309 cu m (81,500 gal) per day. Based on this production and the ratios listed above, the raw waste loads for the model plant are as follows:

Flow (MGD)	0.0610
BOD (mg/l)	1380
SS (mg/l)	167
Total KN (mg/l)	23
pH	3 to 7

SUBCATEGORY A 27 - SOFT DRINK BOTTLING CANNING PLANTS

The methology for determining the wastewater characteristics for this subcategory was the same as for Subcategory A 26.

Process Waste Streams

The major waste stream associated with bottling plants is the bottling washer. Mixing tank and filler line washdown is expected to be similar to that from canning plants as previously discussed.

Bottle Washer - As described in Section III, the sources of pollutants from the bottle washer and sugar residues from left-over product, suspended solids from labels and material left in bottles, and caustic carry-over from sprays and soaking tanks. Typical values for prerinse and final rinse sections of a bottle washer taken at Plant 86A32 were as follows:

	Prerinse	Final Rinse
BOD (mg/l)	1130	35
SS (mg/l)	76	28
M Alkalinity (mg/l)	263	206
pH	10.3	10.3

The flow associated with this washer was 230 l/min (60 GPM).

Combined Process Flow

The final discharge of any plant with a bottle washer will thus be higher in flow, pH, and alkalinity than a plant which only cans. Table 58 itemizes and summarizes the characteristics of plants in this subcategory. A separate mean has been calculated for three plants which had conducted extensive monitoring. Many of the other plants had data collected only from grab samples and flow estimates. For this reason it is felt that the ratios for these three plants more accurately reflects actual operating conditions. Based on these means it is felt the following ratios are typical for this subcategory.

Flow Ratio (l/cu m)	BOD Ratio (kg/cu m)	SS Ratio (kg/cu m)
3540	2.38	0.380

It should be noted that the three plants with the lowest flow ratios were primarily canners with minor bottle washing or, in the case of Plant 86A29, a bottler whose bottles were being washed by an outside agent.

The pH for this subcategory is expected to vary between 5.5 and 12 with relatively high alkalinity due to the bottle washer. BOD to nitrogen and phosphorus ratios are expected to remain 60:1 and 110:1, respectively.

Model Plant

For the purposes of control and treatment technology and cost analysis a model plant has been designed. The production was set at 135 cu m (35,900 gal) per day. Based on this production and the ratios listed above, the raw waste loads for the model plant are as follows:

Flow (MGD)	0.126
BOD (mg/l)	660
SS (mg/l)	108
Total KN (mg/l)	11
pH	5.5 to 12

SUBCATEGORY A 28 - BEVERAGE BASE SYRUPS AND/OR CONCENTRATES

As discussed in Section III, it has been determined that the major individual waste streams generated in the beverage base manufacturing process are as follows:

1. Washing of mixing tanks and flavor tanks at the end of each day and between flavor changes.

2. Washing of syrup tank cars, 208 l (55 gal) drums, and 19 l (5 gal) containers prior to refilling.

3. General plant cleanup.

DRAFT

TABLE 58

RAW WASTE CHARACTERISTICS
SUBCATEGORY A27

Plant	Flow Ratio (l/cu m)	BOD Ratio (kg/cu m)	SS Ratio (kg/cu m)
86A04	1260	0.826	0.155
86A06	1990	0.257	0.031
86A07	4120	0.371	0.283
86A13	4520	2.02	0.393
86A16	6780	4.68	2.29
86A20	4290	0.806	0.322
86A24	9370	1.31	0.019
86A25	5910	6.74	0.065
86A26	6380	3.01	-----
86A29	169	0.624	0.074
86A32	2260	3.00	0.335
86A34	2540	3.04	0.226
86A37	3090	1.72	0.247
86A38	2760	1.11	0.190
86A39	3991	4.12	0 629
86A40	3050	1.92	0.325
Mean	3905	2.22	0.372
Mean (38, 39, 40)	3267	2.38	0.380

DRAFT

Washing of Mixing Tanks

Plant 85S06 generates approximately 76 cu m/day (0.02 MGD) of wastewater from the washing of six mixing tanks and eleven flavor tanks which feed the mix tanks. It should be noted that this figure is highly variable with the daily quantity dependent on the number of flavor changes made and the number of batches mixed on any given day. The equipment is commonly washed using automatic or manually operated spray ball devices mounted within the equipment and the quantity of water used is usually regulated closely.

Washing of Tank Cars, Drums and Containers

The cleaning of tank cars generally consists of a hot water wash followed by a sanitizing rinse. Drums are commonly washed in sealed wash tanks. Each drum is fitted with one resealable opening at the drum's equator. The drums are positioned on a rack wih the opening face down. Hot wash water followed by hot rinse water is injected into the drum. After draining, the drums are removed. The 19 l (5 gal) containers are washed by vertical placement (opening down) in a revolving washer which regulates the water output into each container.

Plant 87S06 reported the following daily quantities of wastewater from each of these cleaning operations during a normal day:

1. Tank cars (average eleven) - 57 cu m/day (0.015 MGD)

2. Drums - 303 cu m/day (0.08 MGD)

3. Containers - 7500 l/day (2,000 gal/day)

It is noted that these quantities will vary within the plant and between plants depending on daily cleaning requirements.

General Plant Cleanup

Wastewater quantities typically generated during cleanup at Plant [illegible], consisting of pipe line sterilization and floor washing, average 30 cu m/day (0.008 MGD) and this quantity would not be expected to vary markedly throughout the industry.

Non-Contact Water

There is a small amount of non-contact machinery cooling water and boiler blowdown generated in the manufacture of beverage bases. This non-contact water is generally discharged into the process waste stream or into storm sewers.

Total Plant Effluent

The wastewater characteristics of the total plant effluent for five beverage base plants are summarized in Table 59. The data indicate a wide range of flow and BOD concentrations but consistently show low

DRAFT

TABLE 59

SUMMARY OF WASTEWATER CHARACTERISTICS
SUBCATEGORY [illegible]

PLANT CODE	FLOW cu m/day	FLOW cu m/cu m	BOD mg/l	BOD kg/cu m	SS mg/l	SS kg/cu m	N mg/l	P mg/l
87S06	598	1.05	1868	2.02	32	0 032		
87S07	68		5910		328			
87S08	125	0.40	3750	1.43	40	0.016		
87S09	396		1140		162		35.1	12.2
87S14	459	1.16	3050	3.56	353	0.36		

suspended solids concentrations as compared to BOD concentrations. The pollutant ratios were determined based on additional data provided by Plants 87S06, 87S08, 87S14. Plants 87S06 and 87S14 showed good agreement in terms of wastewater flow per unit of product produced. However, the pollutant loadings per unit of product produced are dissimilar. Plant 87S08 which generated roughly 60 percent less flow per unit of product produced than Plant 87S06 had a BOD pollutant loading 30 percent less and a suspended solids loading 50 percent less. This indicates a rough correlation of 0.5 between the two plants. The nutrient to BOD ratio (BOD:N:P) was determined to be 100:3.1:1.1 based on the data obtained from Plant 87S09. It must be noted that only a limited number of data points was available in determining the data presented in Table 59. However, the data do offer sufficient information to allow reasonable assumptions as to the anticipated characteristics of a model beverage base manufacturing plant.

Model Plant

Based on the above considerations, a hypothetical model plant was developed for Subcategory A 28 and is illustrated in Figure 133. The plant generates an average wastewater flow of 379 cu m/day (0.10 MGD) due to washing of mixing and flavor tanks, washing of tank cars, drums, and containers, and general plant cleanup. The model plant has the following average characteristics.

Production	379 cu m/day (0.10 MGD)
Flow	379 cu m/day (0.10 MGD)
BOD	2400 mg/l
SS	50 mg/l
pH	8.0

The assumed characteristics would be expected to vary with seasonal production demands and the amount of cleanup operations conducted in the plant on any given day. There is some reason to believe that the waste stream may be slightly deficient in nitrogen based on the BOD:N:P ratio for Plant 87S09.

SUBCATEGORY A 30 - INSTANT TEA

Production of instant tea generates wastewater from two sources, clarifier sludge and cleanup.

Clarifier Sludge

Periodic discharge of tea sludge is the only process wastewater generated in the processing of instant tea. There is no reliable way to estimate the quantities of pollutant loadings of the clarifier waste stream since the discharge is highly variable.

Cleanup Water

Cleaning of equipment may be done on several different schedules as indicated in the following:

DRAFT

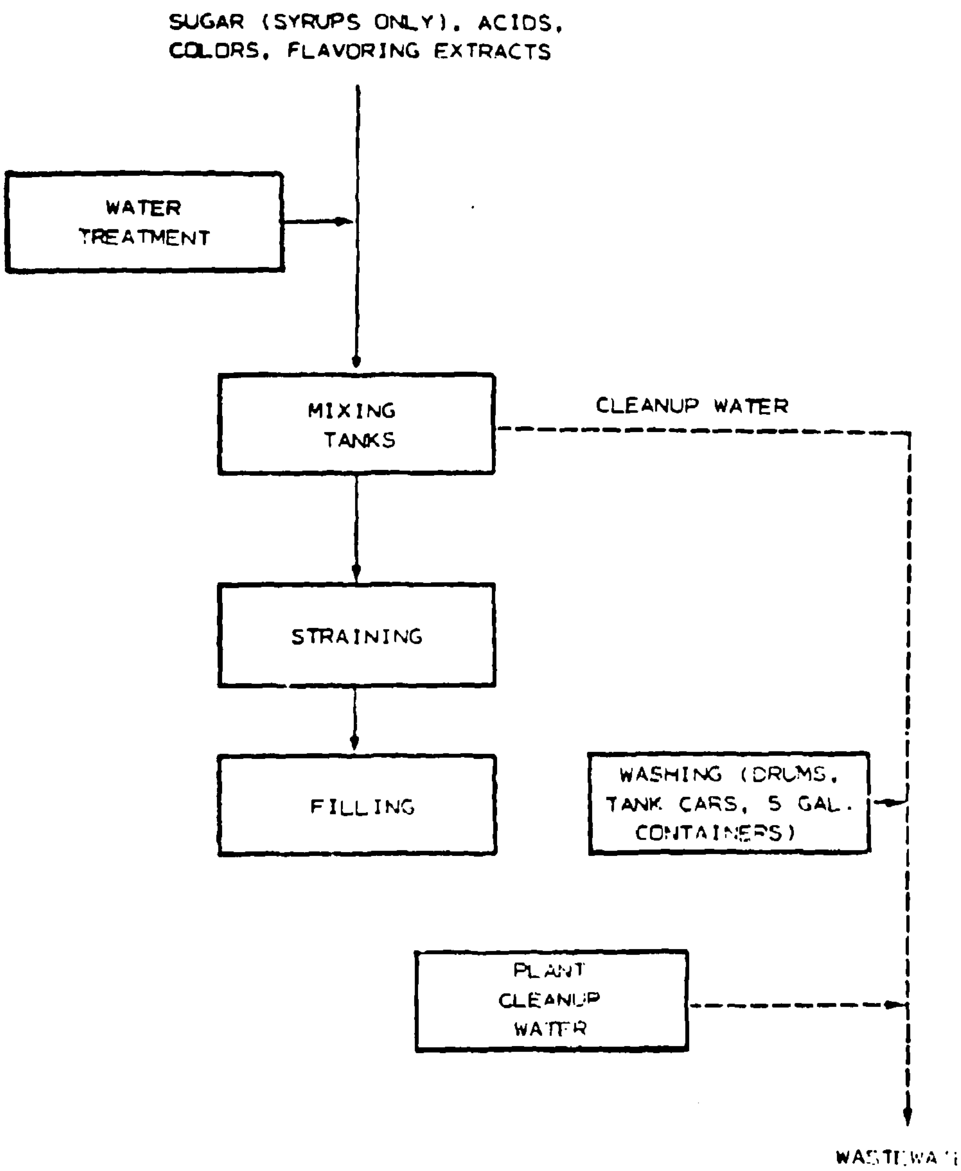


FIGURE 133

MODEL PLANT FOR
BEVERAGE CONCENTRATE AND SYRUP MANUFACTURING PROCESS

1. One plant (99T04) operating 365 days per year implements cleanup of the entire plant every ten days.

2. Two plants (99T01 and 99T02) generally operating on a five-day per week basis implement plant cleanup at the end of each week.

All plants contacted did some periodic cleaning of equipment during the week as needed. All plants contacted also did some hosing of floors in the plant for cleaning of leaks from connections. Equipment cleanup is generally done by spray ball devices contained within the equipment which are operated manually as needed. The cleanup consists of the following sequential steps: (1) fresh water rinse, (2) caustic wash, (3) fresh water rinse, (4) acid rinse and (5) fresh water rinse.

Non-Contact Water

A considerable amount of cooling water is generated in the processing of instant tea. Only one plant contacted (99T04) separated all cooling water from process water. Two plants, 99T02 and 99T03, provided no separation of contact and cooling water and no recycling of cooling water. One plant (99T01) recycled a majority of the cooling water used in the process and discharged the unrecycled into the wastestream.

Total Plant Effluent

The wastewater characteristics of the instant tea industry are summarized in Table 60. The two plants (99T02 and 99T04), for which the portion of total effluent attributable to process water was known, showed good agreement regarding process waste flows with the values being 49,500 l/kkg (11,900 gal/ton) and 46,500 l/KKg (11,100 gal/ton), respectively. Plants 99T01 and 99T03 contained an indeterminant amount of cooling water which could account for the significant difference in flow.

Pollutants in the waste stream considered of significance in instant tea manufacturing are BOD and suspended solids. Plants 99T01 and 99T02 showed good agreement of mass of BOD and suspended solids generated per unit of product produced. Of the remaining two plants, 99T03 generated four times the BOD load of the two showing agreement and 99T04 generated a BOD load which was a factor of four less than the two showing agreement. A possible explanation of the low BOD and suspended solids loadings generated by plant 99T04 is that clarified tea sludge, rather than being added to the wastestream, is centrifuged and the dewatered sludge is sold as cattlefeed.

Model Plant

Based on the data presented in Table 60 and the preceeding discussion a hypothetical instant tea manufacturing plant was determined and is illustrated in Figure 134. The plant operates 24 hours per day, five days per week with cleanup of all equipment at the end of each production week. Daily wasteflow consists of cleanup of equipment as needed, floor washdown to clean leakage from equipment connections, and deposition of

TABLE 60

SUBCATEGORY A 30 - SUMMARY OF WASTEWATER CHARACTERISTICS

Plant	Flow l/KKg	BOD Kg/KKg	SS Kg/KKg
99T01	*94,700	41.1	34.7
99T02	49,500	52.4	38.2
99T03	*167,000	196.3	-
99T04	46,500	10.0	5.8

* Values are high due to indeterminant amount of cooling water in the plant effluent.

DRAFT

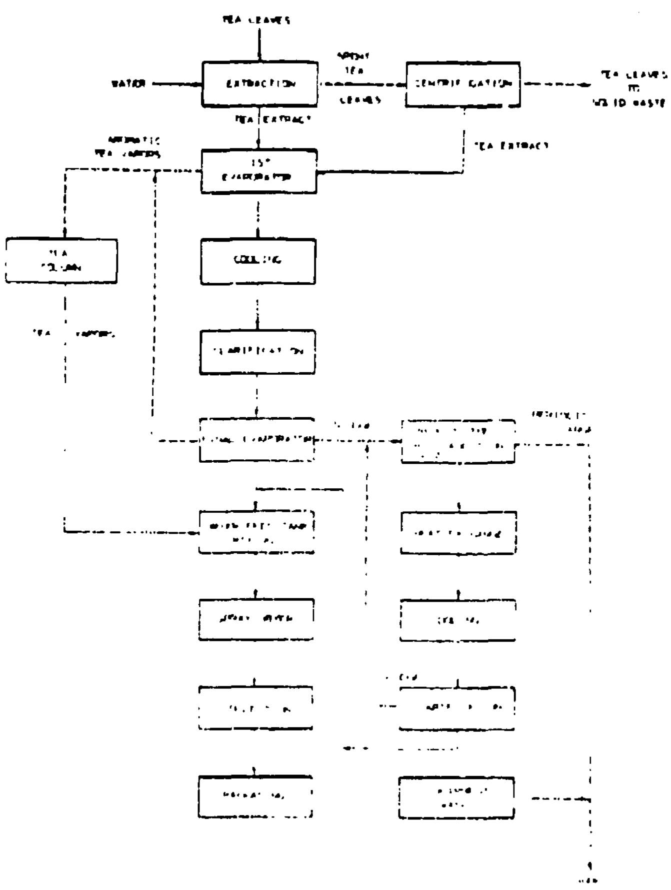


FIGURE 124

MODEL PLANT FOR CATEGORY A 30
INSTANT TEA MANUFACTURING PROCESS

DRAFT

clarifier tea sludge into the wastestream. All cooling water is discharged separately from the process waste stream. The characteristics of the model plant are as follows:

Production	9.1 KKg/day (10 ton/day)
Flow	450 cu m (0.12 MGD)
BOD	1000 mg/l
SS	750 mg/l
pH	6.0

Spent tea leaves from the centrifuge are sold as cattle feed or disposed as solid waste.

SUBCATEGORY C 8 - COFFEE ROASTING UTILIZING ROASTER WET SCRUBBERS

Roaster Wet Scrubbers

A study conducted at a coffee roasting plant utilizing a once-through type of wet scrubber reported an effluent with a BOD of 100 to 500 mg/l, suspended solids of 180 to 240 mg/l and a flow rate of 2100 liters per kkg (508 gallons per ton) of green beans roasted. No data are currently available on the wastewater characteristics of the recirculating type of wet scrubbers used on coffee roasters.

Total Processing Effluent

Roaster wet scrubbers are the only source of wastewater from a coffee roasting plant. Table 61 presents a raw waste summary of this wastewater.

Model Plant

The model plant for this subcategory is a coffee roasting plant which utilizes a once-through type of roaster wet scrubber. The model plant roasts 30 kkg (33 tons) per day of green coffee beans.

Wastewater - The only source of wastewater from the model plant is the roaster wet scrubber. Parameters of the wastewater are assumed to be as follows:

1. Flow rate - average - [illegible]
2. BOD - 350 mg/l
3. SS - 200 mg/l
4. pH - 4.0 - 7.2
5. 0.76 - kg BOD per kkg of green beans
6. 0.43 - kg SS per kkg of green beans
7. N - 0 mg/l (assumed, none suspected)
8. P - 0 mg/l (assumed, none suspected)

DRAFT

TABLE 61

RAW WASTE SUMMARY SUBCATEGORY C 8
COFFEE ROASTING

Parameter	Log Mean	Minimum	Maximum
Shift Time Hr/Day	8	8	8
Flow Ratio L/kkg	2120	2030	2250
(gal/ton)	508	486	539
5 Day BOD mg/l	270	113	645
Ratio kg/kkg	0.51	0.27	0.62
(lb/ton)	1.02	0.54	1.50
SS mg/l	202	180	240
Ratio kg/kkg	0.43	0.39	0.54
(lb/ton)	0.86	0.77	1.08

SUBCATEGORY C 9 - DECAFFEINATION OF COFFEE

Extract Centrifuge and Still Blowdown

The blowdown liquor from the solvent recovery still and the extract centrifuge are normally disposed of as part of the waste stream from the decaffeination process. These blowdown liquors are a significant source of both wastewater strength and volume from the decaffeination process. They contain high concentrations (quantitative data is not available) of suspended solids, and to a lesser extent, BOD.

Dewatering Screen

After the extract and the beans have been separated, the beans are washed and screened before drying. The dewatering screen is the source of the greatest volume of wastewater in decaffeination plants which employ this device. Although no data is available to quantitatively define the characteristics of this wastewater, it is estimated that the strength of this source of wastewater is less than all others except general plant cleanup.

Cleanup

In plants which do not utilize a dewatering screen, cleanup is the most significant source of wastewater volume. In addition, decaffeination processing plant cleanup is an important source of waste strength. [illegible] in the process area are hosed down as needed, usually once or twice a day. The decaffeinating equipment is thoroughly wet cleaned weekly and spot cleaned as necessary during the week. Caffeine storage areas are cleaned periodically and also contribute to the wasteload of the plant.

Total Processing Effluent

The quantity and quality characteristics of wastewater from coffee decaffeinating plants vary considerably. These variations can usually be traced to the amount of cleaning required on a given day. In plant [illegible] (82) show almost two fold variations in daily flow, three fold variations in BOD and three fold variations in suspended solids. Table 62 includes data describing the total processing effluent for this subcategory.

Model Plant

The model plant for this subcategory is a hypothetical plant producing whole decaffeinated green coffee beans. Decaffeination is accomplished using the liquid-liquid extraction process. All equipment and floors are wet cleaned. The model plant is assumed to process 55 kkg (60 tons) of green beans per day, operating 24 hours per day, six days per week.

Wastewater - Sources of wastewater from the model plant would include all of the sources listed above with the greatest quantities of waste-

DRAFT

TABLE 62

RAW WASTE SUMMARY SUBCATEGORY C 9 - DECAFFEINATION OF COFFEE

Parameter	NP	Logmean	Minimum	Maximum
Production kkg/day	-	55	-	-
tons/day		60	-	-
Flow MLD	2	0.242	0.213	0.275
MGD		0.070	0.062	[illegible]
Flow Ratio l/kkg	2	4406	3980	[illegible]
gal/ton		1164	1025	[illegible]
BOD mg/l	2	864	682	[illegible]
kg/kkg		3.8	3.0	[illegible]
lb/ton		7.5	6.1	[illegible]
SS mg/l	2	[illegible]	1182	[illegible]
kg/kkg		7.0	5.2	[illegible]
lb/ton		[illegible]	10.4	[illegible]
Color index *	1	[illegible]	-	-

* Note: Index 4 is the color normally identified with a [illegible] cup of coffee, [illegible] than the color of a cup of coffee

DRAFT

water coming from the dewatering screen in plants which utilize this device. Lesser quantities of wastewater are generated by general plant cleanup and extract centrifuge and solvent recovery still blowdown.

Parameters of the raw wastewater were assumed as follows:

1. Flow rate - average - 0.24 mld (70,000 gpd).
2. BOD - 364 mg/l
3. SS - 1590 mg/l
4. pH - 4.3 to 7.2
5. N - 0 mg/l (assumed)
6. P - 0 mg/l (assumed)
7. 3.3 kg BOD per kkg of green coffee processed
8. 7.0 kg SS per kkg of green coffee processed.

SUBCATEGORY C 10 - SOLUBLE COFFEE

Grounds Disposal

Soluble coffee plants normally dispose of their spent grounds by incineration or in a sanitary landfill. Most plants hydraulically press the grounds to reduce the moisture content prior to disposal by either of these two methods. The source of the greatest waste load in most soluble coffee plants is the process of grounds pressing. Data compiled during this study indicates that grounds pressing wastewater may have a BOD of up to 30,000 mg/l. A large amount of color is also characteristic of this wastewater.

Some soluble coffee processors still use rotary dryers rather than presses to remove moisture from the spent grounds prior to incineration. In these plants the only source of wastewater is drainage off of the grounds during storage. Although this is also a source of waste load, it is a less significant wastewater source than grounds pressing.

Centrifuge

In the soluble coffee process hot water passes through the coffee grounds to extract the soluble constituents. The solution resulting from this process also contains suspended materials which must be removed by centrifugation. A major source of waste load in nearly all soluble coffee plants is centrifuge cleaning and blowdown. The concentrated sludge and cleanup wastes from the centrifuge are normally discharged as part of the liquid waste stream from the plant.

DRAFT

Extract Concentrator Condensate

Before the extracted soluble coffee materials are converted to a solid by drying, the liquid extract is usually concentrated. Concentration is accomplished either by heating or cooling the solution. Whichever method is utilized, a large volume of condensate is generated. This condensate is the largest single source of wastewater flow from a soluble coffee plant.

Cleanup

General cleaning of equipment and floors in a soluble coffee plant is also a significant source of wastewater generation. Floors are wet cleaned as necessary during production and thoroughly cleaned weekly. The extractors and related equipment are self-cleaned during production. Once a week during general cleanup the extractors are cleaned with a caustic solution.

Total Processing Effluent

The quantity and quality characteristics of soluble coffee processing wastewater can vary as a result of cleaning procedures and the method of grounds handling and disposal. Plants utilizing rotary drying of spent grounds and efficient cleaning procedures are the plants with the lowest wasteload. Table 63 includes data describing the total processing effluent.

Model Plant

The model plant for this subcategory is a hypothetical plant producing approximately equal amounts of spray and freeze dried soluble coffee. Waste coffee gorunds are pressed to reduce the moisture content and used as fuel for the plant's boilers. Cleaning of the equipment and general plant cleanup occurs weekly, and both processes utilize [illegible]. Total production at the model plant is assumed to be 79 kkg (87 [illegible]) per day produced in [illegible] hours per day, six days per week.

Wastewater - Sources of wastewater from the model plant include all sources listed above with the greatest waste strength coming from the grounds pressing operation. The largest amount of wastewater is the extract concentrator condensate. Lesser amounts of waste load are generated by centrifuge blowdown and general cleaning.

Parameters of the wastewater from the model plant are assumed as follows:

1. Flow rate - average - 0.62 mld (0.18 mgd)

2. BOD - 2400 mg/l

3. SS - 1560 mg/l

DRAFT

TABLE 63

RAW WASTE SUMMARY
SUBCATEGORY C 10 - SOLUBLE COFFEE

Parameter	NP	Log Mean	Minimum	Maximum
Production kkg	3	78	40	153
tons		86	44	169
Flow mld	2	0.617	0.355	1.09
mgd		0.180	0.102	0.315
Flow Ratio l/kkg	2	7912	4505	13930
gal/ton		2090	1190	3680
BOD mg/l	3	2377	2136	2940
kg/kkg		18.8	16.9	23.26
lb/ton		39.6	33.7	46.52
SS mg/l	3	1555	623	3565
kg/kkg		12.3	5.4	28.[illegible]
lb/ton		24.7	10.8	56.[illegible]
Color cpu*		2775	-	-

* Cobalt - platinum units

4. pH - 4 to 5
5. 18.8 kg BOD per kkg of green coffee processed
6. 12.3 kg SS per kkg of green coffee processed
7. N - 0 mg/l (assumed)
8. P - 0 mg/l (assumed)
9. Color - 2775 Cobalt - platinum units

SUBCATEGORY F 1 - TEA BLENDING

The blending of tea has been determined to be a dry process involving the generation of no wastewater.

BAKERY AND CONFECTIONERY PRODUCTS

SUBCATEGORY [illegible] CAKES, PIES, DOUGHNUTS, AND SWEET YEAST GOODS UTILIZING PAN WASHING

Pan Washing

The source of the greatest waste load in a cake or pie bakery is the process of washing pans. Pan washing is almost exclusive to the cake baking industry whether the cakes are full size or the snack cake variety. Normally, the pans that are used in baking cakes must be washed after each use. After cakes have been removed from their baking pan, a thin layer of cake crumbs usually remains in the pan and is removed in the pan washing operation. The crumbs are essentially pieces of the cake and thus have a high organic content. Previous studies ([illegible]) and the wet sampling associated with this project indicates that the cake pan wash water may have a BOD of up to 50,000 mg/l.

Efforts are being made by a number of bakeries to decrease the amount of pan washing required in their cake production. Some bakeries are washing less than once every use, and at least one bakery has completely eliminated pan washing in their snack cake production.

Wash Room

A feature of virtually every bakery is a wash room in which portable equipment is cleaned. Items such as small mixers, mixing vats, [illegible] ingredient containers, and [illegible] are normally dry cleaned as thoroughly as possible before and [illegible] after being taken to the wash room. In the wash rooms, these items are thoroughly cleaned using hot water or steam, with the wastewater being collected by floor drains or sinks.

Cake bakeries may have more than one wash room. Some may be operated in the manner described above with manual cleaning of equipment. [illegible] types of wash rooms are essentially large dishwashers. Racks of cake pans and other items are rolled into these units. They are completely closed and then the equipment inside is washed in a manner similar to that accomplished by home dishwashing equipment.

Clean-In-Place Equipment

Large equipment handling liquid or semi-solid materials are usually fitted with clean-in-place (CIP) equipment. This equipment includes the plumbing, controls, and sewer connections necessary to wash the unit without moving it to the wash room. During interruptions in processing caused by changes in variety of product or due to end of shift cleanup, equipment with CIP is normally dry cleaned as thoroughly as possible and then wet cleaned using hot water and detergent supplied through the CIP equipment. Wastewater discharge from CIP equipment is normally through a direct connection to the plant's plumbing system.

Examples of equipment with CIP include the following:

1. Large mixers for cake batter
2. Piping used to deliver the batter from the mixer to the depositer.
3. The depositer which fills each cake pan with the proper amount of batter.

Cleanup

General cleanup of other equipment associated with the baking process and the plant itself is a relatively minor contributor to the waste load. Conveyors used for the baking and cooling of cakes and pies are usually dry cleaned; however, they may be wet cleaned as frequently as once a week. Cleanup procedures in most plants stress the dry cleaning of equipment and the floor spaces around the equipment. However, some wet cleaning is normally accomplished. Some exceptionally dirty areas may be hosed down; however, more common practices include the use of mop and bucket or the vacuum type of wet scrubber for floors.

Total Processing Effluent

The quantity and quality characteristics of wastewater from cake and pie bakeries can vary considerably. These variations can usually be traced to operating and cleanup procedures associated with the amount and type of product being produced and the associated cleaning requirements. In-plant studies (83) show five fold variations in BOD from one day to the next and three fold variations in wastewater flow. Table 64 includes data describing the total processing effluent for this subcategory.

Model Plant

The model plant for this subcategory is a hypothetical bakery producing a variety of cake and pie items. Production includes both full sized and snack cakes, full sized pies, and sweet yeast goods. The cakes and snack cakes are baked in pans which are washed after each use. The pies and sweet yeast goods are baked on conveyors or in one-way containers thus the containers require little or no wet washing. Operating procedures stress dry cleaning of all equipment prior to their cleaning with water. Total production at the model plant is assumed to be 135 kkg (150 tons) per day produced in 24 hours per day, seven days per week operation.

Wastewater - Sources of wastewater from the model plant would include all sources listed above with the greatest strength and quantities of waste coming from the pan washing equipment and the wash rooms. Lesser quantities of wastewater are generated by the clean-in-place equipment and general plant cleanup.

Parameters of the wastewater are assumed as follows:

1. Flow rate - average - 0.45 mld (120,000 gpd)
   minimum - 0.20 mld (53,000 gpd)
   maximum - 0.60 mld (160,000 gpd)

2. BOD - 23,000 mg/l

3. SS - 5,000 mg/l

4. Oil and Grease - 500 mg/l

5. pH - 6.0 to 7.0

6. N - 2 mg/l (deficient)

7. P - 20 mg/l (deficient)

8. Ratio - kg BOD to kkg of product - 94.2

9. Ratio - kg SS to kkg of product - 16.8

10. Ratio - kg O & G to kkg of product - [illegible]

These parameters generally follow those listed in Table 64 for this subcategory with the exception of suspended solids. The suspended solids data reported for Subcategory C [illegible] appears unrealistically low. This is particularly true when a [illegible] is made among suspended solids data from Subcategories C 1, C [illegible], [illegible], and bakeries which span these subcategories. Thus, the figure of [illegible] mg/l was used and is based on data from a bakery spanning subcategories C 1 and C 3.

SUBCATEGORY C 2 - CAKES, PIES, [illegible], AND SWEET YEAST GOODS NOT UTILIZING PAN WASHING

With the exception of pan washing, the sources of wastewater in bakeries not utilizing pan washing are identical to those in Subcategory C 1. The principal sources of wastewater are as follows:

DRAFT

TABLE 64 . RAW WASTE SUMMARY
CAKES, PIES, DOUGHNUTS, AND SWEET YEAST
GOODS UTILIZING PAN WASHING

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	1	172	--	--
(TON/DAY)		190	--	--
SHIFT TIME HR/DAY	1	24.0	--	--
FLOW VOLUME MGD	1	0.160	--	--
FLOW RATE L/SEC	1	7.01	--	--
(GAL/MIN)		111	--	--
FLOW RATIO L/KKG	1	3531	--	--
(GAL/TON)		845	--	--
5 DAY BOD MG/L	1	15000	--	--
RATIO KG/KKG		53.5	--	--
(LB/TON)		127	--	--
TSS MG/L	1	1590	--	--
RATIO KG/KKG		5.63	--	--
(LB/TON)		11.2	--	--

PROCESS CODE(S): 510751

1. Wash room

2. Clean-in-place equipment

3. Cleanup

See the previous discussion of Subcategory C 1 for a description of these sources and their effects on the total plant effluent.

Total Processing Effluent

The quantity and quality of wastewater from cake and pie bakeries not utilizing the pan washing vary considerably. These variations can usually be traced to operating and cleanup procedures associated with the amount and type of product being produced. In-plant studies (84) show up to five fold variations in BOD from one day to the next and three fold variations in the wastewater flow. Table 65 includes data describing the total processing effluent for this subcategory.

Model Plant

The model plant for this subcategory is a hypothetical bakery primarily producing cakes and snack cakes. Pies baked in one-way pans are also produced, but account for only a small percentage of the plant's total production. All of the items baked in the plant are produced by methods which completely eliminate pan washing. Operating procedures stress dry cleaning of all equipment prior to cleaning with water. Total production at the model plant is 130 kkg (200 tons) per day produced in [illegible] hours per day, five days per week operation

Wastewater - Sources of wastewater from the model plant will include all sources listed above with the greatest strength and quantities of waste coming from the wash room. Lesser quantities of wastewater are generated by the clean-in-place equipment and general [illegible].

Parameters of the wastewater [illegible]:

1. Flow rate - average [illegible]
   minimum [illegible]
   maximum [illegible] ([illegible],000 gpd)

2. BOD - [illegible],100 mg/l

3. SS - 1,[illegible]0 mg/l

4. Oil & Grease - [illegible] mg/l

5. pH - 5.0

6. N - 30 mg/l (deficient)

DRAFT

TABLE 65

RAW WASTE SUMMARY SUBCATEGORY C2

CAKES, PIES, DOUGHNUTS, AND SWEET YEAST GOODS NOT UTILIZING PAN WASHING

Parameter	Log Mean	Minimum	Maximum
Prod kkg/day	180	---	---
(ton/day)	200	---	---
Shift time hr/day	24	---	---
Flow volume MGD	0.043	0.037	0.051
MLD	0.163	0.140	0.193
Flow ratio l/kkg	397	722	1064
(gal/ton)	215	185	255
5 day BOD mg/l	2190	1890	2540
Ratio kg/kkg	2.0	1.7	2.3
(lb/ton)	4.0	3.4	4.6
SS mg/l	1020	950	1100
Ratio kg/kkg	0.92	0.86	1.0
(lb/ton)	1.[illegible]	1.72	2.0
O & G mg/l	6[illegible]	570	830
Ratio kg/kkg	0.62	0.51	0.7[illegible]
(lb/ton)	1.24	1.02	1.50

7. P - 15 mg/l (sufficient)
8. 2.0 kg BOD per kkg of product
9. 0.94 kg SS per kkg of product
10. 0.63 kg O & G per kkg of product

SUBCATEGORY C 3 - BREAD AND BUNS

Mixing Equipment Cleaning

The cleaning of mixing equipment is the largest source of wastewater in a bread and bun bakery. The cleaning may be done manually or with clean-in-place (CIP) equipment, which consists of the plumbing, controls, and sewer connections necessary to wash the equipment automatically. The mixing equipment is normally cleaned daily by first scraping the walls of the mixers to remove adhering dough and then washing. The solid (dry) material is either sold as animal feed or handled as solid waste. In plants using the continuous mix method, the mixers and dough slurry tanks are then rinsed daily with water. In plants using the batch mix method, the mixers are normally wet cleaned once or twice a week.

General Cleanup

General cleaning of floors and utensils is the other important source of wastewater from bread and bun bakeries. Utensils are normally washed in a sink in the production area in which they are used. Floors in the mixing area are generally wet cleaned daily using mops and buckets, hoses, or scrubbers which vacuum the water and spilled product from the floor as it is used. Floors throughout the rest of the plant are routinely cleaned several times a day using brooms and dry vacuum cleaners. Once or twice a week all of the floors in the plant are wet cleaned with mop and bucket or vacuum scrubber.

Total Processing Effluent

The quantity and quality of wastewater from bread and bun bakeries [illegible] considerably. These variations are [illegible] the result of the amount of cleanup taking place and the [illegible] of the [illegible]. Data from various plants show [illegible] variations in flow and in [illegible] one day to the next. Table 26 [illegible] data [illegible] the total [illegible] effluent for this subcategory.

Model Plant

The model plant for this subcategory is a hypothetical bakery producing bread and buns. Buns are a minor [illegible] item. All items are batch mixed, baked in pans (sometimes with lids), and mechanically packaged in plastic bags. Operating [illegible] cleaning of all [illegible] prior to wet cleaning (if required). Total production of the model plant

DRAFT

TABLE 66. RAW WASTE SUMMARY
BREAD AND BUNS

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	14	40.8	21.4	[illegible]
(TON/DAY)		45.0	23.6	[illegible]
SHIFT TIME HR/DAY	14	22.7	16.0	[illegible]
FLOW VOLUME MGD	14	[illegible].026	0.014	[illegible]
FLOW RATE L/SEC	14	1.32	0.561	[illegible]
(GAL/MIN)		21.[illegible]	[illegible].91	[illegible]
FLOW RATIO L/KKG	14	[illegible]	[illegible]	[illegible]
(GAL/TON)		499	22[illegible]	[illegible]
5 DAY BOD MG/L	14	[illegible]	11[illegible]	[illegible]
RATIO KG/KKG		0.877	[illegible]	[illegible]
(LB/TON)		1.75	0.926	[illegible]
TSS MG/L	[illegible]	[illegible]	[illegible]	[illegible]
RATIO KG/KKG		[illegible]	[illegible].144	[illegible]
(LB/TON)		[illegible]	[illegible]	[illegible]

PROCESS CODE(S): [illegible]

is assumed to be 41 kkg (45 tons) per day produced in 24 hours per day, five days per week.

Wastewater - Sources of wastewater from the model plant would include all sources listed above with nearly all of the wastewater generated by cleaning of mixing equipment and floors throughout the plant.

Parameters of the wastewater are assumed to be as follows:

1. Flow - average - 0.10 mld (0.026 mgd)
   minimum - 0.053 mld (0.014 mgd)
   maximum - 0.19 mld (0.051 mgd)

2. BOD - 427 mg/l

3. SS - 214 mg/l

4. pH - 6.0 to 9.0

5. P - 0 mg/l (assumed)

6. N - 0 mg/l (assumed)

7. 0.[illegible] kg BOD per kkg of product

8. 0.[illegible]6 kg SS per kkg of product

SUBCATEGORY [illegible] - COOKIE AND CRACKER MANUFACTURING

Wash Room

A feature of virtually every cookie and cracker baker is a wash room in which portable equipment is cleaned. The cleaning may be done manually or the wash room may be essentially a large automatic [illegible] washer. Equipment such as small [illegible] mixers, mixing [illegible], formers, [illegible], and hand [illegible] [illegible] and dry cleaned before and/or after [illegible] [illegible] [illegible]. These items are then cleaned in the wash room using hot water and/or steam.

The major source of wastewater in the wash room is associated with the cleaning of [illegible] with cookie manufacturing. [illegible] wastewater generated [illegible] the wash room varies greatly [illegible].

Clean-In-Place Equipment

Large equipment handling liquid [illegible] materials [illegible] fitted [illegible] clean-in-place [illegible] equipment includes the plumbing, controls, and [illegible] necessary to wash the unit without moving it to the [illegible] interruptions in processing caused by changes [illegible] product or due to [illegible] of shift cleaning, equipment with CIP is normally dry cleaned as thoroughly as possible and then wet cleaned using hot water and detergent supplied through the CIP equipment. Wastewater discharge is normally through a direct connection to the plant waste plumbing system.

Cleanup

General cleanup of other equipment associated with the baking process and the plant itself is the least significant contributor to the waste load. Conveyors used for the baking and cooling of cookies and crackers are usually dry cleaned; however, they may be wet cleaned as frequently as once a week. Cleanup procedures in most plants stress the dry cleaning of equipment and the floor spaces around the equipment. However, exceptionally dirty areas may be hosed down, or more commonly be cleaned with a vacuum type wet scrubber or a mop and bucket.

Total Processing Effluent

The quantity and quality of wastewater from cookie and cracker bakeries can vary considerably. These variations are usually the result of cleanup procedures associated with the type of product being produced and the training and management of the personnel. Data collected during this study show six fold variations in BOD from one day to the next and two fold variations in wastewater flow within a single plant. Table 67 includes data describing the total processing effluent for this subcategory.

Model Plant

The model plant for this subcategory is a hypothetical bakery producing a variety of cookie and cracker items. Production includes crackers, iced and plain cookies, pretzels and sugar wafers. The model plant produces cookie items and cracker items in approximately equal quantities. All items are batch mixed, baked on conveyor belts in tunnel ovens (except sugar wafers which are baked in plates in a special type of oven), and tumble or shingle stack packaged. Operating procedures stress dry cleaning of [illegible] [illegible] wet cleanup (if required). Total production for the model plant is assumed to be 180 kkg (200 tons) per day, produced in 24 hours per day, five days per week.

Wastewater - Sources of wastewater from the model plant would include all sources noted above with the greatest strength and quantities of waste coming from the wash room. Smaller quantities of wastewater are generated by the clean-in-place equipment and general plant cleaning.

Parameters of the wastewater are assumed as follows:

1. Flow rate - average - [illegible] mld (90,000 gpd)
   minimum - [illegible] mld (53,000 gpd)
   maximum - 0.45 mld (120,000 gpd)

DRAFT

TABLE 67 . RAW WASTE SUMMARY
COOKIES AND CRACKERS

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	8	122	41.9	[illegible]
(TON/DAY)		135	[illegible]	[illegible]
SHIFT TIME HR/DAY	8	21.1	[illegible]	[illegible]
FLOW VOLUME MGD	[illegible]	0.036	[illegible]	[illegible]
FLOW RATE L/SEC	8	[illegible]	[illegible]	[illegible]
(GAL/MIN)		[illegible]	[illegible]	[illegible]
FLOW RATIO L/KKG	[illegible]	[illegible]	[illegible]	[illegible]
(GAL/TON)		[illegible]	[illegible]	[illegible]
5 DAY BOD MG/L	[illegible]	[illegible]	[illegible]	[illegible]
RATIO KG/KKG		[illegible]	[illegible]	[illegible]
(LB/TON)		[illegible]	[illegible]	[illegible]
TSS MG/L	[illegible]	[illegible]	[illegible]	[illegible]
RATIO KG/KKG		[illegible]	[illegible]	[illegible]
(LB/TON)		[illegible]	[illegible]	[illegible]

PROCESS CODE(S): [illegible]

2. BOD - 1200 mg/l

3. SS - 900 mg/l

4. pH - 6.0 - 8.0

5. Ratio - kg BOD to kkg of product - 2.0

6. Ratio - kg SS to kkg of production - 1.5

SUBCATEGORY D 1 - CANDY AND CONFECTIONERY PRODUCTS EXCLUDING GLAZED FRUITS

Of the total number of confectioners contacted 15 were considered to have reliable historical wastewater data on which to characterize the industry as a whole. A summary of this data is given in Table 68.

Direct product contact water usage was not observed in any segment of this subcategory. The primary source of wastewater with the highest pollutant loading is derived from the periodic or daily clean-up of the plant. Although washdown is practiced in most parts of the plant at some time, the largest and most consistent area of washdown water generation is the candy kitchen. Washdown water in the remainder of the plant is usually restricted to mopping and wiping. Some machinery parts and molding pans may be removed to a separate area for cleansing. In addition, certain molding machines were observed to use a clean-in-place system. Other areas which may contribute to the total effluent loading are boiler blowdown, air scrubbers and barometric condensers. Non-contact cooling water was observed to be either discharged to storm sewers, surface water, sanitary sewers or was recirculated.

As noted in Table 68, the average flow ratio was 3770 l/kkg (904 gal/ton). The average BOD was 5.10 kg/kkg (10.2 lb/ton) with a range of 1.69 to 15.4 kg/kkg (3.38 to 30.7 lb/ton); suspended solids was 0.648 with a range of 0.168 to 2.50 kg/kkg (0.336 to 5.00 lb/ton). No correlation between suspended solids and BOD was noted due to the solubilized carbohydrates characteristically discharged by this industry. Oil and grease loadings ranged from 0.05 to 0.832 kg/kkg (0.10 to 1.664 lb/ton) with an average of 0.21 kg/kkg (0.42 lb/ton) for the six plants with this data available. Variability of the wasteloading and flow was significantly influenced by variations in processing, raw materials, production level, washdown and general housekeeping practices. Wastewater in all plants visited was discharged to municipal treatment facilities. Many plants utilized some minor form of pretreatment and/or in-plant controls to reduce waste loadings; particularly where oil and grease were of concern. Pretreatment was usually in the form of a grease trap. One plant, however, was considering dissolved air flotation as a method of reducing effluent concentrations.

DRAFT

TABLE 68 RAW WASTE SUMMARY
CANDY AND CONFECTIONERY

PARAMETER	NO. PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	15	97.0	30.7	307
(TON/DAY)				
SHIFT TIME HR/DAY	14	16.8	8.00	338
FLOW VOLUME MGD	15	0.099	0.024	0.422
FLOW RATE L/SEC	14	6.80	1.71	27.0
(GAL/MIN)		108	27.1	429
FLOW RATIO L/KKG	15	3770	2070	6880
(GAL/TON)		904	495	1650
5 DAY BOD MG/L	14	1290	523	3200
RATIO KG/KKG		5.10	1.69	15.4
(LB/TON)		10.2	3.38	30.7
TSS MG/L	15	172	54.1	545
RATIO KG/KKG		0.648	0.168	2.50
(LB/TON)		1.29	0.336	5.00
OIL & GREASE MG/L	6	55.7	13.3	222.3
RATIO KG/KKG		0.2[illegible]	0.50	0.8[illegible]
(LB/TON)		0.[illegible]2	0.10	1.68

PROCESS CODE (S): 65*80M, 65*83M, 65*84I, 65*85M, 65*86I, 65*87M, 65*21NT, 65880M2, 65382I, 65883M, 65384I, 65885M, 65H81M, *CD801

DRAFT

Model Plant

The following information reflects those conditions judged to be applicable to a representative candy and confectionery product plant:

Production = 97 kg/day (107 ton/day)
Effluent Volume = 375 cu m/day (0.099 MGD)

Effluent characteristics:

BOD = 1300 mg/l
SS = 170 mg/l
Oil and Grease = 56 mg/l
pH = 7.7

Primary source of wastewater: Washdowns.
Special consideration: Oil and grease.

SUBCATEGORY D 2 - CHEWING GUM

Data from a total of five plants were used to develop the wastewater characteristics as summarized in Table 69. Three of the data points contributing to this summary were from plants visited by the contractor. Other data points represent data contributed by the National Association of Chewing Gum Manufacturers (NACGM). Because the NACGM included much supplemental processing and water usage information with the historical data, it was concluded that such data could be reliably utilized as part of the data base making the necessary wastewater characterization.

Water used in the manufacture of chewing gum is primarily for air scrubber systems with lesser quantities being consumed during plant washdown. No direct finished product contact water use was observed or indicated. Washdown of the plant is usually restricted to mopping and wiping in most areas with a separate room used for cleaning various pieces of equipment. Some miscellaneous water use generally occurs in cleaning of mixing room floors. Air scrubber water is usually recirculated and periodically purged.

The ratio of water use to production averages 4500 l/kkg (1080 gal/ton) with an expected range of 3300 to 6130 l/kkg (792 to 1470 gal/ton). This range is due primarily to variations in plant size and different conditions affecting the performance of the air scrubber systems. Expected BOD ratios ranged from 1.2 to 13.6 kg/kkg (2.4 to 27.2 lb/ton) with an average of 4.04 kg/kkg (8.07 lb/ton). Suspended solids ranged from 0.175 to 0.858 kg/kkg (0.351 to 1.71 lb/ton) with an average of 0.388 kg/kkg (0.774 lb/ton). Variability of the BOD and SS loadings could not be rationalized in all cases, but is likely to be influenced by variable amounts of sugar dust that is subsequently removed by the air scrubber system. Differences in general cleanup practices are suspected to account for a significant variation in wastewater pollutant load.

DRAFT

TABLE 69 . RAW WASTE SUMMARY
CHEWING GUM

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	5	70.9	42.1	[illegible]
(TON/DAY)		78.2	46.4	[illegible]
SHIFT TIME HR/DAY	5	14.4	8.00	24.0
FLOW VOLUME MGD	5	0.035	0.030	0.187
FLOW RATE L/SEC	5	6.74	3.39	13.4
(GAL/MIN)		107	53.7	[illegible]
FLOW RATIO L/KKG	5	4500	3300	6130
(GAL/TON)		1080	792	1470
5 DAY BOD MG/L	5	897	360	2240
RATIO KG/KKG		4.04	1.20	[illegible]
(LB/TON)		8.07	2.40	27.2
TSS MG/L	4	94.1	35.6	[illegible]
RATIO KG/KKG		0.339	0.175	[illegible]
(LB/TON)		0.774	0.351	[illegible]

PROCESS CODE(S): 67G81I ,67G82I ,67G83I ,67G84I ,*CG8[illegible]

Intake waters are generally obtained from municipal water supplies; however, some plants do utilize well water for non-contact cooling and air washer make-up water. All effluents, except from one plant, observed during the study were discharged directly to municipal treatment systems. Pre-treatment was generally not employed; however, one plant treated and subsequently spray irrigated its effluent.

Model Chewing Gum Plant

Based on available information, a representative plant for this subcategory has been selected as follows:

Production:	70.9 kkg/day (78.2 ton/day)	
Wastewater flow volume:	322 cu m/day (0.085 MGD)	
Wastewater characteristics:	BOD	= 900 mg/l
	SS	= 95 mg/l
	Oil and Grease	= 30 mg/l
	pH	= 7.5

Primary Sources of Wastewater - Air scrubbers, cleanup operations.

Special Considerations - None.

SUBCATEGORY D 3 - CHEWING GUM BASE

As in the case of Subcategory D 2, data for two of the plants supplied by NACGM were considered valuable for the reasons mentioned in the previous subsection. Table 70 summarizes the data from three chewing gum base manufacturers.

During the production of chewing gum base, water is used for washing of the natural gums, for contact and non-contact cooling, and for periodic cleanup. The greatest volume of water is used during the washing operation with considerably less being used for general cleanup. The ratio of water used to production would be expected to range from 1030 to 11,200 l/kkg (247 to 2690 gal/ton) with an average of 3400 l/kkg (815 gal/ton). Although the range of water use is great, the total waste-loading does not reflect the same wide range, suggesting different approaches to water use to achieve the same degree of product and/or plant cleaning.

Expected BOD ratios range from 1.11 to 1.90 kg/kkg (2.21 to 3.80 lb/ton) with an average of 427 kg/kkg (2.9 lb/ton); suspended solids from 0.800 to 1.82 kg/kkg (1.60 to 3.63 lb/ton) and an average of 1.21 kg/kkg (2.41 lb/ton). The reason for the variability of the wastewater flow cannot be attributed to specific processing differences between plants but is most likely due to differences in raw material quality; i.e., the amount of extraneous material which must be removed.

The pH range (two plants) was from 8.76 to 9.5 with a numerical average of 9.13. Sodium hydroxide (NaOH) used as a bleaching agent, is the cause of the above neutral pH. Surges of higher hydroxide ion concentration would be expected during the bleaching cycle pump and subsequent rinsing of the product to remove residual NaOH.

DRAFT

TABLE 70 RAW WASTE SUMMARY
CHEWING GUM BASE

PARAMETER	NO. PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	3	105	98.7	112
(TON/DAY)		116	109	123
SHIFT TIME HR/DAY	2	20.0	16.0	24.8
FLOW VOLUME MGD	3	0.094	0.030	0.310
FLOW RATE L/SEC	2	8.40	3.58	19.7
(GAL/TON)		133	56.8	312
FLOW RATIO L/KKG	3	3400	1030	11200
(GAL/TON)		815	247	2690
5 DAY BOD MG/L	3	427	162	1120
RATIO KG/KKG		1.45	1.11	1.90
(LB/TON)		2.90	2.21	3.80
TSS MG/L	3	355	74.2	1700
RATIO KG/KKG		1.21	0.800	1.82
(LB/TON)		2.41	1.60	3.63
PH	2	9.13	8.76	9.50

PROCESS CODES(S): *CG80H, 67B801, 67B851

During periodic cleanup of equipment and processing areas, various solvents are utilized to remove built-up gum residues. According to a treatment feasibility study (85) prepared for a gum base plant, a maximum of 2000 gallons per week of solvent was used with a yearly average of 24,000. This consumption was based on a production average of 5000 lb/day.

Of the three plants used for characterization, two discharged wastewater to municipal treatment systems and one plant employed its own treatment system prior to discharge to a local tributary.

Model Gum Base Plant

Production:	105 kkg/day (116 ton/day)	
Wastewater flow volume:	356 cu m/day (0.094 MGD)	
Wastewater characteristics:	BOD	= 430 mg/l
	SS	= 355 mg/l
	Oil and Grease	= 30 mg/l
	pH	= 9.1

Primary Sources of Wastewater - Gum base wash water, contact cooling water, cleanup.

Special Considerations - Bleaching agent (sodium hydroxide), solvents.

SUBCATEGORY D 5 - MILK CHOCOLATE PRODUCTION WITH CONDENSORY PROCESSING AND SUBCATEGORY D 6 - MILK CHOCOLATE WITHOUT CONDENSORY PROCESSING

As noted in Section III, some producers of chocolate products may also engage in the condensing of milk for milk chocolate and were, therefore, segregated for separate consideration. Wastewater characteristics for Subcategory D 5, Chocolate Production with Milk Condensory, is based on six data sets which reflect the majority of chocolate and cocoa products manufactured in the United States. Three data sets were used in characterization of Subcategory D 6, Chocolate Production without Milk Condensory. These data are summarized on Tables 71 and 72 and are further discussed herein.

The presence of water is not compatible with the production of cocoa products; therefore, the open use of water is controlled so as to avoid entrainment in the product. The major portion of wastewater generation occurs during the periodic cleaning of holding or mixing tanks, transfer buggies, and molding pans. The production area floors are also cleaned on a periodic basis, usually preceded by dry collection and then mopping, and/or using industrial floor sweepers. Cocoa butter may be used as a cleaning solvent with the later recovery of the cocoa butter and chocolate material. Washdown water is also generated during the cleaning of the condensed milk line and milk receiving areas, Subcategory D 5.

For Subcategory D 5 BOD loadings averaged 7.48 kg/kkg (14.9 lb/ton) with an expected range of 8.69 to 25.7 (kg/kkg (4.35 to 12.9 lb/ton); suspended solids averaged 1.68 kg/kkg (3.35 lb/ton), ranging from 1.83 to 3.08 kg/kkg (1.83 to 6.15 lb/ton). Oil and grease averaged 0.69 kg/kkg (1.38 lb/ton) with an expected range of 0.32 to 1.06 kg/kkg (0.64 to 2.12 lb/ton) and for

DRAFT

TABLE 71 RAW WASTE SUMMARY
CHOCOLATE, WITH MILK CONDENSORY

PARAMETER	NO. PLANTS	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	5	333	117	944
(TON/DAY)		367	129	1040
SHIFT TIME HR/DAY	5	22.4	16.8	24.0
FLOW VOLUME MGD	5	0.201	0.077	0.524
FLOW RATE L/SEC	5	7.22	1.51	34.4
(GAL/MIN)		114	24.0	546
FLOW RATIO L/KKG	5	4070	2310	7170
(GAL/TON)		975	553	1720
5 DAY BOD MG/L	5	1840	1300	2600
RATIO KG/KKG		7.48	4.35	12.9
(LB/TON)		14.9	8.69	25.7
TSS MG/L	5	413	308	553
RATIO KG/KKG		1.68	0.915	3.08
(LB/TON)		3.35	1.83	6.15
OIL & GREASE MG/L	4	169.5	78.6	260.4
RATIO KG/KKG		0.69	0.32	1.06
(LB/TON)		1.38	0.64	2.12

PROCESS CODE (S): 66*80I, 66*80W, 66*80W1, 66*83I5, 66*83W5

DRAFT

TABLE 72 RAW WASTE SUMMARY
CHOCOLATE, WITHOUT MILK CONDENSORY

PARAMETER	NO. PLANTS	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	3	253	50.3	1270
(TON/DAY)		278	55.5	1400
SHIFT TIME HR/DAY	3	13.3	8.00	15.0
FLOW VOLUME MGD	3	0.243	0.103	0.579
FLOW RATE L/SEC	3	20.2	12.6	32.4
(GAL/MIN)		320	200	514
FLOW RATIO L/KKG	3	6560	5000	8620
(GAL/TON)		1570	1200	2070
5 DAY BOD MG/L	3	705	145	3420
RATIO KG/KKG	3	4.63	1.18	18.1
(LB/TON)		9.24	2.36	36.1
TSS MG/L	3	229	81.8	642
RATIO KG/KKG		1.50	0.669	3.38
(LB/TON)		3.01	1.23	6.76
OIL & GREASE MG/L	1	1.59	-	-
RATIO KG/KKG		1.06	-	-
(LB/TON)		2.12	-	-

PROCESS CODE (S): 66*82M, 66*8314, 66*83W4

Subcategory D 6, the BOD averaged 4.63 kg/kkg (9.24 lb/ton) with an expected range of 1.18 to 18.1 kg/kkg (2.36 to 36.1 lb/ton); suspended solids averaged 1.50 kg/kkg (3.01 lb/ton), ranging from 0.669 to 3.38 kg/kkg (1.34 to 6.76 lb/ton). Oil and grease for the one plant which analyzed this parameter was 1.06 kg/kkg (2.12 lb/ton).

BOD and suspended solids loadings appear to be dependent on the relative amounts of chocolate products produced, i.e., cocoa, syrup, sweetened, unsweetened, and milk chocolate. Of special note is the necessary cleaning of tanks and product containers of the chocolate syrup line. Oil and grease variability is due to the efficiency of general operating housekeeping practices used to minimize entrainment of cocoa butter in the wastewater. In addition, Subcategory D 5 is influenced by washdown from the milk condensing process and milk receiving area; the total wasteloading for any one plant being dependent upon the amount of dry milk and/or condensed milk which may come from other sources.

Plants in these subcategories characteristically discharge their wastewater to municipal treatment systems, usually after some form of preliminary oil and grease removal. This pretreatment may involve only a grease trap or, as in the case of one plant, a flotation unit. Non-contact cooling water may either go to municipal treatment or be discharged to surface waters; the latter being the situation in the larger plants.

Model Chocolate Plant with Condensory		Without Condensory
Production:	[illegible]0 ton/day	240 ton/day
Wastewater flow volume:	761 cu m/day	920 cu m/day
	0.201 MGD	0.243 MGD
Wastewater characteristics:		
BOD	= 1840 mg/l	705 mg/l
SS	= 415 mg/l	230 mg/l
Oil and Grease	= 170 mg/l	160 mg/l

Primary source of wastewater: Washdowns.
Special considerations: Oil and grease removal.

PET FOOD

SUBCATEGORY B 5 - LOW MEAT CANNED PET FOOD

General Plant Cleanup

Clean up in a low meat canned pet food plant is a continuous, minute-to-minute process which contributes by far the largest share of both volume and pollutants to the wastewater stream. Clean up can basically be divided into two main types: in-plant housekeeping and end of shift clean up.

Housekeeping - Housekeeping is the most continuous of clean up steps. The various operations throughout a typical low meat pet food plant generate considerable amounts of scrap. Included in this would be various spillages from gravy tanks, can filling, meat thawing, grinding, etc. Grinders as well as mixing tanks, filler bowls, double seamers, etc., also require periodic washdown to comply with in-plant and regulatory sanitation requirements. All of these individual operations contribute heavily to the organic waste load. These streams are characterized by small pieces of grain, starches, blood, meat scraps, and other formulation ingredients. These waste streams constitute a major portion of the total plant effluent.

End of Shift Cleanup - End of shift clean up is to some extent similar to the daily minute-to-minute operations inasmuch as all the floor and equipment surfaces are thoroughly washed and rinsed. Additionally, however, the larger cooking kettles are typically "boiled-out" with the aid of detergents. Pipes may be disassembled and scrubbed with brushes. Large pieces of equipment such as extruders, grinders, screw conveyors, etc., may also receive a final "sanitizing" step. These types of cleaning operations are usually responsible for peak loadings and probably contribute an equivalent amount of pollutants as would be experienced by an entire shift of housekeeping washdowns.

Retort Cooling Water

The only other process contributing to the wastewater stream is retort cooling water. The water which is used to cool the cans is basically low load water, typically continuously circulated, although some plants were observed to discharge this segment directly under NPDES permit. Some of the plants not only recirculate cooling water but reuse it for clean up, but this was atypical of the plants visited. No quantitative data are available to determine its relative proportion in the waste stream.

Model Plant

The model plant is one that produces 159 kkg of finished product generating 0.147 mgd of wastewater. The average BOD loading as shown in Table 73 is 3.55 kg/kkg with a range of 1.62 to 7.82 kg/kkg. The average BOD concentration is 1,130 mg/l with a range of 497 to 2,560 mg/l. The reason for the wide variation in concentration is principally due to the various product styles and types found within this subcategory. The other flow related parameters follow this same pattern.

SUBCATEGORY B 6 - HIGH MEAT CANNED PET FOOD

General Plant Cleanup

Clean up in a high meat canned pet food plant is a continuous, minute-to-minute process which contributes by far the largest share of both volume and pollutants to the wastewater stream. Clean up can basically be divided into two main types: in-plant housekeeping and end of shift clean up.

TABLE 73. RAW WASTE SUMMARY
LOW MEAT CANNED PET FOOD

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	9	159	76.9	329
(TON/DAY)		175	84.8	362
SHIFT TIME HR/DAY	9	19.8	12.0	24.0
FLOW VOLUME MGD	9	0.147	0.059	0.371
FLOW RATE L/SEC	8	9.36	4.71	18.6
(GAL/MIN)		148	74.7	295
FLOW RATIO L/KKG	11	3150	1750	5670
(GAL/TON)		755	420	1360
5 DAY BOD MG/L	11	1130	497	2560
RATIO KG/KKG		3.55	1.62	7.[illegible]
(LB/TON)		7.11	3.23	15.[illegible]
TSS MG/L	11	645	397	15[illegible]
RATIO KG/KKG		2.66	1.21	[illegible]
(LB/TON)		5.33	2.42	11.[illegible]

PROCESS CODE(S): 47N64S ,47N54I ,47N54W ,47N50M ,47N50W ,
47N51I ,47N55I ,47S66I ,47S67S ,47S59I ,47S56I

Housekeeping - Housekeeping is the most continuous of clean up steps. The various operations throughout a typical high meat pet food plant generate considerable amounts of scrap. Included in this would be various spillages from gravy tanks, can filling, meat thawing, grinding, etc. Grinders as well as mixing tanks, filler bowls, double seamers, etc., also require periodic washdown to comply with in-plant and regulatory sanitation requirements. All of these individual operations contribute heavily to the organic waste load. These streams are characterized by small pieces of meat, fat, starches, blood, and other formulation ingredients. These waste streams constitute a major portion of the total plant effluent.

End of Shift Cleanup - End of shift clean up is to some extent similar to the daily minute-to-minute operations inasmuch as all the floor and equipment surfaces are thoroughly washed and rinsed. Additionally, however, the larger cooking kettles are typically "boiled-out" with the aid of detergents. Pipes may be disassembled and scrubbed with brushes. Large pieces of equipment such as extruders, grinders, screw conveyors, etc., may also receive a final "sanitizing" step. These types of cleaning operations are usually responsible for peak loadings and probably contribute an equivalent amount of pollutants as would be experienced by an entire shift of housekeeping washdowns.

Retort Cooling Water

The only other process contributing to the wastewater stream is retort cooling water. The water which is used to cool the cans is basically low load water, typically continuously circulated, although some plants were observed to discharge this segment directly under NPDES permit. No quantitative data are available to determine its relative proportion in the waste stream.

Model Plant

The canned high meat pet food subcategory is characterized by several different product styles as described in Section III. The processing and meat handling techniques are diverse, and as such the data presented show extreme ranges for concentrations and loadings for all of the flow-related parameters.

The model plant is one that produces 167 kkg of finished product generating 0.179 mgd of wastewater. The average BOD loading as shown in Table 74 was 48.6 kg/kkg with a range from 29.2 to 80.8 kg/kkg. The average BOD concentration was 11,800 mg/l with a range of 6,910 to 20,200 mg/l. The reason for the wide variation in concentrations is principally due to the various product styles found within this subcategory. The other flow-related parameters follow this same pattern.

DRAFT

TABLE 74. RAW WASTE SUMMARY
HIGH MEAT CANNED DOG AND CAT FOOD

PARAMETER	NO PLANT	LOG MEAN	MINUMUM	MAXIMUM
PROD KKG/DAY	3	167	153	182
(TON/DAY)		184	169	201
SHIFT TIME HR/DAY	2	24.0	--	--
FLOW VOLUME MGD	3	0.179	0.178	0.180
FLOW RATE L/SEC	2	7.84	7.78	7.90
(GAL/MIN)		124	123	125
FLOW RATIO L/KKG	3	4120	3820	4430
(GAL/TON)		987	917	1060
5 DAY BOD MG/L	3	11,800	6910	20,200
RATIO KG/KKG		48.6	29.2	80.8
(LB/TON)		97.2	58.4	162
TSS MG/L	3	9130	2520	33,100
RATIO KG/KKG		37.6	11.1	127
(LB/TON)		75.1	22.2	254

PROCESS CODE(S): 47N79W , 47N79I , 47N63H

SUBCATEGORY B 7 - DRY PET FOOD

General Plant Clean Up

Clean up in a dry pet food plant is generally a combination of both dry and wet methods with each coming at different times within a processing period.

Wet Clean Up - Wet clean up generally consists of periodic floor washings along with some "end-of-production" equipment clean up. At "start-up" of a production run, some "off-test" material is usually generated. The excess is generally scooped away, but the floor areas around the extruder/expander equipment is typically washed. Similarly, in some plants, the fat application areas were observed to be periodically wet-cleaned to maintain sanitary conditions. Some plants had pre-blending or tempering chambers in which water or steam was added to the pre-mixed grains before the extruders. These chambers were periodicaly scrubbed and rinsed.

The principal components discharged are bits of grain, finished product, and minute fat coated particles. Volume, however, from these clean up operations is generally minor relative to non-contact cooling water.

Dry Methods - Dry pet food is essentially a blend of dry ingredients to which water or steam has been added to facilitate the extruding/expanding process. As such, most of the periodic, housekeeping type clean up involves handling dry or semidry materials which have been lodged between pieces of equipment or have fallen on the floor. Continuous dry clean up is a necessity for good housekeeping.

Non-Contact Cooling Water

The largest source of water in the manufacture of dry pet food is non-contact cooling water and steam condensate from the extruder/expander operation. This water acts as a dilutor for the clean up water, the results of which are very low waste loads in terms of the various flow-related parameters.

Model Plant

Dry pet foods are typically manufactured with similar equipment and processing techniques. As a result, the waste loadings and concentrations (with the exception of plant 47D611) show limited and predictable ranges. The model plant produces 211 kkg/day of finished product with a resulting effluent 0.019 mgd. As can be seen from Table 75 the flow ratio is only 155 l/kkg is an indication of the small amount of waste loads from these plants.

Average BOD loading was .032 kg/kkg with a range from .011 to .096 kg/kkg. The average BOD concentration was 202 mg/l with a range of 51 to 796 mg/l. The other flow-related parameters follow the same pattern as described above.

DRAFT

TABLE 75. RAW WASTE SUMMARY
DRY DOG AND CAT FOOD

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	7	211	71.0	626
(TON/DAY)		232	78.3	690
SHIFT TIME HR/DAY	6	26.2	8.00	53.3
FLOW VOLUME MGD	6	0.019	0.009	0.047
FLOW RATE L/SEC	6	0.339	0.019	6.1[illegible]
(GAL/MIN)		5.05	0.240	10[illegible]
FLOW RATIO L/KKG	7	155	41.0	587
(GAL/TON)		37.2	9.83	141
5 DAY BOD MG/L	7	202	51.0	796
RATIO KG/KKG		0.032	0.011	0.[illegible]
(LB/TON)		0.061	0.021	0.[illegible]
TSS MG/L	7	186	69.4	437
RATIO KG/KKG		0.030	0.017	0.[illegible]
(LB/TON)		0.059	0.032	0.[illegible]

PROCESS CODE(S): 47050W ,47052M ,47052W ,47060I2 ,4706[illegible]I1 ,
47051I ,47065I

SUBCATEGORY B 8 - SOFT-MOIST PET FOOD

General Plant Clean Up

Clean up in a soft-moist pet food plant is a function of the type of soft-moist product style manufactured. The products which call for the direct use of meat, fish, or poultry generally require more periodic cleaning than do the grain-based formulations. As is true in all of pet foods, clean up can be divided into housekeeping and end of shift clean up.

Housekeeping - Housekeeping is the most continuous of clean up steps. The various grinding, mixing, extruding, and conveying operations generate scraps of grain, meat, and finished product. Typically these are disposed of by dry methods such as scoops, shovels, or brooms. Occasionally the floors will be washed to remove minute particles which can't be removed by scraping. These few uses of water contribute a small percentage of flow and pollutants to the waste stream.

End of Shift Clean Up - End of shift clean up with regards to soft-moist production is generally end of production dry clean up. At this time, grinders, augers, mixing tanks, extruders, conveyors, etc., are completely and thoroughly washed with detergents. A final sanitizing rinse sometimes follows. This type of cleaning generates a peak flow and loading condition which is generally responsible for a majority of the flow and almost all of the pollutants.

Non-Contact Cooling Water

The on[illegible] other source of water used in the production of soft-moist pet food is extruder cooling water or condensate from an expander. Flows vary widely according to the type of process. No quantifying data are available to further delineate these effluent streams. In some plants, these non-contact cooling waters were observed to be discharged directly under NPDES permit.

Model Plant

The model soft-moist pet food plant produces daily 51.4 kkg of finished product while generating an effluent of 0.017 mgd. As shown in Table 76 average BOD loading is 6.73 kg/kkg with a range from 6.28 to 7.20 kg/kkg.

The average BOD concentration was 4600 mg/l with a range of 3420 to 6200 mg/l. The reason for the wide range of concentrations is due principally to the surges of water attributable to the various clean up cycles within varied time spans. The other flow-related parameters follow the same pattern as described above.

DRAFT

TABLE 76. RAW WASTE SUMMARY
SOFT MOIST DOG AND CAT FOOD

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	2	51.4	2.02	1310
(TON/DAY)		56.7	2.23	1450
SHIFT TIME HR/DAY	2	16.0	8.00	24.0
FLOW VOLUME MGD	2	0.017	--	[illegible]
FLOW RATE L/SEC	2	1.33	0.067	26.8
(GAL/MIN)		21.1	1.05	425
FLOW RATIO L/KKG	2	1460	1010	2100
(GAL/TON)		350	243	504
5 DAY BOD MG/L	2	4600	3420	6200
RATIO KG/KKG		6.73	6.28	7.20
(LB/TON)		13.4	12.5	14.[illegible]
TSS MG/L	2	1090	436	2740
RATIO KG/KKG		1.60	0.443	5.77
(LB/TON)		3.19	0.883	11.[illegible]

PROCESS CODE(S): 47M65I ,47M52W

DRAFT

MISCELLANEOUS AND SPECIALTY PRODUCTS

SUBCATEGORY A 29 - FLAVORING EXTRACTS

As discussed in Section III, it has been determined that a typical flavor manufacturing plant produces flavoring extracts which are subsequently combined with other extracts and/or ingredients to produce finished specific flavors. Natural extracts are produced by vacuum distillation, solvent extraction, or expression of whole plants, plant parts, or plant essential oils, while synthetic extracts are produced by the combination of ethyl alcohol and organic acids. A discussion of the waste streams which would be expected from the manufacturing of finished specific flavors is presented below.

Vacuum Distillation

Wastewater generated by the vacuum distillation of essential oils and plant tissues consists of still bottoms. The still bottoms from distillation of essential oils would be expected to contain terpenes while distillation of plant tissues would result in remnant tissue in the still bottoms.

Solvent Extraction

There is no wastewater generated from the solvent extraction of plant tissues. All installations participating in the study indicated that solvents were recovered and that spent plant tissue was hauled to landfill.

Expression

The expression of essential oils from fruits generally results in the generation of fruit water and spent fruit tissues. Fruit water becomes part of the plant waste stream and spent plant tissues are generally sold for production of pectin (citrus fruit only) or sold as cattle feed.

Synthetic Flavoring Extracts

The organic synthesis of solvents such as ethyl alcohol, methylene chloride, benzene, and toluene, with organic acids results in the production of synthetic flavoring extracts. Based on available information, there appears to be no wastewater generated in this process other than equipment cleanup.

Dehydration

The dehydration of flavoring extracts to produce dry concentrates generates no process water other than cleanup since all liquid is released into the atmosphere as vapor.

Evaporation

The evaporation of flavoring extracts to produce concentrated flavors generates no process wastewater other than cleanup since all evaporated liquid is released into the atmosphere as vapor.

Finished Specific Flavor Blending Tanks

The blending of flavoring ingredients to produce finished flavors generates no wastewater other than cleanup water.

Plant Cleanup

Plant 87E05 reported that organic synthesis tanks were cleaned either by hot water flushing or steam, while stills and extraction tanks were steam cleaned. The waste streams from the cleaning of organic synthesis and solvent extraction tanks contain a certain amount of solvents. The cleanup waste stream from the stills would not be expected to contain toxic solvents unless the flavoring extract distilled had been initially produced by organic synthesis or solvent extraction. Plants 87E03 and 87E05 both segregate these three cleanup waste streams, along with still bottoms, from the remainder of the plant effluent.

The cleanup of finished flavor mixing tanks is generally done between flavor changes and consists of a detergent wash followed by a final rinse. Floors in the blending tank areas are hosed as needed to remove spills and leaks from equipment connections.

Non-Contact Water

Non-contact condenser cooling water is generated in the vacuum distillation process. Boiler blowdown is another source of non-contact water.

Total Plant Effluent

Based on the above considerations it may be concluded that the quantity and quality of the wastewater generated from the manufacturing of finished flavors could be dependent on the following factors:

1. If the flavoring extracts used in the manufacturing of finished flavors are produced in-house or purchased. Purchasers of extracts would generally require no distillation, solvent extraction, expression, or organic synthesis equipment and consequently, the waste streams from these processes would be eliminated.

2. The form in which the finished flavors are produced. A plant producing dry flavor concentrates and/or concentrated

flavors might conceivably have a smaller waste flow with a lower pollutant loading, especially if dehydration equipment is cleaned without use of water.

Wastewater characteristic data was obtained for two plants during the course of this study. The average wastewater characteristics of plant 87E02 were determined to be as follows:

Flow	5.7 cu m/day (0.0015 MGD)
BOD	0.017 cu m/cu m
SS	0.0155 cu m/cu m
pH	7.4

The plant's production operations consisted of the following:

1. Production of natural vanilla flavoring from the alcohol extraction of raw vanilla beans.

2. Production of finished specific flavors from purchased flavoring extracts.

3. Production of spices by dry grinding and blending.

4. Production of certified colors.

The total wastewater flow was attributable to cleanup operations such as washing blending tanks between flavor changes. The average flow from the plant was estimated to be 5.7 cu m/day (0.0015 MGD) with a range of 0 to 11.4 cu m/day (0 to .003 MGD).

The average wastewater characteristics of plant 87E03 were determined to be as follows:

Flow	125 cu m/day (0.033 MGD)
BOD	0.56 cu m/cu m
SS	0.054 cu m/cu m
pH	7.1

The production operations at this plant consisted of the following:

1. Production of synthetic flavors by organic synthesis.

2. Purification of essential oils by vacuum distillation to produce standard extracts.

3. Blending of flavoring materials to produce finished specific flavors.

The wastewater from the organic synthesis and vacuum distillation processes was segregated from the rest of the waste stream, neutralized, and contracted to a private service for ultimate disposal. According to plant personnel the contracted waste is composed of "soluble organics" and totals 23 cu m/week (0.006 mg/week). A similar waste generated at plant 87E05 was reported to be composed of the following constituents: still bottoms, methylene chloride, methyl ketone, methyl hydroxide, toluene, benzene, and carbon aromatics.

Model Plant

Based on available information from industry, it appears that plant 87E03 is more typical of the industry than plant 87E02. Therefore, plant 87E03 was selected as the model plant for Subcategory A 29 and is illus ated in Figure 135. The major wastestreams generated at the plant consist of still bottoms, and cleanup of stills, organic synthesis tanks, and blending tanks. However, the wastestreams from the cleanup of stills and synthesis tanks as well as still bottoms are segregated from the remainder of the wastestream. All non-contact water is also separated from the waste stream.

The wastewater characteristics of the model plant are as follows:

Flow	125 cu m/day (0.033 MGD)
BOD	1350 mg/l
SS	130 mg/l
pH	7.1

SUBCATEGORY A 31 - BOUILLON

The process description of bouillon manufacturing was presented in Section III and it was determined that equipment cleanup water constituted the total wastewater flow from a bouillon manufacturing plant.

Equipment Cleanup

Plant 99Q01 conducts a daily plant cleanup of equipment used in bouillon processing and this wastewater was found to have the following characteristics:

Flow	114 cu m/day (0.03 MGD)
BOD	4200 mg/l
SS	192 mg/l
FOG	150 mg/l
pH	10.4

Plant 99Q02 which conducts periodic daily plant cleanup and weekly cleanup of all equipment generated wastewater with the following characteristics:

Flow	720 cu m/day (0.19 MGD)
BOD	1610 mg/l
SS	239 mg/l
FOG	82 mg/l
pH	6.9

DRAFT

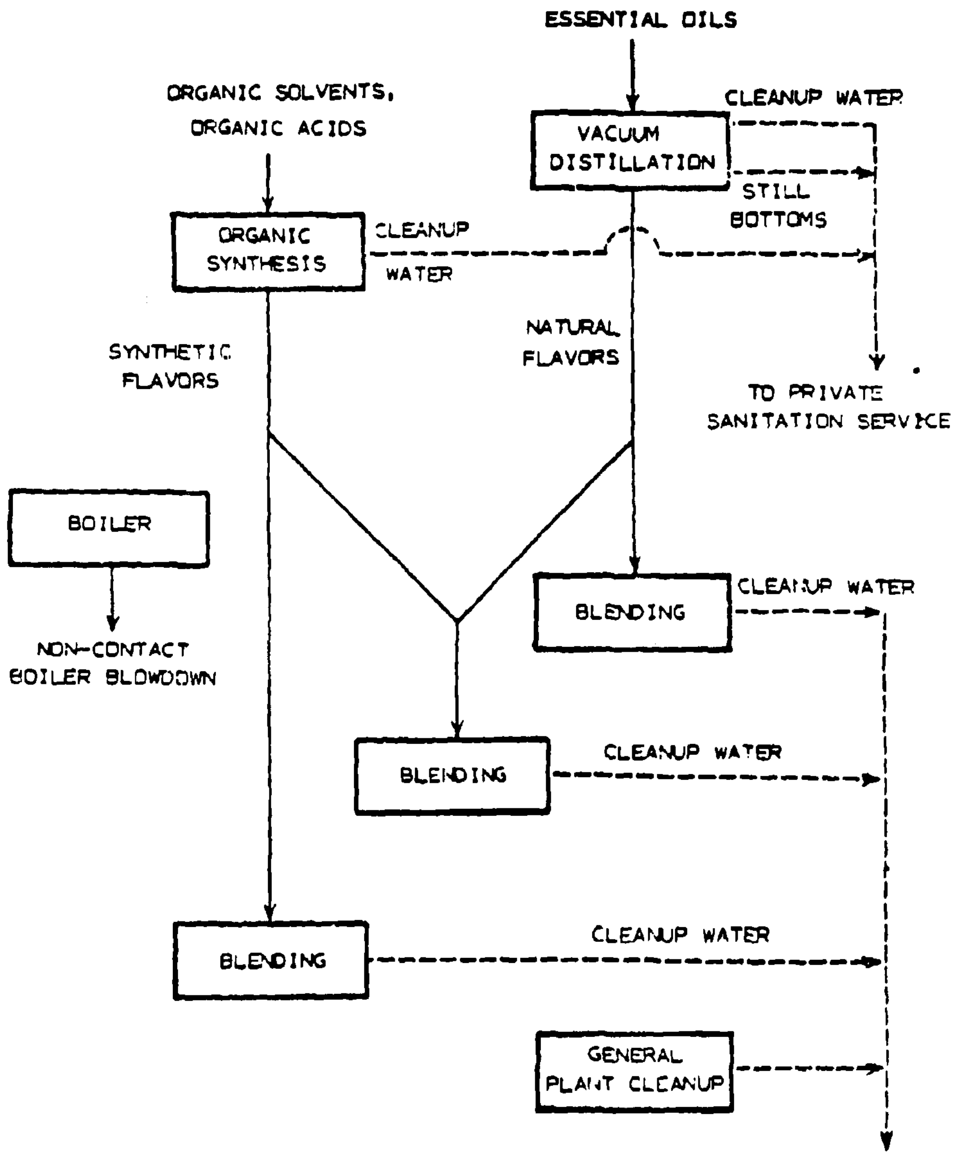


FIGURE 135

MODEL PLANT FOR SUBCATEGORY A 29
FLAVORING EXTRACTS

Dry Cleanup

All plants contacted utilized dry cleaning and generated no wastewater in packaging areas.

Total Plant Effluent

The total plant effluent is attributable to equipment cleanup and consequently the waste characteristics presented for equipment cleanup also apply for total plant cleanup.

Model Plant

The model plant for this subcategory is a hypothetical plant producing bouillon products exclusively and is illustrated in Figure 136. The plant operates 16 hours per day, five days per week with daily equipment cleanup. The wastewater characteristics of the plant are as follows:

Production:	7.3 kkg/day (8.0 ton/day)
Flow:	151 cu m/day (0.03 MGD)
BOD:	3000 mg/l
SS:	200 mg/l
FOG:	150 mg/l

All cleanup in packaging areas is done with air. A grease trap prior to discharge from the plant is provided to decrease the fats and oil content of the wastewater.

SUBCATEGORY A 32 - NON-DAIRY CREAMER

Based on processing information obtained during the course of this study, the major source of wastewater generated in the manufacturing of both liquid and powdered non-dairy creamer is determined to be equipment cleanup water. Generally, clean-in-place systems are used for equipment cleanup. Minor contributors to wastestream quantity are hosing of floors and wet scrubber discharge.

Clean-in-Place Systems

The clean-in-place systems used for equipment cleanup in non-dairy creamer plants generally employ six cleaning cycles consisting of the following sequential steps: (1) hot water pre-rinse, (2) caustic wash, (3) chlorine rinse, (4) final rinse, (5) sanitization, and (6) air drying. The quantity of water used in each of the six cycles is usually fixed and thus water requirements are minimized. For plants of equal size there is no indication that the quantity of water necessary for the cleaning cycles would vary markedly. However, the frequency of cleaning does vary, causing significant differences in wastewater quantity. Within the industry three distinct patterns of CIP system cleanup exist:

DRAFT

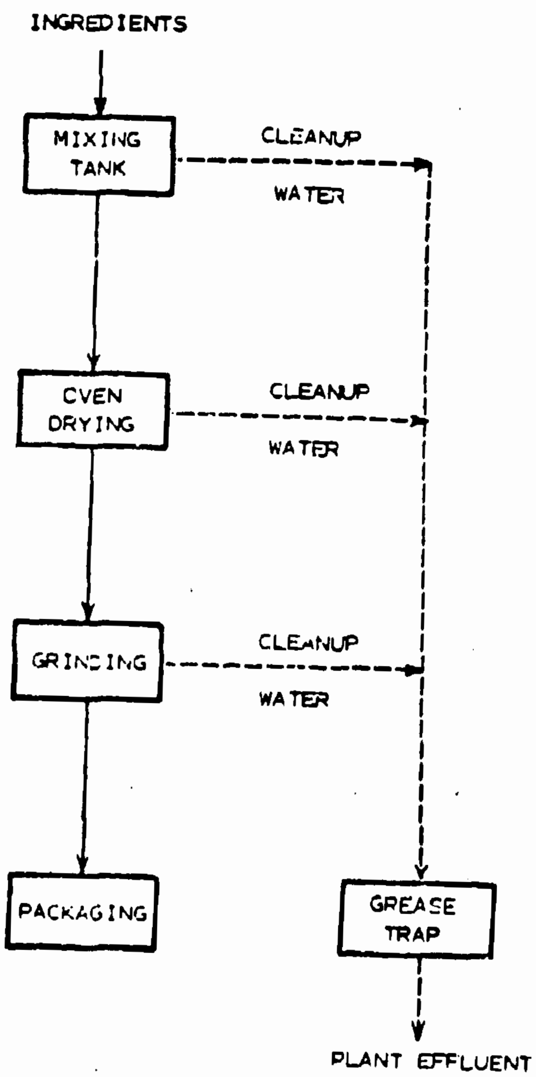


FIGURE 136

SUBCATEGORY A 31 MODEL PLANT
MODEL PLANT - BOUILLON MANUFACTURING PROCESS

(1) cleanup at the end of each day, (2) cleanup at the end of each week (plants operating 24 hours per day), and (3) cleanup at the end of each processing cycle (plants which produce creamer on an irregular basis and for varying lengths of processing). Assuming recycling of caustic and acid rinse water, a typical plant will use about 7.57 cu m/day (0.002 MGD) of water for each CIP system cleanup.

General Plant Cleanup

Liquid non-dairy creamer plants generally hose packaging area floors continuously to remove product spills. Powdered non-dairy creamer plants periodically hose floors in areas where spills of dry product from equipment connections occur. The quantity of water used in hosing of floors is unregulated in both cases.

Wet Scrubber

In the case of powdered non-dairy creamer manufacturing, wet scrubbers are used over the spray dryers to prevent dispersion of fine particulates into the atmosphere. The effluent from each scrubber at Plant 99NN01 is approximately 16,000 l/day (4000 gal/day). The pollutant characteristics were determined to be:

BOD:	4.6 mg/l
SS :	7 mg/l
F&O:	0.1 mg/l

Non-Contact Water

A substantial amount of cooling water is needed in the manufacturing of non-dairy creamer. Based on plant water intake minus the quantity of wastewater generated, the quantity of non-contact cooling water and boiler blowdown for a typical plant would be about 378 cu m/day (0.10 MGD) One multi-product plant (99NN02) producing liquid creamer recycled cooling water and only makeup water was needed. A powdered creamer plant (99NN01) discharged non-contact cooling and boiler blowdown water separately from the waste stream with the quantity estimated at 454 cu m/day (0.12 MGD).

Total Process Effluent

Plant 99NN01 producing only powdered non-dairy creamer generated a total process effluent with the following average characteristics:

Flow:	56.8 cu m/day (0.015 MGD)
BOD :	1250 mg/l (range 1000-15000)
SS :	415 mg/l (range 355-475)
F&O :	250 mg/l (range 227-275)
pH :	7.0 (range 6.8-7.2)

Plant 99NN02, producing liquid creamer in a multi-product facility, generated wastewater with the following average characteristics:

Flow:	1800 cu m/day (0.47 MGD)
BOD :	3000 mg/l
SS :	2200 mg/l
F&O :	140 mg/l
N :	15 mg/l
P :	8.0 mg/l

Although it is not possible to determine which portion of these pollutants is specifically attributable to the manufacturing of liquid creamer, the data are presented to indicate that the wastewater from the plant is nutrient deficient. This particular plant produces a wide variety of products, each of which is composed of the same basic ingredients as liquid creamer but in varying proportions. Therefore, it can be concluded that the wastewater from a plant producing solely liquid creamer would also be nutrient deficient.

Model Plant

The model plant developed for Subcategory A32 as illustrated in Figure 137 is a hypothetical plant which would produce either liqid or powdered non-dairy creamer. The plant operates five days per week with two eight hour shifts per day. Clean-in-place system cleaning is conducted periodically as needed and at the end of each day and generates approximately 7.57 cu m/day (0.002 MGD) of wastewater with recycling of caustic and acid rinse water. If the plant produced liquid creamer, the only other wastestreams generated would be hosing of floors in packaging areas and other general plant cleanup amounting to about 56.8 cu m/day (0.015 MGD). If the plant produced powdered creamer, two spray dryers would be needed and therefore two wet scrubbers are necessary. Combined flow from wet scrubbers would be 30 cu m/day (0.008 MGD). An additional wastewater generation of 26.4 cu m/day (0.007 MGD) would be generated by hosing of dry product spills and general plant cleanup. In either case the total plant waste effluent is approximately 64.3 cu m/day (0.017 MGD).

Non-contact water is discharged separately from the waste stream and amounts to about 380 cu m/day (0.10 MGD). There is no recycling of the non-contact cooling or boiler blowdown water. The proposed model plant would have the following characteristics:

Production: 90 KKg (100 ton) dry product
or 180 KKg (200 ton) wet product

Flow	64.3 cu m/day (0.017 MGD)
BOD	1100 mg/l
SS	440 mg/l
F&O	265 mg/l
N	5.5 mg/l
P	2.9 mg/l
ph	7.0

DRAFT

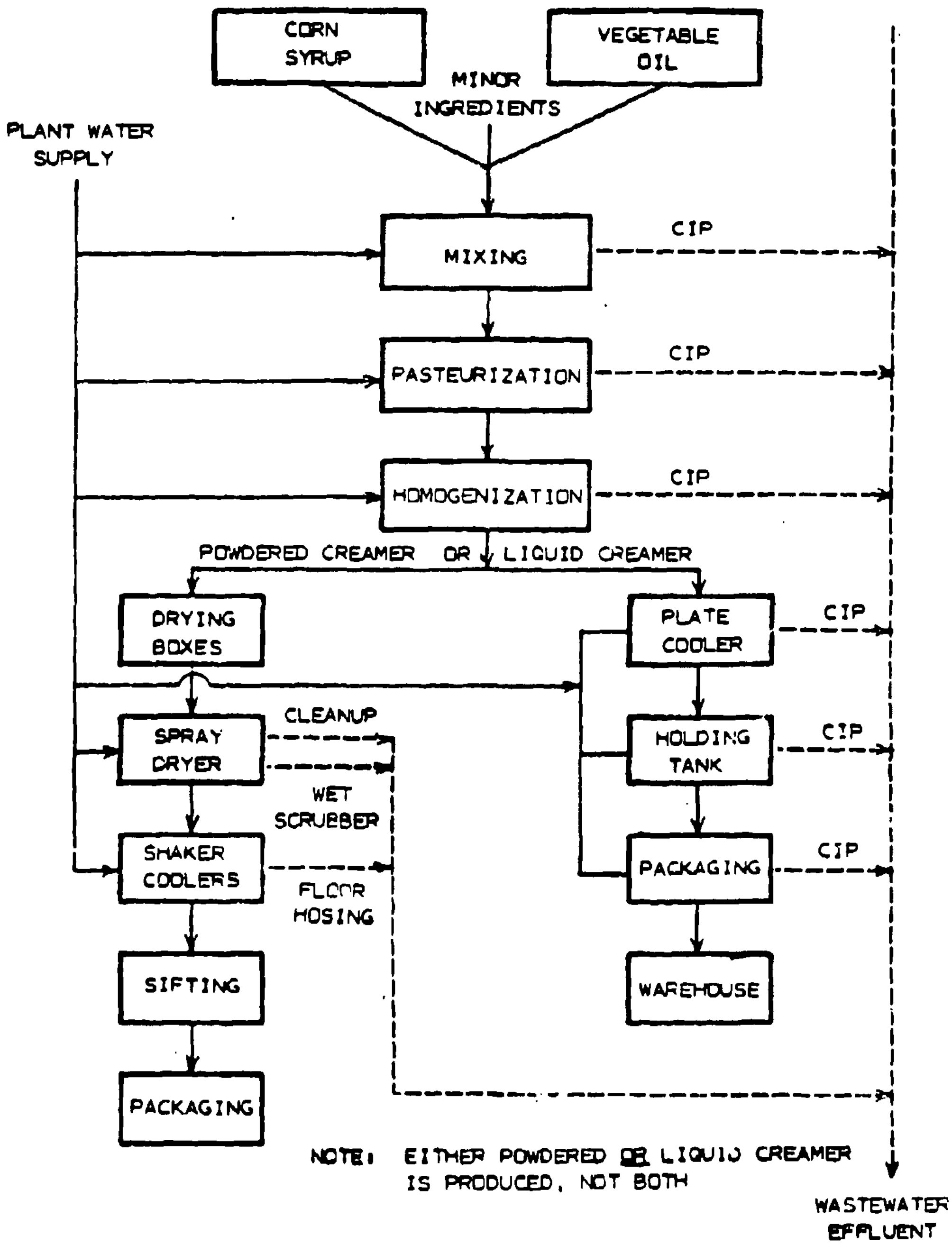


FIGURE 137

SUBCATEGORY A32 - MODEL PLANT
NON-DAIRY CREAMER MANUFACTURING

SUBCATEGORY A 33 - YEAST

The use of water in yeast factories includes: (1) feed wort preparation; (2) fermenter start water; (3) sterilization of molasses and feed wort tanks, fermenters, and piping; (4) separation wash water; (5) cleaning of separation and dewatering equipment; (6) miscellaneous floor and equipment cleanup; (7) cooling water; and (8) boiler feed. Considering strength and volumes, the wastestreams from yeast production can be ranked in the following order: (1) first separation beer, (2) second separation beer, (3) third separation beer, (4) filtration water from yeast dewatering; (5) fermenter and storage tank cleanup water; and (6) floor and equipment cleanup water.

Table 77 shows the pollutant loads of the above operations at a typical plant (99Y03) producing 76.5 kkg/day (84.3 ton/day). First separation beer accounts for 43 percent of the total flow, 78 percent of the BOD, and 31 percent of suspended solids at this plant. The high strength waste of combined first and second separation beer account for 92 percent of the total flow, 90 percent of the BOD and 58 percent of the suspended solids reported from in-plant sampling. Third separation beer is reused for cold washing during second separation.

Rudolfs and Trubnick (86) reported that first separation beer at a similar plant (99Y01) producing 82.2 kkg/day (90.6 ton/day) was responsible for approximately 70 percent of the plant raw waste load. The BOD of spent beer may vary from 2000 mg/l to 15,000 mg/l. Wide variations in flow also occur as the result of different water usage by individual plants during centrifugal separation of yeast from spent nutrients.

Third separation beer was reused in the second separation by 66 percent of plants supplying data, since it contains only a small portion of plant waste. First and second separation beer typically account for 50 percent of the flow and 75 percent of the BOD and SS plants that do not reuse process water.

Discharges from yeast dewatering consist of water removed from the yeast cream by rotary vacuum filters and recessed-plate filter presses. Table 78 presents the wastewater characteristics for five composite samples (Plant 99Y03) dewatering operations. Filter discharges, containing varying amounts of yeast and spent filter aid, cause substantial daily fluctuations in strength. Quantities of water discharged depend upon production levels and the moisture content of the final product, but are generally less than 10 percent of plant flow.

Cleanup of fermenters and feed wort storage tanks is normally performed using hot water and steam between batch operations to prevent bacterial contamination during fermentation. Molasses storage tanks are cleaned weekly using clean-in-place systems with hot water and a 3 percent sodium hydroxide solution. Tank cleanup varies according to cleaning techniques and equipment, and the age and size of the plant storage facilities, but

TABLE 77

YEAST PLANT 99Y03
UNIT OPERATIONS WASTEWATER CHARACTERISTICS

Operation	Flow (cu m/day)	% Total	pH	Bod (kg/day)	% Total	SS (kg/day)	% Total
First Separation	1,008	43	6.8	8,656	78	317	31
Second Separation	1,132	49	7.0	1,317	12	273	27
Third Separation	529(1)	--	6.8	324	3	142	14
Tank Washdown	79	3	5.8-13.6	571	5	121	12
Yeast Dewatering	109	5	6.8	191	2	15	16
TOTAL	2,328	100		11,059	100	1,0[illegible]2	100

(1) Third separation wash reused in second separation.

DRAFT

TABLE 78

YEAST DEWATERING EFFLUENT CHARACTERISTICS

PLANT 99Y03

Day	Flow (cu m/day)	Production (kkg)	COD (mg/l)	COD (kg)	BOD Ratio (kg/kkg)	SS (mg/l)	SS (kg)	SS Ratio (kg/kkg)	COD (mg/l)	COD (kg)	COD Ratio (kg/kkg)	COD/COD Ratio
1	290.0	103	480	140	1.4	960	30	0.29	2880	835	8.1	0.17
2	377.0	76.5	700	263	3.5	680	256	3.4	1532	578	7.5	0.46
3	492.0	85.0	1780	876	10.3	1320	650	7.6	3210	1579	18.6	0.56
4	95.4	85.4	1360	130	1.5	1540	141	1.7	3085	294	3.4	0.44
5	307.3	99.3	960	295	3.0	1080	332	3.3	2410	741	7.4	0.40
Average	312.3	89.9		431	3.9		287	3.2		805	9.0	0.41

TABLE 79

WATER USAGE AND WASTEWATER CHARACTERISTICS

YEAST PLANTS RECYCLING SEPARATION WATER-PLANTS 99Y01, 99Y05

VARIABLE	N	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	COEFFICIENT OF CONVARIANCE (%)
Flow (MGD)	126	0.693399	0.083141	0.0069	0.440000	0.910000	11.991
Prod. (ton/day)	126	90.408730	3.742085	14.0032	69.200000	96.200000	4.139
BOD (mg/l)	126	6252.944444	1023.914718	1048401.3489	3600.000000	10800.000000	16.349
SS (mg/l)	126	1822.230159	999.185341	998371.3466	420.000000	8900.000000	54.833
COD (mg/l)	1	14602.000000	0.0	0.0	14602.000000	0.0	0.0
BOD (lb/day)	126	36214.451772	7280.916476	53011744.7306	19527.300000	68495.760000	20.105
COD (lb/day)	1	91999.535950	0.0	0.0	91999.535950	91999.535950	0.0
SS (lb/day)	126	10570.723429	6041.406934	36498597.7454	2593.626000	52732.055000	57.152
Lb/ton-BOD	126	401.560349	84.916591	7210.8275	202.986486	794.614385	21.147
Kg/kkg-BOD	126	200.780174	42.458296	1802.7069	101.493243	397.307193	21.147
Lb/ton-COD	1	1091.334946	0.0	0.0	1091.334946	1091.334946	0.0
Kg/kkg-COD	1	545.667473	0.0	0.0	545.667473	545.667473	0.0
Lb/ton-SS	126	116.654232	66.615573	4437.6346	28.532739	584.612583	57.007
Kg/kkg-SS	126	58.427116	33.307787	1109.4086	14.266370	292.306296	57.007
BOD/COD Ratio	1	0.461649	0.0	0.0	0.461649	0.461649	0.0
Flow Ratio	126	7679.939779	958.015079	917792.8924	4695.837780	9790.979098	12.474

N = Number of data points. Note: Computer calculations for this table show no regard for significant figures.

it typically generates less than 5 percent of the total flow, 5 percent of the total BOD, and 15 percent of the suspended solids.

Floor and equipment cleaning is performed as needed to maintain bacteriological cleanliness. Hot water and occasional small amounts of detergent or caustic are used to clean molasses clarifiers, centrifugal separators, filters, and packaging equipment. Cleanup effluent is a small part of combined plant waste.

Table 79 presents a statistical analysis of combined plant raw effluent data for plants that reuse third separation beer during second separation. Although flow was found to range as high as 6800 cu m/day (1.8 MGD) in a plant not recycling separation water, the generation of pollutants per unit of production varied less than 10 percent for similar production levels. The two largest producers both reported an average of 170 kg/kkg (340 lg/ton) of BOD, while suspended solids varied from 50 kg/kkg (100 lb/ton) to 76 kg/kkg (152 lb/ton).

Yeast effluents (86), composed predominantly of highly putrescible dissolved organic waste substances, have a specific yeasty odor that rapidly becomes unpleasant (87), a coffee color, and fairly high turbidity. The wastewater contains yeast cells, fatty residue, albumens, and their decomposition products and carbohydrates. Inorganic compounds include, phosphates, large amounts of potassium, and sulphates. These effluents putrefy easily as sulphates are biologically reduced to sulphides, and require oxygen for stabilization in much the same manner as domestic sewage. They are usually acidic since a pH of 4.5 is maintained during fermentation. The pH of a total plant effluent samples collected during this study ranged from 4.2 to 7.7, but more typical values were in the range of 6.0 to 6.8

Since molasses is deficient in nitrogen and phosphorus, ammonia, and phosphoric acid are both required chemical nutrients added in fermentation. After yeast growth, the effluents from production are again nutrient deficient. Analyses (79) of similar spent molasses in the rum industry found the distillery slope to have a 94 percent phosphorus deficiency and a 56 percent nitrogen deficiency. Plant 39Y20, operating an oxygen activated sludge treatment system, adds ammonia and 227 l/day (60 gal/day) of 70 percent phosphoric acid before treatment.

Model Plant

Based on the above discussion, a model plant for Subcategory A33 is defined as follows:

Production	82 kkg/day (90.4 ton/day)
Flow	2650 cu m/day (0.7 MGD)
BOD	6300 mg/l
SS	1850 mg/l

It is assumed that the model plant practices reuse of third separation spent beer, and that first and second separation beer constitute 50 percent of plant flow and contribute 75 percent of the BOD and suspended solids of raw waste.

SUBCATEGORY A 34 - PEANUT BUTTER WITH JAR WASHING

The uses of water in peanut butter processing plants include: 1) jar washing, 2) floor and equipment cleanup, 3) cooling,water, 4) boiler feed, and 5) vacuum seal water. Peanut butter is immiscible in water, and does not not require the addition of water to the product during processing. In fact, bacteriological cleanliness demands special attention to insure that water does not enter the interior of pumps, piping, and other process equipment. Water use varies widely for individual plants due to production requirements, and dissimilar water conservation and recycling techniques. For example, grinder cooling water may be discharged directly after use or recirculated through cooling towers. Table 80 presents a breakdown of water usage per operating day by a plant (99P21) producing 59 to 77 kkg/day (65 to 85 tons/day) and demonstrates that over 98 percent of all water used does not contact the product.

Sources of polluted wastewater from peanut butter production can be ranked in the following manner: 1) jar washer discharges, and 2) floor and equipment cleanup discharges. All of the plants surveyed dispose of jar washer effluent and cleanup related wastewater, mixed with substantial amounts of non-contact water, to municipal sewer systems.

Jar Washing - In plants employing jar washing to reclaim glass for packaging, the detergent rinse is normally discharged and constitutes the major process waste stream. Plant 99Y20, producing 10 kkg/day (11 tons/day) has a jar washer discharge of 680 l (180 gal) per 500 jars washed, and a maximum daily discharge of 2040 l/day (541 gal/day). Approximately 6000 jars/month are washed at this plant. Jar washer effluent is a low volume, high strength waste that produces 10 gm (0.022 lb) of BOD, 3.8 gm (0.0081 lb) of suspended solids, 125 gm (0.0275 lb) of COD, and 4.5 gm (0.01 lb) of fats and oils per 510 gm (1.125 lb) jar washed. Table 81 shows the calculated results of plant 99P20 jar washer effluent sampling after correcting flow to account for non-contact water.

Bad product manually scraped from improperly filled or sealed jars is sold as inedible oil stock. Variations in pollutant loading per unit of production may be attributed to differences in the number and size of jars washed, and the method of product removal from reclaimable glass.

The largest plant (99Y01) in the industry, producing 140 to 230 kkg/day (150 to 250 tons/day), reported BOD concentrations nearly doubled and suspended solids concentrations tripled while practicing glass reclamation. Waste load data from this plant was not used in selecting a model plant because the wastewater contained large, undetermined amounts of non-contact water and resulted from the production of several products.

Floor and Equipment Cleanup - Other than jar washer effluent, floor and equipment cleanup are the only other sources of process wastewater from peanut butter production. Production facilities typically operate five days per week, 24 hours per day. Floors in processing areas are normally

DRAFT

TABLE 80

APPROXIMATE WATER USAGE PER OPERATING DAY
FOR PEANUT BUTTER PROCESSING PLANT 99P21

SOURCE	VOLUME LITERS	GALLONS
Cooling Towers	37,000	9,700
Cooling of Refrigeration and Air Compressors	16,000	4,300
Boiler Feed Water	9,400	2,500
Sanitary	16,000	4,200
Cleanup and Miscellaneous	1,100	300
With evaporation loss, estimated discharge	65,000	17,000

DRAFT

TABLE 81

JAR WASHER WASTEWATER CHARACTERISTICS PLANT 99P20

Flow	2040 l/day (540 gal/day)
BOD	7320 mg/l
BOD Ratio	1.41 kg/kkg (2.82 lb/ton)
COD	9150 mg/l
COD Ratio	1.77 kg/kkg (3.53 lb/ton)
SS	2810 mg/l
SS Ratio	0.58 kg/kkg (1.15 lb/ton)
FOG	3550 mg/l
FOG Ratio	0.69 kg/kkg (1.37 lb/ton)

scrubbed daily using a small quantity of water and detergent, and the water is collected using mops or vacuum equipped floor scrubbers.

Water use for equipment cleanup is typically less than 757 l/day (200 gal/day) and is normally sewered. One plant (99P13) reported an estimate based on hose flow rates of 2710 l/day (715 gal/day) used for cleanup. Table 82 lists cleanup frequency and quantities of water used for equipment cleanup by a typical plant (99P21). Periodic equipment cleanup occurring at weekly or less frequent intervals is usually done using steam hoses in a specially designated area equipped with grease traps on all drains. Equipment cleanup is performed between shifts or on weekends, and normally is not done while production processes are in operation. Plant cleaning procedures are subject to occasional revisions due to equipment changes and constantly improved programs of housekeeping and sanitation. Although no data is available to document the strength of combined cleanup wastewater, an estimated 6.8 to 14 kg/day (15 to 30 lb/day) of product is reported lost to sewers. Residual product clinging to equipment may contain up to three percent added vegetable oil.

Model Plant

Based on the above discussion of wastewater characteristics, the following model plant was defined:

Daily Jar Washer Effluent	2044 l/day	(540 gal/day)
Avg. Daily Cleanup Effluent	757 l/day	(200 gal/day)
Avg. Daily Flow	2801 l/day	(740 gal/day)

The model plant assumes separation of all domestic sewage and non-contact water from the process wastewater. Since strength of cleanup wastewater is unknown, no determination of combined waste strength can be made.

SUBCATEGORY A 35 - PEANUT BUTTER WITHOUT JAR WASHING

The uses of water and wastewater characteristics for peanut butter plants in Subcategory A 35 are identical to those in Subcategory A 34, except that jar washing is not practiced.

Model Plant

The model plant is defined as follows:

Flow = 757 l/day (200 gal/day)

TABLE 82

OCCASIONAL CLEANUP WASTEWATER DISCHARGED-PLANT 99P21

SOURCE	DETERGENT	FREQUENCY	FLOW PER CLEANUP (l)	FLOW YEARLY (cu m)	BOD (mg/l)	COD (mg/l)	SS (mg/l)	FOG (mg/l)	pH
1. Warehouse concrete floor scrubber	1.1 l liquid	daily	114	29523	37600	85760	89800	189	10.8
2. Production building wood floor scrubber	Concentrate	2/week	95	9680	28433	42346	16600	573	8.0
3. Chunk equipment cleanup	None	1/week	76	3936	2267	6788	2880	1217	6.1
4. Equipment exterior wipe-down	Concentrate	1/week	1136	59046	3050	8464	370	126	11.5
5. Equipment exterior wipe-down	Concentrate	1/week	379	19708	11766	37352	6460	399	9.9
6. Elevator conveyor bucket cleanup	None	1/week	189	9841	-----	-----	-----	-----	-----
7. Process line piping cleanup	None	1/month	946	11355	-----	-----	-----	-----	-----
8. Bucket and drip pan cleanup	None	1/month	1514	18168	-----	-----	-----	-----	-----
9. Oil stock drum wash	None	1/month	568	6813	-----	-----	-----	-----	-----
10. Elevator conveyor bucket cleanup	2.3 kg Powder	4/year	833	3332	-----	-----	-----	-----	-----
11. Raw nut elevator conveyor cleanup	2.3 kg Powder	2/year	883	3332	-----	-----	-----	-----	-----

DRAFT

SUBCATEGORY A 36 - PECTIN

As described in Section III, there are two methods of manufacturing pectin; precipitation by alcohol and precipitation by use of aluminum compounds. The characteristics of each waste stream generated in the alcohol precipitation process at plant 99K01 are presented in Table 83. The waste stream characteristics of plant 99K02, which uses aluminum precipitation in the recovery of pectin, are summarized in Table 84. Comparison of similar waste streams from the two plants yields the following observations:

1) The quantity of alcohol still bottoms generated per day by plant 99K01 is approximately 4.5 times greater than at plant 99K02. This is attributable to the fact that more alcohol is used in the process at plant 99K01 and therefore more still bottoms from the recovery of the alcohol would be expected.

2) The amount of peel washwater generated at plant 99K02 is greater than at plant 99K01 which is expected due to the higher production at the former.

3) The quantity of general plant cleanup water is larger at plant 99K01 than at plant 99K02 which is probably attributable to an unknown amount of cooling water included in the waste stream of the former.

It should be noted that there is no evaporation of pectin solution prior to precipitation at plant 99K02 and therefore no caustic wash waste stream is generated. In contrast the pectin mother liquor waste stream at plant 99K02 is not generated at plant 99K01 because this waste stream is ultimately distilled for alcohol recovery at plant 99K01 and as a result becomes a portion of the alcohol still bottoms. This observation supports the previous comparison of still bottom waste streams. Additionally, press liquor wastewater at plant 99K02 is generated when filter sluice is pressed to separate water from diatomaceous earth.

The wastewater analysis for the total plant effluent from three plants (99K01, 99K02 and 99K03) is presented in Table 85. It should be noted that the alcohol still bottoms and filter sluice waste streams at plants 99K01 and 99K02 were not considered in arriving at the figures presented. Plants 99K02 and 99K03 showed good agreement between waste flow generated per unit of product produced. The slightly higher flow figure at plant 99K01 can be partially attributed to an undeterminable amount of non-contact cooling water in the waste stream.

Model Plant

Based on the information presented above a model plant was chosen for this subcategory. The plant operates 24 hours per day, 365 days per

TABLE 83

WASTEWATER CHARACTERISTICS OF INDIVIDUAL WASTE STREAMS AT PLANT 99K01

DRAFT

Wastestream	Flow cu m/day	COD mg/l	TS mg/l	Cl mg/l	pH
1. Alcohol still bottoms	170	17,000	19,200	9,930	0.8
2. Filter sluice	223	4,050	4,500	146	6.5
3. Peel washing	424	18,800	20,800	37	4.5
4. Evaporator caustic wash	0.0008	1,190	29,700	-----	12.3
5. General cleanup, non-contact cooling water	681	500	-----	*(18)	*(7.0)
Total (excluding items 1 & 2)	1,105	7,521	7,981	25.3	6.04

* Estimate based on plant intake water.

TABLE 84

WASTEWATER CHARACTERISTICS OF INDIVIDUAL WASTE STREAMS AT PLANT 99K02

Wastestream	Flow cu m/day	COD mg/l	Cl mg/l	N mg/l	pH
1. Alcohol still bottoms	37.9	2,800	----	----	----
2. Filter sluice	757	3,200	160	25	7.0
3. Peel washing (leach)	662	14,600	95	235	4.0
4. Pectin mother liquor	492	2,150	38	406	4.1
5. Press liquor wastewater	189	11,425	170	224	5.5
6. General Plant cleanup	189	2,000	*(20)	----	*(7.0)
Total (Excluding items 1 & 2)	1,532	8,655	76.7	259.6	4.59

*Estimate based on plant intake water

TABLE 85

SUMMARY OF WASTEWATER CHARACTERISTICS

Subcategory A 36 - Pectin

PLANT	FLOW cu m/kkg	COD kg/kkg	BOD kg/kkg	SS kg/kkg	CL kg/kkg	pH
99K01	955	10,160			21.6	6.04
99K02	844	7,304	*(4,821)		64.7	4.59
99K03	821		3,476	1,753		

* Estimate based on BOD:COD ratio of 2:3 at the plant.

year and has the following characteristics:

Production	1.8 kkg/day (2.0 tons/day)
Flow	1530 cu m/day (0.404 MGD)
BOD	4950 mg/l
SS	2100 mg/l
N	260 mg/l
pH	5.0 (4.6 to 6.0) range

The above characteristics are averages only and would be expected to vary. Production is dependent on whether rapid set or slow set pectin is produced and whether the raw material used is dry or wet peel. It is assumed that still bottoms, pressure filter cake sluice, wet spent peel, and non-contact water are separated from the process waste stream.

SUBCATEGORY A37 PROCESSING OF ALMOND PASTE

There are currently four known processors of almond paste in the United States. All four discharge their process wastewater to municipal facilities. Results of a telephone survey to three plants and one plant visitation indicate that the production of almond paste contributes a relatively insignificant wasteload to the total wasteload of the four multi-product processing plants. The production of almond paste exists in combination with the production of a large variety of other products such as nut pastes (i.e., pecan, walnut, hazel nut, cashew, and apricot kernels), granulated nuts, and nut toppings. The wastewater characteristics of almond paste processing are currently unavailable for the following reasons: 1) the multi-product plants contacted were unable to furnish historical data on almond paste production alone, with the only available information being that of the final combined products wasteload, 2) the actual sampling of the almond paste production line was impractical due to the combination of wastestreams from other product lines, and 3) production data was unobtainable.

The industry has made no future plants for the construction of any new almond paste processing plants and, as previously mentioned, discharges its wastewaters to municipal facilities. Therefore, the possibility of a future point source discharge from an installation primarily engaged in the production of almond paste is minimal. Due to a lack of information on the industry's product line, production variability, and wastewater characteristics, the development of effluent guidelines for almond paste processing at this time is not feasible.

SUBCATEGORY B 1 - FROZEN PREPARED DINNERS

General Plant Clean Up

The wastes generated from these types of processing plants are a direct function of the various raw ingredients used and subsequent handling steps involved in transforming these ingredients into finished products. By far the predominant waste loadings (flow, BOD, SS, COD, and oil and grease) are generated during clean up. Sanitation requirements are such that in-process clean up is virtually continuous with one large entire-plant clean up performed at the end of each operating day.

In-Process Clean Up - The raw ingredients are usually pre-processed elsewhere and are then further processed, cooked, assembled, packaged, and frozen at the prepared dinner plants. Consequently, the majority of the wastes from these types of operations originate from clean up of vats, kettles, fryers, mixers, and other equipment used in the preparation. Included in this group would be various spillages from gravy tanks, tray filling, meat thawing, grinding, etc. In addition, equipment coming into contact with food must be cleaned every four hours.

End of Shift Clean Up - Because of sanitary requirements, a complete plant clean up is performed after each shift, and a general plant clean up is undertaken at the end of each processing day. The floors as well as immovable equipment are cleaned, and this operation may involve the disassembling of the equipment for a thorough cleaning and inspection. Included in this type of equipment would be pipes, cooking kettles, infra-red cookers, extruders, and injectors. The wastes generated typically contain fine particles and dissolved organics from each of the unit operations; consequently the pollutants generated may vary widely from day to day within a particular plant, depending on the products produced. Contributing to the waste stream's pollutants are the necessary chemicals and detergents required to remove the various organic stains and residues from the various units of processing equipment.

Defrost Water

The prepared dinners are assembled and then individually quick-frozen and stored in large blast refrigerated warehouses, along with raw ingredients awaiting movement to the preparation area. Because of the large capacity of the storage facilities, a considerable volume of wastewater is generated. The water which is used is basically low load water, typically continuously circulated, although some plants discharge this segment directly under NPDES permit.

Model Plant

The subcategory for frozen prepared dinners includes T.V. dinners, meat pies, and other frozen dinners and entrees. Ingredients usually include meat, fowl, or fish; vegetables; gravies; and minor additives. In addition, there may be added starches (such as noodles), grains (such as rice), and a variety of small dessert dishes. The bulk of the wastes generated originates from clean up of processing equipment.

The model plant is one that produces an average BOD loading of 15.6 kg/kkg with a range from 9.41 to 25.9 kg/kkg as shown in Table 86. The average BOD concentration was 1530 mg/l with a range of 718 to 3260 mg/l. The wide range in concentrations was due largely to the product type and style variations as outlined above. The other flow-related parameters follow this same pattern.

SUBCATEGORY B 2 - FROZEN BREADED AND BATTERED SPECIALTIES

General

This subcategory has marked similarity to the other frozen specialties for two important reasons. The first is the multiplicity and variation of products within the subcategory - breaded fish fillets, shrimp, scallops, mushrooms, onions, etc. Secondly, a majority of the waste loadings and flows are a result of the extensive clean ups necessary for adequate sanitation. In addition to plant clean up, a considerable volume of waste can be generated from thawing and washing operations.

Thawing and Washwater

Thawing produces a substantial waste volume since it is followed by thorough washing and clean up of equipment and spills. If the shells, heads, and tails are included in the washwater, they constitute a major organic load and should be removed as solid waste.

Frozen onion rings are by far the major item in battered and breaded vegetable specialties and a considerable portion of the wastewater may originate from the onion washing operation. However, in most plants, they arrive already washed.

Model Plant

The breaded and battered frozen specialty subcategory is characterized by extreme ranges due to the various production techniques and raw materials handled. Wastewater generation results from clean up of equipment and spills, and juices from the onion slicing and washing operation. The batter is very high in organic strength, and the clean up wastes are correspondingly strong. A process summary is presented in Table 87.

The model plant produces an average BOD loading of 16.2 kg/ kkg with a range from 8.98 to 29.3 kg/kkg. The average BOD concentration was 1,350 mg/l with a range of 244 to 7,510 mg/l. The wide range in concentration was due largely to the product type and style variations as outlined above. The other flow-related parameters follow this same pattern.

TABLE 86 . RAW WASTE SUMMARY
FROZEN PREPARED DINNERS

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	5	86.3	25.8	289
(TON/DAY)		95.1	28.4	319
SHIFT TIME HR/DAY	6	24.0	--	--
FLOW VOLUME MGD	5	0.253	0.073	0.977
FLOW RATE L/SEC	5	11.1	3.13	39.3
(GAL/MIN)		176	49.7	623
FLOW RATIO L/KKG	6	10200	5340	19500
(GAL/TON)		2450	1230	4670
5 DAY BOD MG/L	6	1530	718	3250
RATIO KG/KKG		15.6	9.41	25.[illegible]
(LB/TON)		31.2	18.8	51.[illegible]
TSS MG/L	6	1150	548	2420
RATIO KG/KKG		11.7	6.17	22.4
(LB/TON)		23.5	12.3	44.7

PROCESS CODE(S): 38*50L ,38*52L ,38*53L ,38*54L ,38*55L ,
38D50L

TABLE 87. RAW WASTE SUMMARY
FROZEN BATTERED AND BREADED SPECIALTIES

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	2	9.86	7.64	12.7
(TON/DAY)		10.9	8.43	14.[illegible]
SHIFT TIME HR/DAY	2	24.0	--	--
FLOW VOLUME MGD	2	0.032	0.005	0.245
FLOW RATE L/SEC	2	1.37	0.176	10.[illegible]
(GAL/MIN)		21.7	2.79	1[illegible]
FLOW RATIO L/KKG	2	12000	1190	12[illegible]
(GAL/TON)		2870	286	28[illegible]
5 DAY BOD MG/L	2	1350	244	751[illegible]
RATIO KG/KKG		16.2	8.98	2[illegible]
(LB/TON)		32.4	17.9	5[illegible]
TSS MG/L	2	1540	176	1[illegible]
RATIO KG/KKG		18.5	16.1	2[illegible]
(LB/TON)		36.9	32.2	[illegible]

PROCESS CODE(S): 33356L ,36358L

DRAFT

SUBCATEGORY B 3 - FROZEN BAKERY ITEMS

General Plant Clean Up

The subcategory frozen bakery items includes an assortment of commodities such as frozen pies, cakes, doughnuts, cheesecakes, sweet rolls, etc., utilizing ingredients and techniques as detailed in Section III which are unique to this subcategory. The majority of pollutant loadings are the result of clean up of the various mixing, extruding, and forming equipment. The various cleaning techniques, additives, and detergents used to remove hardened dough, eggs, milk solids, and the like contribute significantly to the wastewater loadings.

In-Process Clean Up - The raw ingredients, e.g., butter, sugar, cream, etc., are purchased in bulk, received, blended under controlled conditions, further assembled in the final product form, sometimes baked, packaged, and frozen. In order to maintain sanitary conditions, the frozen bakery dessert plants must thoroughly clean with hot water all the many mixing vats, cooking kettles, measuring devices, pumps, piping, etc., which have come in contact with the ingredients and product. This clean up is continuous during the shift as different products are manufactured.

End of Shift Clean Up - Because of sanitary requirements a complete plant clean up is performed after each shift, and a general plant clean up is undertaken at the end of each processing day. The floors as well as immovable equipment are cleaned, and this operation may involve the dissasembling of the equipment for a thorough cleaning and inspection. Also included in this type of equipment would be pipes that are cleaned in place as well as small mobile pieces used in batch preparations. The wastes generated typically contain fine particles and dissolved organics from each of the unit operations; consequently the pollutants generated may vary widely from day to day within a particular plant, depending on the products produced.

Defrost Water

The dessert items are assembled and then individually quick-frozen and stored in large blast refrigerated warehouses, along with raw ingredients awaiting movement to the preparation area. Because of the large capacity of the storage facilities, a considerable volume of wastewater is generated. The water which is used is basically low load water, typically continuously circulated, although some plants discharge this segment directly under NPDES permit.

Model Plant

The model plant for this subcategory would be one manufacturing frozen dessert items including pies, cakes, pastries, and rolls. The bulk of the wastes generated originates from clean up of processing equipment. The model plant has an average BOD loading of 22.4 kg/kkg and the average BOD concentration was 2,090 mg/l as shown in Table 88. Average TSS loading was 13.6 kg/kkg at a concentration of 1,270 mg/l.

DRAFT

TABLE 88. RAW WASTE SUMMARY
FROZEN BAKERY PRODUCTS

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	1	50.9	--	--
(TON/DAY)		56.1	--	--
SHIFT TIME HR/DAY	1	24.0	--	--
FLOW VOLUME MGD	1	0.144	--	--
FLOW RATE L/SEC	1	6.31	--	--
(GAL/MIN)		100	--	--
FLOW RATIO L/KKG	1	10700	--	--
(GAL/TON)		2570	--	--
5 DAY BOD MG/L	1	2090	--	--
RATIO KG/KKG		22.4	--	--
(LB/TON)		44.8	--	--
TSS MG/L	1	1270	--	--
RATIO KG/KKG		13.6	--	--
(LB/TON)		27.2	--	--

PROCESS CODE(S): 3*059L

SUBCATEGORY B 4 - FROZEN TOMATO-CHEESE-STARCH COMBINATIONS

General Plant Clean Up

The processing of frozen tomato-cheese-starch items (frozen pizza, macaroni, lasagna, ravioli, etc.) involves the combining of preprocessed ingredients into the final product form. The principal waste generation step is plant clean up. The cleaning procedures are similar to those described for the frozen prepared dinner subcategory, and its clean up, with very little modification, can be applied to the frozen tomato-cheese-starch subcategory.

Defrost Water

Refrigeration water is generally recycled, but, if not recycled, contributes a significant volume of clean water to the waste stream.

Spillage and Clean Up

The types of pollutants generated by a plant are a direct function of the various raw ingredients used and the subsequent handling steps involved in transferring these ingredients into finished product. An efficient plant can hold its waste ingredients to under one percent of the incoming ingredient weight, e.g., loss of less than one pound of tomato paste used.

Model Plant

All major ingredients are preprocessed elsewhere and arrive at the manufacturing plant in bulk containers. These ingredients include tomato paste, cheese, flour, milk, oil, noodles, seasonings, and meat. The waste generated from plant clean up contributes the most significant portion of the waste stream. A process summary is presented in Table 89.

The model plant is one that produces an average BOD loading of 18.8 kg/kkg. The average BOD concentration was 239 mg/l. The average SS loading was 14.3 kg/kkg with a concentration of 180 mg/l.

SUBCATEGORY B 9 - PAPRIKA AND CHILI PEPPER

The subcategory paprika and chili pepper consists of wet sampling data from two plants -- 99C50W and 99C51W. As shown in Table 90, average BOD loading was 8.44 kg/kkg with a range of 6.32 to 11.3 kg/kkg. The average BOD concentration was 391 mg/l with a range of concentrations from 253 to 604 mg/l. SS and flow ratio parameters showed similar consistencies.

Model Plant

The model plant for Subcategory B 9 was selected to have a flow of 2000 cu m/day (0.5 MGD) with the following characteristics:

BOD	400 mg/l
SS	250 mg/l
pH	6 to 9
N&P	Sufficient

DRAFT

TABLE 89. RAW WASTE SUMMARY
FROZEN TOMATO-CHEESE-STARCH DISHES

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	1	2.41	--	--
(TON/DAY)		2.66	--	--
SHIFT TIME HR/DAY	1	24.0	--	--
FLOW VOLUME MGD	1	0.044	--	--
FLOW RATE L/SEC	1	1.92	--	--
(GAL/MIN)		30.4	--	--
FLOW RATIO L/KKG	1	79200	--	--
(GAL/TON)		19000	--	--
5 DAY BOD MG/L	1	237	--	--
RATIO KG/KKG		18.8	--	--
(LB/TON)		37.5	--	--
TSS MG/L	1	180	--	--
RATIO KG/KKG		14.3	--	--
(LB/TON)		28.5	--	--

PROCESS CODE(S): 3PT57L

DRAFT

TABLE 90. RAW WASTE SUMMARY
CHILI PEPPERS AND PAPRIKA

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	2	104	97.8	111
(TON/DAY)		115	108	123
SHIFT TIME HR/DAY	2	24.0	--	--
FLOW VOLUME MGD	2	0.586	0.486	0.707
FLOW RATE L/SEC	2	25.7	21.3	31.0
(GAL/MIN)		407	337	491
FLOW RATIO L/KKG	2	21600	18700	25000
(GAL/TON)		5180	4470	5990
5 DAY BOD MG/L	2	391	253	[illegible]
RATIO KG/KKG		8.44	6.32	11.3
(LB/TON)		16.9	12.6	[illegible]
TSS MG/L	2	249	229	271
RATIO KG/KKG		5.39	5.05	5.74
(LB/TON)		10.8	10.1	11.5

PROCESS CODE(S): 99050W ,99051W

SUBCATEGORY C 4 - EGG PROCESSING

Liquid Egg Processing Equipment Cleaning

According to Siderwicz (88), cleaning of liquid egg handling equipment is the largest source of wastewater from egg processing plants. Virtually all egg processors have clean-in-place systems for the cleaning and sanitizing of their pasteurizing equipment, liquid egg holding tanks and associated piping. This equipment is normally drained of egg product as completely as possible before cleaning. The cleaning is accomplished in three steps; pre-rinse, washing, and rinsing. Some egg processors have reduced their water consumption by recovering the final rinse water and reusing it in the pre-rinse step of the next cleaning cycle. The quantity of wastewater and the waste load from this cleaning process depends on whether the egg product remaining in the pipes after the pumps are shut off is discharged to the sewer or goes to inedibles. No data is available to quantitatively define the wastewater generated by these cleaning processes as opposed to an egg processor's total effluent.

Egg Breaker Wastewater

When a substandard egg is broken the cup and sometimes the entire breaking machine must be washed down. Siderwicz (88) indicates that the washing of the egg breaking equipment is the second largest source of wastewater flow and the third most important source of wastewater strength. Schultz (89) reports that egg breaker wastewater from a plant processing 70 kkg (64 tons) of eggs per day has a BOD of 4500 mg/l, a suspended solids concentration of 1000 mg/l and a flow of [illegible] mld (0.006 mgd).

Egg Washing

Siderwicz (88) notes that egg washing is another important source of wastewater volume and the second most important source of wastewater strength. Egg washers wash eggs with a recirculating detergent/disinfectant solution and then rinses them with potable water. The rinse water is added to the washer tank and provides a continuous overflow. Every four hours the washer tank is dumped and refilled with fresh water.

Schultz (89) has reported that egg washer wastewater from a plant processing 70 kkg (74 tons) of eggs per day has a BOD of 1450 mg/l, a suspended solids concentration of [illegible] mg/l, and a flow of 0.017 mld (0.004 mgd).

Plant Cleaning

General cleaning of egg processing plants is also a source of wastewater. Some eggs fall to the floor during handling and must be scraped up. mopped up or rinsed into a floor drain. All equipment and floors must be cleaned periodically. The frequency of general plant cleaning varies from plant to plant, and the waste load varies dramatically, depending on the housekeeping practices.

Combined Plant Effluent

Total discharge volumes from egg processing plants range from 0.015 to 0.53 mld (0.004 to 0.14 mgd). Total discharge per units of production varies from 0.9 to 17.8 l per kg (0.5 to 10 gal per lb), with remarkable differences in wastewater discharge for apparently similar operations. Total production ranges from 4 to 85 kkg per day (4.4 to 94 tons per day). The data collected indicated no relationship between the total production per day and the total discharge per unit of production. The BOD values of the total plant effluent from the plants surveyed ranged from 1,800 to 8,600 mg/l and the suspended solids concentrations ranged from 540 to 1,600 mg/l. Table 91 is a summary of the plant effluent.

Model Plant

The model plant for this subcategory is a hypothetical egg processing plant which produces frozen, liquid and dried egg products. The eggs are trucked to the plant in 21 kg cases (30 dozen eggs). After a short period of refrigerated storage, the eggs are loaded, candled, washed and broken as described in Section III of this document. The eggs are then pasteurized and frozen, dried, or sold as liquid egg. Total eggs broken at the model plant in a 24 hr per day operation (including an 8 hr cleanup shift) is assumed to be 30 kkg per day (33 tons per day).

Wastewater - Sources of wastewater from the model plant would include all sources listed above. Inedible eggs are recovered and sold or handled as solid waste to help reduce the waste strength. Total wastewater flow for the model plant is assumed to be 0.2 mld (0.05 mgd) and flow per kkg of eggs broken is 6.5 l. Effluent BOD is 3,700 mg/l and the effluent suspended solids concentration is 850 mg/l. Thus, the waste load from the model plant will be 23 kg BOD and 5.4 kg SS per kkg of eggs broken. It is also assumed that this model plant utilizes a catch basin to remove shells from its waste stream. Some of the in-plant technology described in Section VII is utilized by the model plant.

SUBCATEGORY C 5 - SHELL EGGS

Egg Washing

Egg washing is the major source of wastewater strength and volume from shell egg plants. Egg washing machines use a recirculating disinfectant detergent solution for washing, which is followed by a potable water rinse. The rinse water added to the washer tank provides a continuous overflow. Every four hours the washer tank is dumped and refilled with fresh water. Schultz (89) reported that continuous overflow from the egg washer had a COD of 935 mg/l and suspended solids of 150 mg/l. Samples taken from an egg washer tank during this study had BOD values between 1800 and 3600 mg/l and suspended solids values between 240 and 1400 mg/l.

DRAFT

TABLE 91. RAW WASTE SUMMARY
EGG PROCESSING

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	9	27.1	10.3	[illegible]
(TON/DAY)		29.9	11.3	[illegible]
SHIFT TIME HR/DAY	9	9.55	8.00	[illegible]
FLOW VOLUME MGD	9	0.032	0.011	[illegible]
FLOW RATE L/SEC	9	3.43	1.24	[illegible]
(GAL/MIN)		54.4	19.6	[illegible]
FLOW RATIO L/KKG	9	4215	3020	[illegible]
(GAL/TON)		1010	725	[illegible]
5 DAY BOD MG/L	9	3190	1330	[illegible]
RATIO KG/KKG		13.4	8.37	[illegible]
(LB/TON)		26.8	16.1	[illegible]
TSS MG/L	6	859	664	[illegible]
RATIO KG/KKG		3.09	2.35	[illegible]
(LB/TON)		6.18	4.09	[illegible]

PROCESS CODE(S): *PS51I ,*PS51W ,17*52L ,17*53L ,17*[illegible] ,
17*61L1 ,17*61L2 ,17A51I ,17A643

DRAFT

TABLE 92 . RAW WASTE SUMMARY
SHELL EGGS

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	7	21.7	7.60	[illegible]
(TON/DAY)		23.9	8.38	[illegible]
SHIFT TIME HR/DAY	7	8.60	7.50	11.0
FLOW VOLUME MGD	5	0.004	0.003	0.005
FLOW RATE L/SEC	7	0.179	0.038	[illegible]
(GAL/MIN)		2.83	0.607	[illegible]
FLOW RATIO L/KKG	7	237	26.0	[illegible]
(GAL/TON)		56.7	6.24	[illegible]
5 DAY BOD MG/L	7	2470	1200	5080
RATIO KG/KKG		0.990	0.061	[illegible]
(LB/TON)		1.18	0.121	[illegible]
TSS MG/L	7	734	154	[illegible]
RATIO KG/KKG		0.171	0.015	[illegible]
(LB/TON)		0.342	0.031	[illegible]

PROCESS CODE(S): 44A50W ,44A51 ,44A53L ,44A55 ,44A [illegible] ,
44A57 ,44A61

DRAFT

Plant Cleaning

General cleaning of shell egg plants is a significant source of wastewater generation. Some eggs fall to the floor during handling and must be scraped up, mopped up, or rinsed into a floor drain. All equipment and floors must be cleaned periodically. The frequency of general plant cleaning varies from plant to plant, and the wasteload varies dramatically, depending on housekeeping practices.

Total Processing Effluent

The quantities and characteristics of wastewater from shell egg plants vary considerably. These variations are usually the result of operating and cleanup procedures, which depend on the training and management of the personnel. Wastewater flow per unit of production varies from plant to plant, but is generally consistent within a given plant. Table 92 includes data describing the total processing effluent for this subcategory.

Model Plant

The model plant for this subcategory is a hypothetical shell egg plant. The eggs are trucked to the plant in 21 kg cases (30 dozen eggs). After a short period of refrigerated storage, the eggs are loaded, washed, candled, graded, and packaged as described in Section III of this document.

Operating procedures stress the recovery of inedible eggs for sale as a component of animal feed or disposal as solid waste. The equipment and floors are wet cleaned after recovery of the inedible egg product. Total production at the model plant is assumed to be 12.5 kkg (14 tons) per day produced in eight hours per day, five days per week operation.

Wastewater - Sources of wastewater from the model plant include all of the sources listed above. Inedible eggs are recovered and sold. Total wastewater volume is assumed to be 0.013 mld (3500 gpd). It is assumed that this model plant utilizes a catch basin or a large 0.6 cm (0.25 in.), mesh screen to remove shells from the waste stream.

DRAFT

SUBCATEGORY C 6 - MANUFACTURED ICE

The quantity of water that is wasted is the parameter of most concern. In fragmentary ice manufacturing the quantity of wastewater discharged approximates the quantity of water incorporated into the ice. The range in discharge is relatively narrow and is not highly operator-dependent. On the other hand, the quantity of water used and wastewater discharged from block ice manufacturing has up to 20-fold variations from plant to plant. These variations are primarily due to water conservation practices or lack thereof, and most of the variations in water use are attributed to discharge of once-through cooling water. The thrust of this program, however, is directed to process water and the waste load in terms of kg of pollutant per kkg of product. Therefore, the following discussion is directed to waste load rather than discharge volume.

The concentration of pollutants from ice manufacturing is nominal. Pollutants, if these constituents should be classified as pollutants, consist predominately of dissolved solids (salts) with very low suspended solids, BOD, and nitrogen concentrations. The concentration of salts and suspended solids in the waste stream is dependent on the characteristics of the water supply. The water used in ice manufacturing must be potable, but if the water had a relatively high salt and solids concentration, the concentration of these constituents in the waste stream will be proportionately high.

The major sources of these pollutants are the following:

1. Water pretreatment, if required to remove suspended solids. Predominant treatment methods are lime, sand filters, and carbon filters.

2. Core pumping. A number of block ice plants pump out the unfrozen core water prior to complete freezing of an ice block. This core water has a volume of 10 to 22 liters (3 to 6 gal) per block, and it contains much of the solids and other impurities found in the water supply.

3. Can dipping in a block ice plant is a source of a small amount of salts. Pollutants in the waste stream from can dipping are primarily brine remaining on the exterior of the cans when they are removed from the brine tank. However, prior to can dipping but after lifting the cans from the brine tank, the cans are suspended for several minutes to allow most of the brine to drip back into the brine tanks. Chloride concentrations in the dip tank are normally below

that which would produce a salty taste in the water and the solids are usually dissolved and of relatively low concentration.

3. Blowdown from fragmentary ice making machines has approximately twice the concentrations of dissolved and suspended solids as the water supply.

4. Snow and end pieces generated by crushing, scoring, and sawing block ice into sized or cube ice contribute relatively pure water with virtually no pollutants. Some plants recycle this water for ice-making and others discharge it as wastewater.

Total Processing Effluent

The quantity and quality characteristics of wastewater from ice manufacturing plants is relatively constant in any particular plant. The same processes are used repeatedly in both block and fragmentary ice production. Thus, the only variations in quantity or quality of the wastewater come from variations in the product mix. Wastewater from ice manufacturing plants is clean in comparison with other industrial waste streams. Characteristics of the wastewater is similar to those of the water supply with slight to 100 percent increase in chloride and dissolves solid concentrations. Table 93 includes data describing the total processing effluent for this subcategory.

Model Plant

The model plant for this subcategory is a hypothetical ice manufacturing plant producing both block and fragmentary ice. The block ice is produced as described in Section III and core water is pumped from the blocks. Both once-through compressor cooling water and core pumping water are discharged to the waste stream. The fragmentary ice machine is located in the same building as the block ice facility and its waste is discharged to the waste stream. Average total production is 17.2 kkg per day (19 tons per day). Production is 24 hours per day, five days per week for six months a year.

Wastewater - Sources of wastewater from the model plant include all sources listed above.

Parameters of the wastewater are assumed as follows:

1. Flow volume - average - 0.04 mld (11,000 gpd)
   minimum - 0.01 mld (3,000 gpd)
   maximum - 0.19 mld (50,000 gpd)

2. BOD - 1.2 mg/l

DRAFT

TABLE 93. RAW WASTE SUMMARY
MANUFACTURED ICE

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD KKG/DAY	3	17.2	10.5	[illegible]
(TON/DAY)		19.0	11.6	[illegible]
SHIFT TIME HR/DAY	3	17.3	8.00	24.[illegible]
FLOW VOLUME MGD	3	0.011	0.003	0.[illegible]
FLOW RATE L/SEC	3	0.694	0.1[illegible]	[illegible]
(GAL/MIN)		11.0	2.1[illegible]	[illegible]
FLOW RATIO L/KKG	3	2220	619	[illegible]
(GAL/TON)		532	145	[illegible]
5 DAY BOD MG/L	3	1.20	0.870	[illegible]
RATIO KG/KKG		0.004	0.002	[illegible]
(LB/TON)		0.00[illegible]	0.00[illegible]	[illegible]
TSS MG/L	3	5.20	2.89	[illegible]
RATIO KG/KKG		0.012	0.006	[illegible]
(LB/TON)		0.024	0.012	[illegible]

PROCESS CODE(S): 97A50W ,97A51W ,97A54[illegible]

3. SS - 5.2 mg/l

4. 0.004 - kg BOD per kkg of product

5. 0.012 - kg SS per kkg of product

SUBCATEGORY C 12 - SANDWICHES

Cleanup and Total Combined Process Waste

General cleaning is the only source of wastewater generation in most pre-packaged sandwich plants. General cleaning consists of washing hand utensils in a sink or dishwasher, wiping off counter tops, and mopping floors. These procedures are normally employed on a daily basis. Portable chopping machines used in plants that blend salad-type sandwich fillings are cleaned daily with a hose. The total volume of process wastewater from the plants contacted ranged from 400 to 11,000 lpd (100 to 3000 gpd).

Model Plant

The model plant for this subcategory is a hypothetical plant which assembles a variety of pre-packaged sandwiches. All of the materials from which the sandwiches are assembled are processed before delivery at the sandwich plant. Total production at the model plant is assumed to be 4.5 kkg (5 tons) per day produced in 8 hours per day, five days per week.

Wastewater - Sources of wastewater from the model plant include general cleaning of hand utensils, counter tops and floors. The wastewater flow from the model plant is 7,600 l (2000 gal) per day.

Two days of sampling were conducted at a major producer of pre-packaged sandwiches. However, the samples were taken by an employee of the plant, and apparently came from the surface of the grease trap. As a result, the values obtained were not representative of the plant's wastewater.

SUBCATEGORY D 4 - VINEGAR

Wastewater characterization is based on data from four plants engaged in the production of vinegar from apple products. Although vinegar is also produced from grape products and purchased ethanol, no historical data for processors utilizing these raw materials was available. Vinegar from apple products represents the largest segment of the industry and is a good representation of the industry as a whole. Table 94 summarizes the data collected.

Water use in the vinegar plant is primarily in the filtration operation with lesser amounts consumed for daily plant cleanup. Wooden holding tanks, when not in use for vinegar storage, are filled with water to avoid shrinking of the wood; draining of these tanks occurs as necessary.

DRAFT

TABLE 94. RAW WASTE SUMMARY
VINEGAR

PARAMETER	NO PLANT	LOG MEAN	MINIMUM	MAXIMUM
PROD CU M/DAY	4	76.1	30.0	[illegible]
(1000 GAL/DAY)		20.1	7.93	[illegible]
SHIFT TIME HR/DAY	4	[illegible]	8.00	[illegible]
FLOW VOLUME MGD	4	0.024	0.011	[illegible]
FLOW RATE L/SEC	4	2.46	0.783	[illegible]
(GAL/MIN)		[illegible]	12.4	122
FLOW RATIO L/CU M	4	1170	540	25[illegible]
(GAL/1000 GAL)		1170	540	25[illegible]
5 DAY BOD MG/L	3	1950	531	7150
RATIO KG/CU M		1.92	1.20	[illegible]
(LB/1000 GAL)		16.0	10.0	[illegible]
TSS MG/L	2	664	443	[illegible]
RATIO KG/CU M		0.654	0.317	[illegible]
(LB/1000 GAL)		5.45	2.63	[illegible]

PROCESS CODE(S): 99V81I ,99V83M ,99V84I ,99V85M

Non-contact cooling water is also used in the vinegar generators and may or may not be recycled. The ratio of wastewater to production averaged 1170 l/kkg (1170 gal/1000 gal) with a range of 540 to 2550 l/kkg (130 to 610 gal/ton).

The expected range of BOD ratios is from 1.20 to 3.07 kg/cu m (10.0 to 25.6 lb/1000 gal) with an average of 1.92 kg/cu m (16.0 lb/1000 gal); suspended solids is from 0.317 to 1.36 kg/cu m (2.63 to 11.3 lb/1000 gal) with an average of 0.654 kg/cu m (5.46 lb/1000 gal). The range of waste loadings is not directly related to any observed differences between the processors. However, the handling of filter washwater and storage tank sedimentation can greatly influence the waste loadings.

Of particular importance in the vinegar process is the presence of acetic acid in the effluent. The arithmetic average pH for three plants with raw effluent data was 5.17 with a range of 4.59 to 5.50. Surges of wastewater with lower pH can be expected during the flushing of holding tanks and cleanup of spillages.

Model Vinegar Plant

Production:	78 cu m/day (20,000 gal/day)
Wastewater flow volume:	90.8 cu m/day (.024 MGD)
Wastewater characteristics:	BOD = 1950 mg/l
	SS = 660 mg/l
	pH = 5.2
Primary source of wastewater:	filtration operation, washdowns.
Special consideration:	pH adjustment.

SUBCATEGORIES E 1 (MOLASSES, HONEY, GLAZED FRUIT, AND SYRUPS), E 2 (POPCORN), E 3 (PREPARED GELATIN DESSERTS), E 4 (SPICES), E 5 (DEHYDRATED SOUP), AND E 6 (MACARONI, SPAGHETTI, VERMICELLI, AND NOODLES)

The processes associated with Subcategories E 1 through E 6 have been found to generate little wastewater. What little wastewater that is generated results from equipment cleanup and floor washing. The volume generally amounts to less than 4000 l/day (1000 gal/day). The pollutant loading is comparable to that of domestic sewage. The development of model plants is not necessary for these subcategories.

SUBCATEGORIES F 2 BAKING POWDER), F 3 (CHICORY), AND F 4 (BREAD CRUMBS NOT PRODUCED IN BAKERIES)

As described in Section III, the processes associated with these subcategories are dry processes that generate no contact process wastewater. Therefore, development of model plants is not necessary for these subcategories.

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

WASTEWATER PARAMETERS OF POLLUTIONAL SIGNIFICANCE

Major wastewater parameters of pollutional significance for the miscellaneous foods and beverages industry include BOD (5-day 20°C), COD, suspended solids, and oil and grease. Minor parameters of significance include pH, nickel, alkalinity, total dissolved solids, nutrients (forms of nitrogen and phosphorus), color, chlorides and temperature. On the basis of all evidence reviewed, there does not otherwise exist any purely hazardous or toxic pollutants (e.g., heavy metals, pesticides) in waste discharged from the miscellaneous foods and beverages industry.

When land disposal of wastewater is practiced, contribution to ground water pollution must be prevented. Under land disposal procedures, all practices should be in general accord with the Environmental Protection Agency's "Policy on Subsurface Emplacement of Fluids by Well Injection" with accompanying "Recommended Data Requirements for Environmental Evaluation of Subsurface Emplacement of Fluids by Well Injection" (90).

Significant pollutional parameters for the protection of ground water from land disposal include BOD, COD, pH, temperature, total dissolved solids, and nutrients.

RATIONALE FOR SELECTION OF IDENTIFIED PARAMETERS

The rationale for selection of the significant parameters for the miscellaneous foods and beverages industry is given below:

Organics

Biochemical oxygen demand (BOD) is a semi-quantitative measure of the biologically degradable organic matter in a wastewater. For this reason, in wastewater treatment, it is commonly used as a measure of treatment efficiency. It is a particularly applicable parameter for the miscellaneous foods and beverages industry since the wastes are highly biodegradable with very few exceptions.

The primary disadvantage of the BOD test is the time period required for analysis (five days is normal) and the considerable amount of care that must be taken to obtain valid results.

Under proper conditions, the chemical oxygen demand (COD) test can be used as an alternative to the BOD test. The COD test is widely used as a means of measuring the total amount of oxygen required for oxidation of organics to carbon dioxide and water by the action of a strong oxidizing agent under acid conditions. It differs from the BOD test in that it is independent of biological assimilability. The major disadvantage of the COD test is that it does not distinguish between biologically active and inert organics. The major advantage is that it can be conducted in a short period of time, or continuously in automatic analyzers. In many instances, COD data can be correlated to BOD data and the COD test can then be used as a substitute for the BOD test where a reliable relationship can be demonstrated to exist. Considerable difficulties occur with the COD test in the presence of chlorides.

The measurement of total organic carbon (TOC) offers a third alternative for an indication o organic concentrations. This test offers the potentiality of a high degree of reliability and produces results in a matter of minutes. However, at the present time the equipment required for the test is relatively expensive, has not been used extensively to date, and has had little experience in the miscellaneous foods and beverages industry.

With a few exceptions, the wastewaters generated by the miscellaneous foods and beverages industry contain relatively high levels of readily biodegradable organics.

Suspended Solids

Suspended solids serve as a parameter for measuring the efficiency of wastewater treatment facilities and for the design of such facilities.

Suspended solids concentration in water affect light penetration, temperature, solubility products, and aquatic life. Upon settling, solids may blanket organisms or their habitats, either killing the organism or rendering the habitat unsuitable for occupation. Suspended solids concentrations greater than 80 mg/l in fresh water streams have been reported (91) to be detrimental to fisheries.

Suspended solids are a major pollutant parameter for most of the subcategories discussed in this document. It is relatively minor for most of the confectionery operations as well as for a few other products for which carbohydrates are of greater importance.

Oil and Grease

Floating oils may interfere with reaeration and photosynthesis and prevent respiration of aquatic insects which obtain their oxygen at the water surface. Free and emulsified oils may interfere with fish respiration and destroy algae and other plankton. Deposited oily substances on the bottom of a stream bed may destroy benthic organics.

Oil and grease is a major parameter for the vegetable oil processing and refining industry, the bakery and confectionery industry, the pet food industry, and for several of the miscellaneous products.

These oils and greases of animal and vegetable origin should not be confused with petroleum wastes. The oils and greases generated by the industries which are subject to this study are readily biodegradable in both municipal and private treatment systems.

pH

pH is an important criterion for in-process control, odor control, and bacterial growth retardation. Highly acidic or caustic solutions can be harmful to aquatic environments and can interfere with water or wastewater treatment processes. The acceptable range for successful performance of biological treatment and a healthy fresh water habitat is between 6.0 and 9.0.

Several of the subcategories discussed in this document require minor pH adjustment before discharge or biological treatment. It is perhaps most significant for vinegar which produces an effluent with high concentrations of acetic acid.

Nickel

Nickel as a pure metal does not consitute a serious threat to receiving waters; however, many of the salts of nickel are soluble in water and may be hazardous to aquatic life. Since the acute and chronic toxicity values of nickel vary widely, the EPA (32) has proposed a limiting application factor of 0.02 of the 96 hour LC_{50} as required to provide adequate protection for aquatic life.

The only known source of nickel in process waste water from the miscellaneous foods and beverages industry would be attributable to the edible oils refining industry where small amounts of nickel are used in the process. The discharge of nickel from edible oil refining plants has been found to be very insignificant under present operating practices. Effluent limitation of nickel within technological capabilities and pollution control requirements is justified in a precautionary sense, due to the potential polluting effects attributable to this material.

Alkalinity

Alkalinity in water is a measure of hydroxide, carbonate, and bicarbonate ions. Its primary significance in water chemistry is its indication of a water's capacity to neutralize acidic solutions. In high concentrations, alkalinity can cause problems in water treatment facilities. However, by control of pH, alkalinity is also controlled.

Total Dissolved Solids

The quantity of total dissolved solids in wastewater is of little meaning unless the nature of the solids are defined. In fresh water supplies, dissolved solids are usually inorganic salts with small amounts of dissolved organics, and total concentrations may often be several thousand milligrams per liter.

It is not considered necessary to recommend limits for total dissolved solids since harmful salts and organics are limited by other parameters.

Nutrients

Forms of nitrogen and phosphorus act as nutrients for the growth of aquatic organisms and can lead to advanced eutrophication in surface water bodies. In water supplies, nitrate nitrogen in excessive concentrations can cause methemoglobinemia in human infants and for this reason has been limited by the United States Public Health Service to ten milligrams per liter as nitrogen in public water supplies (93).

Under aerobic conditions ammonia nitrogen is oxidized to nitrite and ultimately to nitrate nitrogen. Phosphorus compounds are commonly used to prevent scaling in boilers and orthosphosphate may occur in boiler blowdowns. The use of phosphate detergents for general cleaning can contribute phosphates to total wastewater discharges. When applied to soil, phosphorus normally is fixed by minerals in the soil, and movement to ground water is precluded.

Color

True water color is a result of substances in solution after suspended materials have been removed. It may be derived from mineral or organic sources and may be the result of natural processes as well as manufacturing processes.

The effect of extreme water color on aquatic life is to limit light penetration, thereby restricting the photosynthetic zone and impacting benthos. Otherwise, color may serve as an indirect indication of pollution and be aesthetically objectionable.

The production of soluble coffee, tea, rum, and yeast results in a wastewater with considerable color. The effectiveness of biological treatment for color removal is questionable. Carbon filters or other devices may be necessary for color removal in some instances, but present technology for color removal from these wastewaters is nonexistent.

The acceptable limits of color in navigable waters are highly dependent on the natural levels of color in the waters and the degree of available dilution. The Environmental Protection Agency (92) has proposed that acceptable conditions regarding the combined effect of color and turbidity in water will be met if the water's compensation point is not changed by more than 10 percent from its seasonably established norm, and if no more than 10 percent of the biomass of photosynthetic organisms is placed below the compensation point by such changes.

Chlorides

Chlorides can cause detectable taste in drinking water in salt (sodium, calcium, magnesium) concentrations greater than about 150 mg/l; however, the concentrations are not toxic; drinking water standards are generally based on palatability rather than health requirements. In the application of wastewater to land, no practical limits can be recommended by this document since chlorides are generally non-toxic to crops, although some fruit trees are sensitive to chlorides. A consideration of crop irrigation with wastewater should take into account chloride concentrations.

The operations discussed in this document which discharge significant chloride concentrations are block ice production, olive oil production, and pectin production. In the case of block ice production, the concentrations in the wastewater are within drinking water standards. The concentrations for olive oil and pectin are considerably higher and attention must be given to specific discharges.

Temperature

The discharge of heated waters, with inadequate dilution, may result in serious consequences to aquatic environments. Generally, problems of heated water are associated with various cooling waters that are not subject to recommendations in this document. One process stream, currently discharged in some cases from rum distilling, approaches the boiling point of water; however, recommended control technology developed in Section VII would eliminate this problem.

METHODS OF ANALYSIS

During the course of this study a number of wastewater samples were collected and analyzed at the laboratories of Environmental Science and Engineering, Inc., Gainesville, Florida. The following outlines the analytical methods used.

Solids

Total solids was determined by drying an aliquot of sample at 104°C according to EPA methods (EPA, Methods for Chemical Analysis of Water and Wastes, 1974, p. 270; Standard Methods, pp. 535-536).

Dissolved and suspended solids were determined by glass fiber filtration and drying at 104°C, (Standard Methods, pp. 535-536).

Volatile solids was determined by combustion at 550°C, (EPA Methods, 1974, p. 272; Standard Methods, p. 536).

pH and Temperature

pH and temperature were determined at the time of sample collection.

Nitrogen and Phosphorus

Total nitrogen was determined by the Kjeldahl digestion procedure (Standard Methods, p. 469) and total phosphorus by the ascorbic acid method (Standard Methods, p. 526, 532).

Oil and Grease

Oil and grease was determined gravimetrically by the liquid-liquid extraction technique with hexane. The procedure is a modification of the technique described in EPA Methods, pp. 226-228.

BOD

BOD was determined by oxygen depletion at 20°C using a membrane electrode to measure DO (Standard Methods, pp. 489-495; EPA Methods, 1974, pp. 11-12).

COD

COD was determined by dichromate oxidation followed by titration with ferrous ammonium sulfate (Standard Methods, pp. 495-499; EPA Methods, 1974, p. 20).

Color

Color was determined colorimetrically on a Klett-Summerson colorimeter and is reported in chloroplatinate units, a variation of the method given in EPA Methods, 1974, pp. 36-38 and Standard Methods, pp. 160-162. While this method is designed for natural waters, the major need for color analyses has been in the tea and coffee industries where the nature of the color of the wastewaters approximates that of natural waters.

NH_3

Ammonia was determined by a selective ion electrode (EPA Methods, 1974, pp. 165-167).

DRAFT

Chloride

Chloride was determined by titration with mercuric nitrate (EPA Methods, 1974, pp. 29-30; Standard Methods, pp. 97-99).

TOC

TOC was determined by catalytic combustion to CO2 followed by infrared analysis of the CO_2 with a Dow-Beckman Model No. 915 Carbonaceous Analyzer (EPA Methods, 1974, pp. 236-238; Standard Methods, pp. 257-259).

DRAFT

SECTION VII
CONTROL AND TREATMENT TECHNOLOGY

This section identifies, documents, and verifies as completely as possible the full range of control and treatment technology which exists or has the potential to exist within each industrial subcategory identified in Section IV. In addition it develops the control and treatment alternatives applicable to the model plants developed in Section V.

The development of model treatment alternatives for each subcategory is based on the treatment modules listed in Table 95.

The modular approach to treatment is used in order to allow the evaluation of alternative treatment chains, both in terms of probable treatment efficiency and cost effectiveness.

In those cases where plants within a subcategory are expected to be distributed throughout the United States, the prime choice of treatment for that subcategory has been developed as the least land dependent alternative. Nevertheless, since it would normally be expected that at least some members of the subcategory would have available land (where "available land" is defined as land that is owned by the processing plant or can be leased or purchased for a reasonable price, and that can be suitably used for waste disposal), more land dependent alternatives have also been developed.

Other factors which could affect the choice of a particular treatment train for a particular plant include the following:

1. Seasonality of plant operation,
2. Expected skill of operating personnel,
3. Non-water quality aspects (as described in Section VIII) such as noise, odor, solids residue disposal, etc.,
4. Degree of pollution reduction within the process.

Since the purpose of this document is to develop recommended effluent limitation guidelines for point source discharges into navigable waters, municipal treatment is not directly considered as a treatment alternative, but it would obviously be economically attractive in many cases if available. For overall completeness, costs associated with municipal treatment will be discussed in Section VIII even though not directly applicable to the study.

In addition to the treatment modules discussed herein, a considerable number of other modules could be considered. For example, anaerobic digestion could be used in most instances instead of aerobic digestion (and the possible recovery of methane gas as an energy source should not be discounted); however, for the purposes of this document, it

DRAFT

TABLE 95

WASTEWATER TREATMENT UNITS USED IN TREATMENT TRAIN ALTERNATIVES

A. No Treatment
B. Pumping station
C. Equalization
D. Chemical Flocculant Addition
E. Clarifier (includes sludge pumping)
F. Acid Neutralization
G. Caustic Neutralization
H. Nitrogen Addition
I. Phosphorus Addition
J. Air Flotation (includes pumping station)
K. Activated Sludge (includes sludge pumping and clarifier)
L. Aerated Lagoon (includes settling pond)
M. Stabilization Pond (aerobic, anaerobic, flocculation)
N. Dual Media Pressure Filtration (includes pumping station)
O. Centrifugation
Q. Sludge Thickening
R. Aerobic Digestion
S. Vacuum Filtration
T. Sand Drying Beds
U. Spray Irrigation
V. Truck Hauling
W. Pipe Line
X. Roughing Filter
Y. Storage Tank
Z. Activated Carbon

was determined that aerobic digestion would be quite effective and would adequately represent the associated costs. In addition, anaerobic digestion systems may be more land dependent as compared to aerobic processes.

Biological filters or discs could be used in some cases in lieu of activated sludge systems, and, in fact, activated sludge systems are currently employed by several plants. Also, various modifications of activated sludge other than the complete mix system could be successfully used by many plants. However, complete mix activated sludge was selected in this document because of its demonstrated ability to effectively treat high concentration waste loads on a reliable and sustained basis. Other treatment unit processes were not considered with similar justifications applicable for biological filters.

It must be noted that the treatment systems considered herein are for subcategories containing, in most cases, numerous plants located throughout the United States. If a treatment plant is to be designed for a particular industrial operation, the design should be preceded by a characterization of the process wastewater of the specific plant and by pilot plant studies in order to provide an optimum treatment system for the given process. To the extent possible, the performances of the treatment systems discussed herein has been reflected by the demonstrated performance of treatment facilities presently designed for the waste, or as reflected by pilot plant studies for the same or similar wastes.

The operational theory and design procedures for the treatment processes discussed herein may be found in any of a number of sources, including Metcalf and Eddy (94); Fair, Geyer, and Okun (95); Clark, Viessman, and Hammer (96); Nemerow (97); and Eckenfelder (98).

Unless indicated by performance of existing or pilot plant results for the specific wastes, determination of pollutant reductions through conventional secondary treatment measures has been strongly guided by experience in treating general food processing wastes. Ample evidence exists as to the ready biodegradability and treatability of food processing wastes, and studies have continued to support the ability of properly designed, operated, and maintained activated sludge systems to achieve high efficiencies of removal of BOD (95 percent or greater).

The following discussion of each module includes assumptions that, unless otherwise stated for a subcategory, are applicable to all subcategories. Unit A is defined as no additional treatment above that already employed by the model plant; it does not necessarily mean that no treatment whatsoever is being used. For example, all plants represented by the model plant may employ primary sedimentation. In such instances, raw wastewater from the model plant would be the effluent from the primary sedimentation process.

Unit B, the pumping station, illustrated in Figure 138, is assumed to consist of two pumps, each capable of pumping 100 percent capacity at 85 percent efficiency. The pumping station operates at a head of 70 m (230 ft).

Unit C, the equalization basin, provides twenty-four hour detention time. Mixing is provided by 0.05 cu m (0.5 cu ft) of diffused air per liter (gallon) capacity. The basin is a circular, 0.794 cm (5/16 in) steel tank on a concrete base.

Unit D provides for the addition of chemicals for flocculation. The system consists of chemical storage and dry chemical feed through a vibratory hopper.

Unit E consists of a circular steel clarifier as shown in Figures 139 and 140. The system includes sludge and skum collectors, sludge pumping with two pumps at 100 percent capacity, and all necessary electrical and mechanical facilities. The clarifier is designed for a surface over-flow rate of 20,400 l/day/sq m (500 gpd/sq ft).

Unit F, acid neutralization, is provided by a 50 percent solution of sodium hydroxide (NaOH). The system includes two chemical pumps, a fiberglass lined tank, with 30-day storage capacity, and a pH control system.

Unit G, caustic neutralization, is provided by a 93 percent solution of sulfuric acid (H_2SO_4) using the same system as used for sodium hydroxide addition. The feed system is illustrated in Figure 141.

Unit H, provides for addition of nitrogen if the wastewater to be biologically treated is considered to be deficient in nitrogen. A deficiency is assumed if the BOD:N ratio is less than 20. As illustrated in Figure 142, the system for nitrogen addition consists of a steel pressure tank which provides 30 days storage for anhydrous ammonia, and an ammoniator for feed control.

Phosphorus addition, if necessary for biological treatment, is provided by Unit I. Phosphorus addition is considered necessary if the BOD:P ratio is less than 100. This system, illustrated in Figure 143, consists of a 30-day capacity fiberglass lined storage tank for phosphoric acid and a chemical pump.

Unit J is a dissolved air flotation module for the removal of oil and grease from wastewater. It is designed for an overflow rate of 24,000 l/day/sq m (600 gpd/sq ft).

Unit K is a complete mix activated sludge unit, as shown in Figure 144, which includes a clarifier such as that described for Unit E. The MLSS is assumed to be 3500 mg/l and the BOD loading rate to be 0.56 kg/cu m (35 lb BOD/1000 cu ft). Return sludge capacity is 150 percent of influent. Aeration is provided by fixed surface aerators

DRAFT

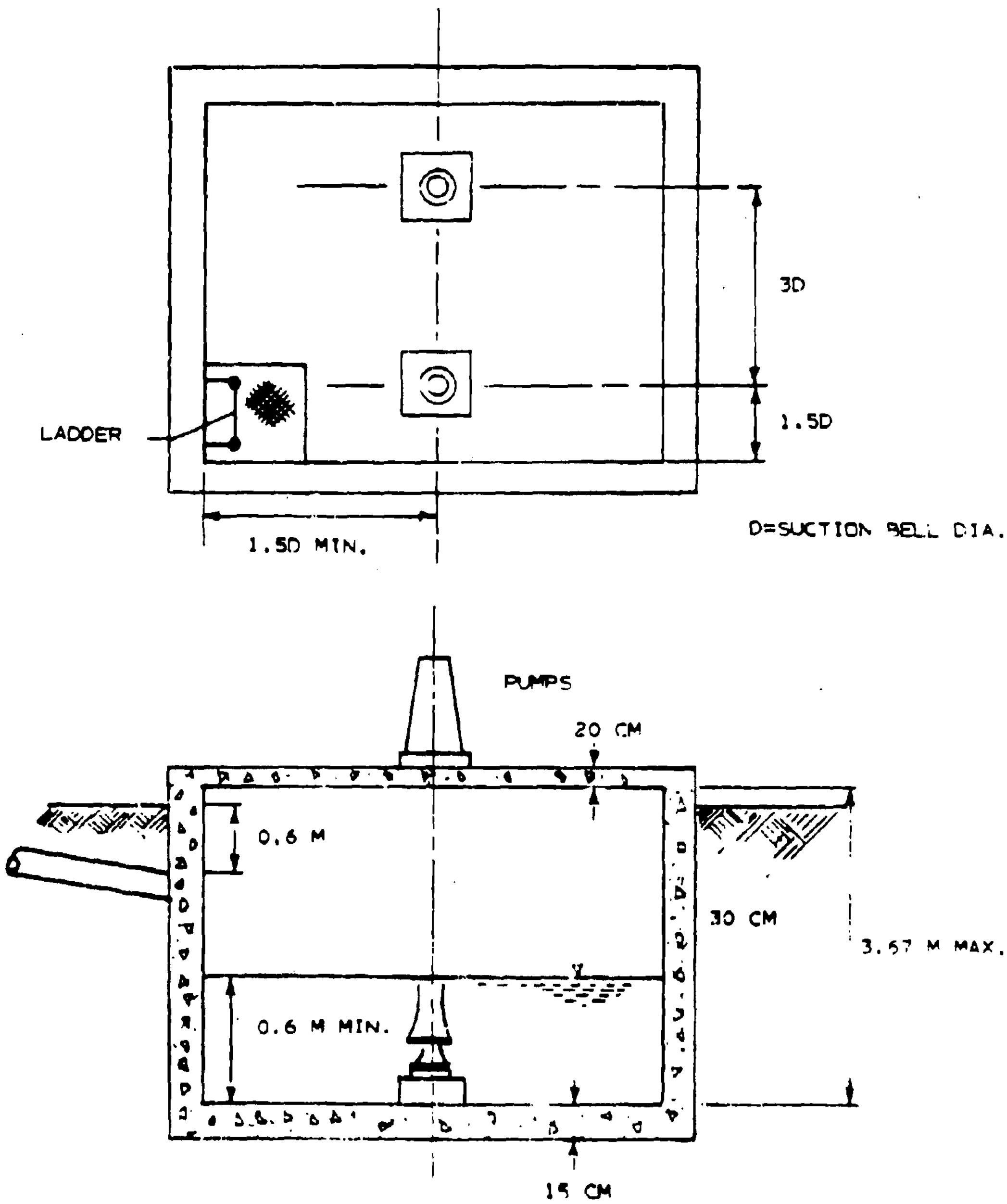


FIGURE 1[illegible]

PUMPING STATION

DRAFT

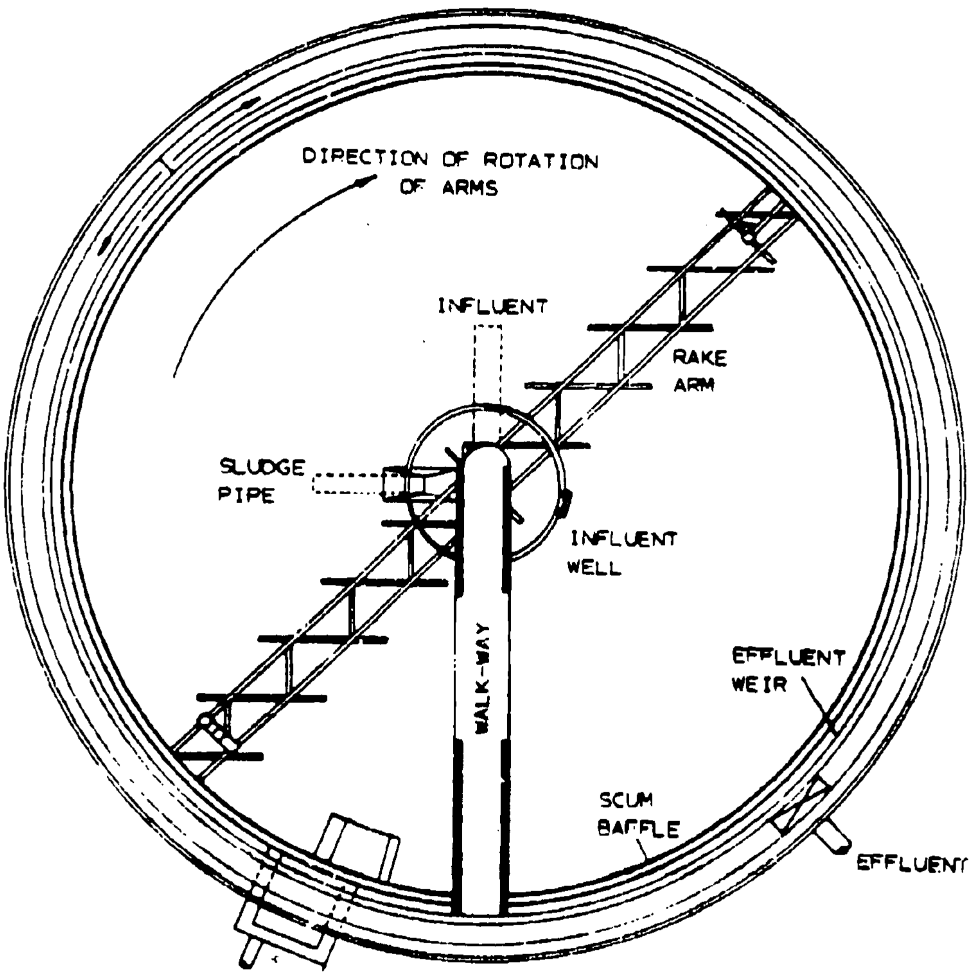


FIGURE 139

CLARIFIER MODULE
PLAN VIEW

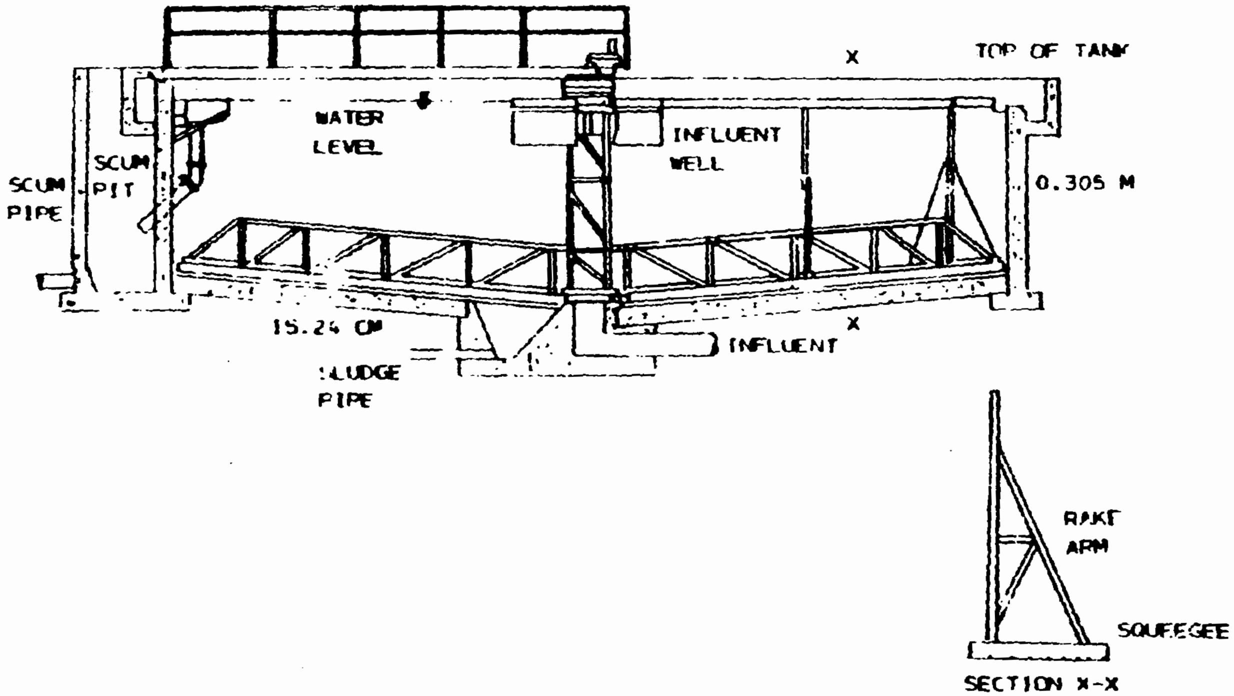


FIGURE 140

CLARIFIER MODULE
ELEVATION VIEW

DRAFT

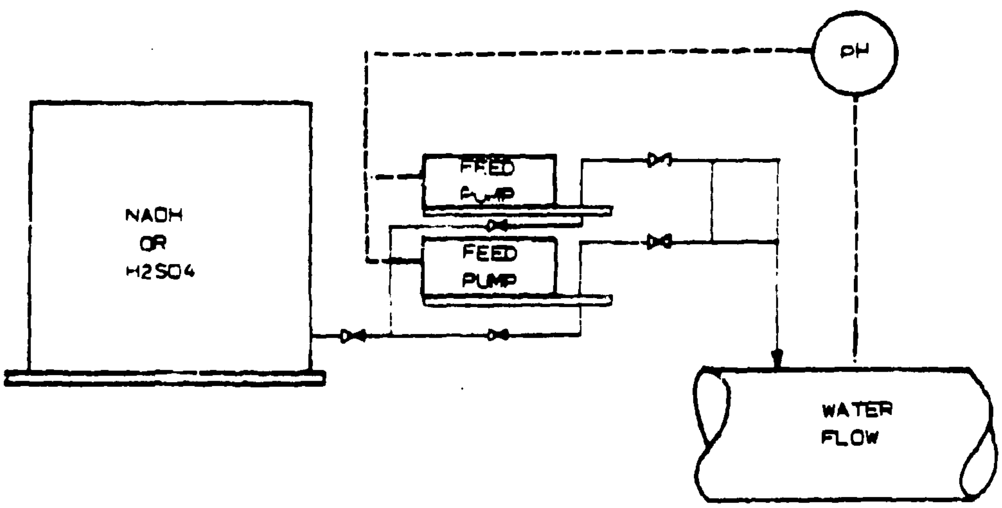


FIGURE 141

NEUTRALIZATION SYSTEM

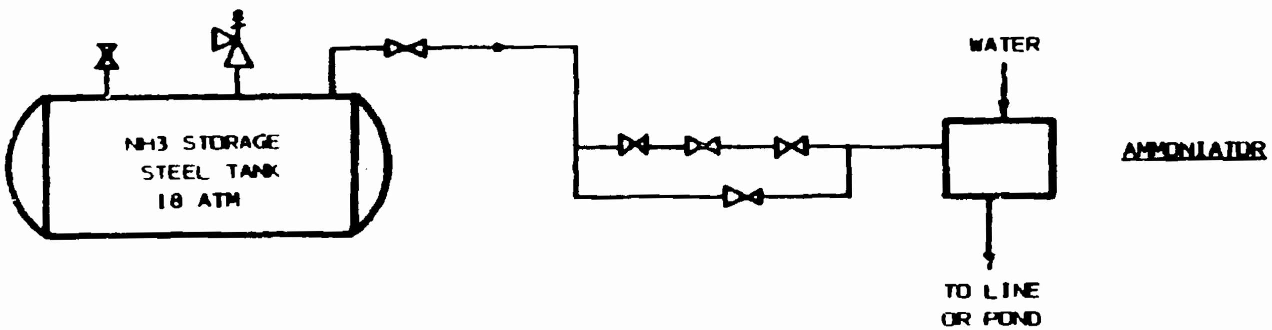


FIGURE :42

NITROGEN ADDITION SYSTEM

DRAFT

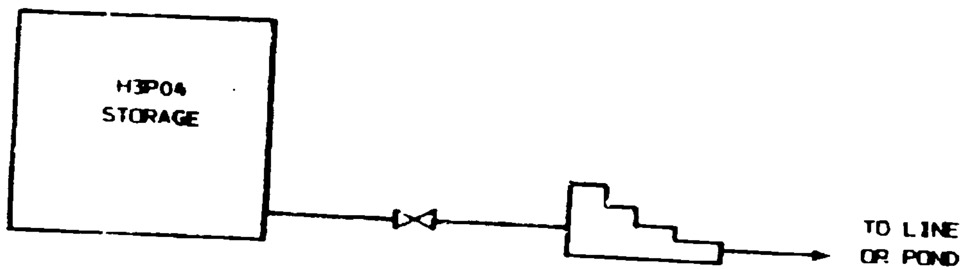


FIGURE 14-3

PHOSPHORUS ADDITION SYSTEM

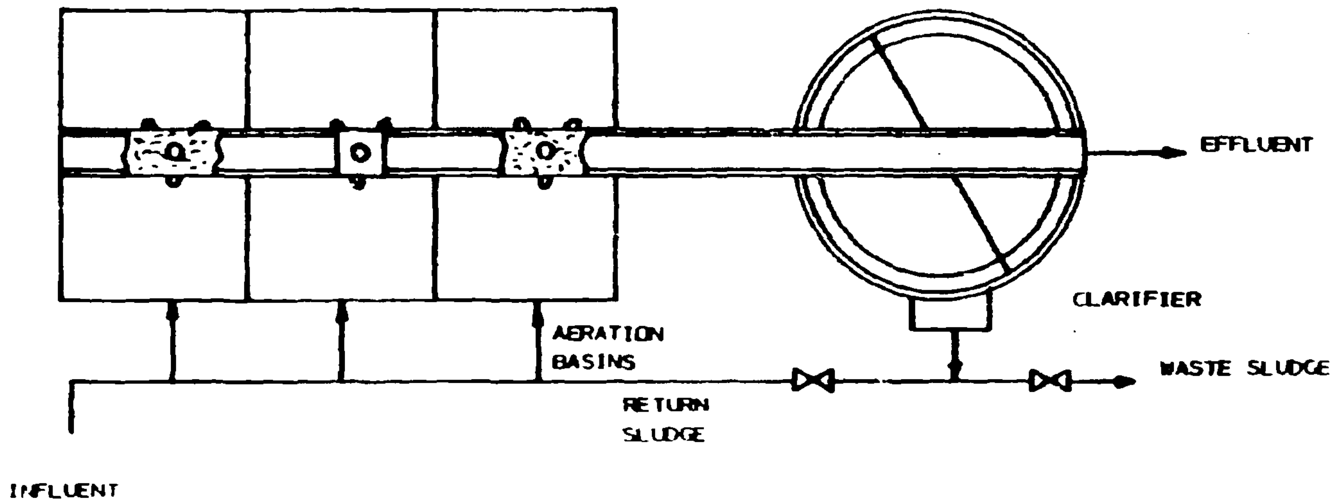


FIGURE 144

ACTIVATED SLUDGE SYSTEM

(as illustrated in Figure 145). It is assumed that 1.5 kg of oxygen (1.5 lb oxygen) are required per kg (pound) of influent BOD.

Unit L is an aerated lagoon system as illustrated in Figure 146. It is assumed that the lagoon achieves the same level of pollutant reduction as Unit K; the lagoon has a length to width ratio of 2:1, and is lined with 10 mil PVC. It has a depth of 3.7 m (12 ft) and is completely mixed. It is designed based on the relation

$$B/A = 1/[1+K(V/Q)]$$

where B = effluent BOD, mg/l

A = influent BOD, mg/l

K = BOD removal rate constant, 1/days

V = volume, cu m

Q = flow rate, cu m/day

The value of K is assumed to be 1.0 for soluble wastes.

Aeration is provided by surface aerators and the same basic assumptions are used as were used for Unit K, except that a mixing requirement of 26.3 kw/cu m (0.5 hp/1000 cu ft) may be an overriding factor.

A separate settling lagoon (Unit M) is provided for sedimentation of solids. The lagoon is 2.4 m (8 ft) in depth and a minimum of two settling lagoons are used. The lagoon is lined with 10 mil. PVC lining. It is assumed that the sludge accumulates for five years, is 60 percent oxidized, and consolidates to a solids content of 15 percent. Once each five years one pond is decanted and the sludge is removed by dragline and hauled away.

Unit N is dual media pressure filtration using anthracite and sand. Pumping is provided to produce an influent head at 30 m (100 ft). Backwash is five percent of flow. The feed is applied at a loading rate of 2.7 l/sec/sq m (4 gpm/sq ft).

Unit O, centrifugation, is a unit process applicable to only a few subcategories within the miscellaneous food and beverages industry. The assumptions used for each application will be discussed for each subcategory using centrifugation.

The sludge thickener, Unit Q, is a concrete basin using mechanical agitation. It is conservatively assumed that the sludge is thickened to a solids content of 2.0 percent.

DRAFT

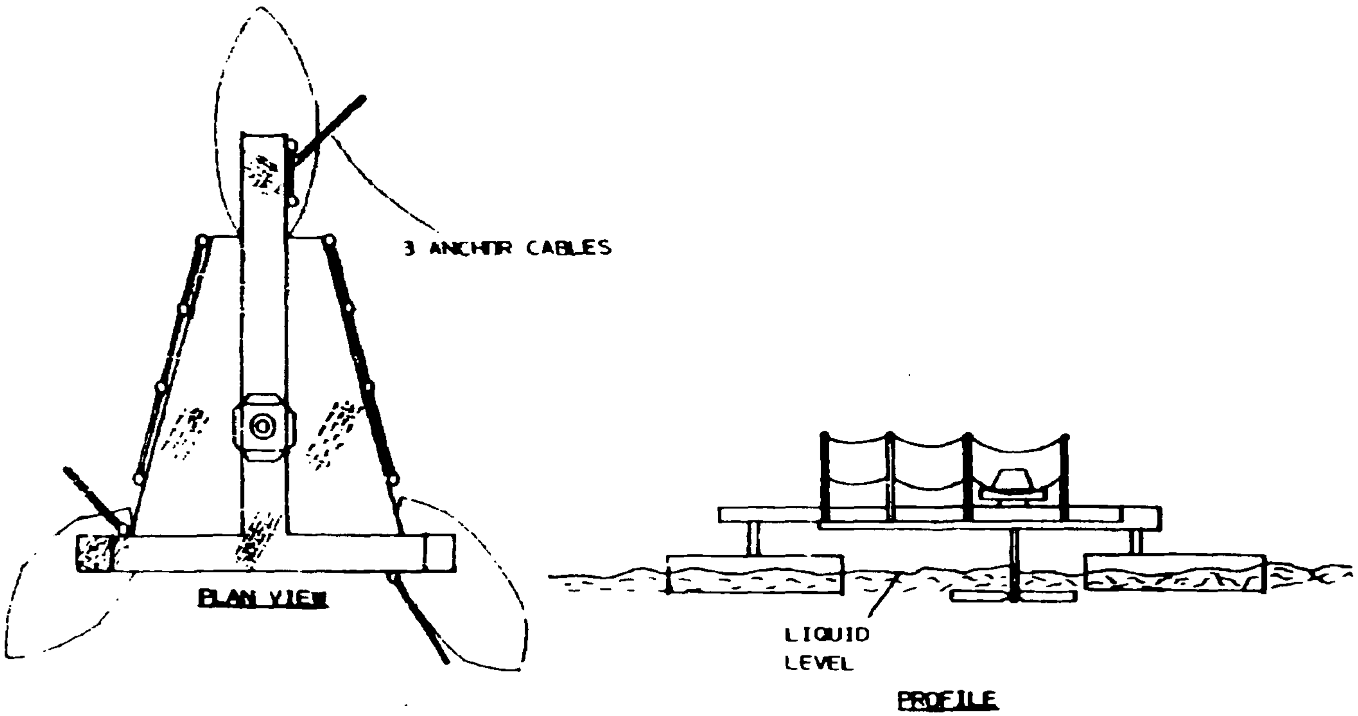


FIGURE 145

FIXED SURFACE AERATOR

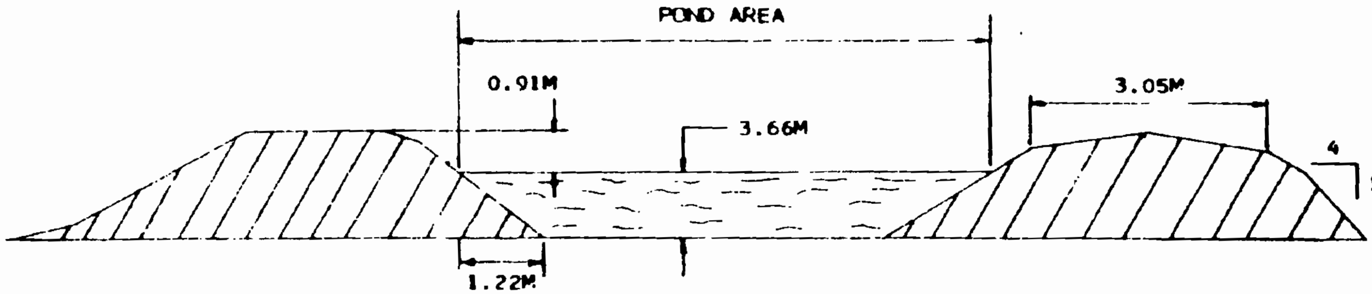


FIGURE 146

AERATED LAGOON CROSS SECTION

Unit R, aerobic sludge digestion, shown in Figure 147, consists of a circular tank constructed of 0.64 cm (0.25 in.) steel. It has a depth of 3.7 m (12 ft) and a detention time of 20 days. Aeration is provided by floating surface aerators at the rate of 75 mg/l/hr. It is assumed that a sludge thickener preceeds this unit and the solids content of the influent sludge is 2.0 percent. It is further assumed that 30 percent of the influent solids are volatilized during digestion.

Figure 148 illustrates Unit S, vacuum filtration. The loading rate of sludge onto the filter is assumed to be 20 kg/sq m/hr (4.0 lb/sq ft/hr). Each filter operates for 12 hr/day. It is assumed that the effluent solids concentration is 15 percent. Chemical addition, in the form of ferric chloride, is at the rate of 7.0 percent by weight of dry solids, and this weight is included in the design loading rate.

The sand drying beds, Unit T, include a tile underdrain system with one collection sump common to all beds. Each bed is 6.1 m (20 ft) by 30 m (100 ft) and has 15 cm (6.0 in) of sand over 30 cm (12 in) of gravel. The beds are constructed with a slope of 0.5 percent. It is assumed that five dryings of a 20 cm (8 in) layer of sludge is possible per year. It is further assumed that the volume of the dried sludge is 50 percent of the applied volume and that the dried sludge is trucked to land disposal.

The spray irrigation system, Unit U, consists of 10.16 cm (4 in.) PVC laterals placed at intervals of 30 m (100 ft) on a 25.4 cm (10 in.) PVC main. "Rainbird" type sprinklers are placed at intervals of 24 m (80 ft) on each lateral. A shut-off valve is located at each connection of a lateral with a main. The wastewater application rate is assumed to be 46,800 l/ha/day (5000 gal/acre/day) and, if sludge is to be applied for irrigation, the application rate is assumed to be 56 kkg/ha/yr (25 ton/ac/yr).

Unit V consists of disposal of process wastewater and/or sludge by truck hauling to an approved sewage treatment plant or land disposal site. It is assumed for cost purposes that an outside contractor is employed to perform this service.

Unit W includes a cast iron pipeline requiring 1.2 m (4 ft) excavation. The line has a gate valve at every 300 m (1000 ft) interval and an air relief valve every 600 m (2000 ft).

Unit X is a trickling filter for biological waste treatment not followed by a solids settling unit. Such filters are commonly termed a "roughing" biological filter.

Unit Y is a storage tank which may be used for storing either wastewater or sludge.

DRAFT

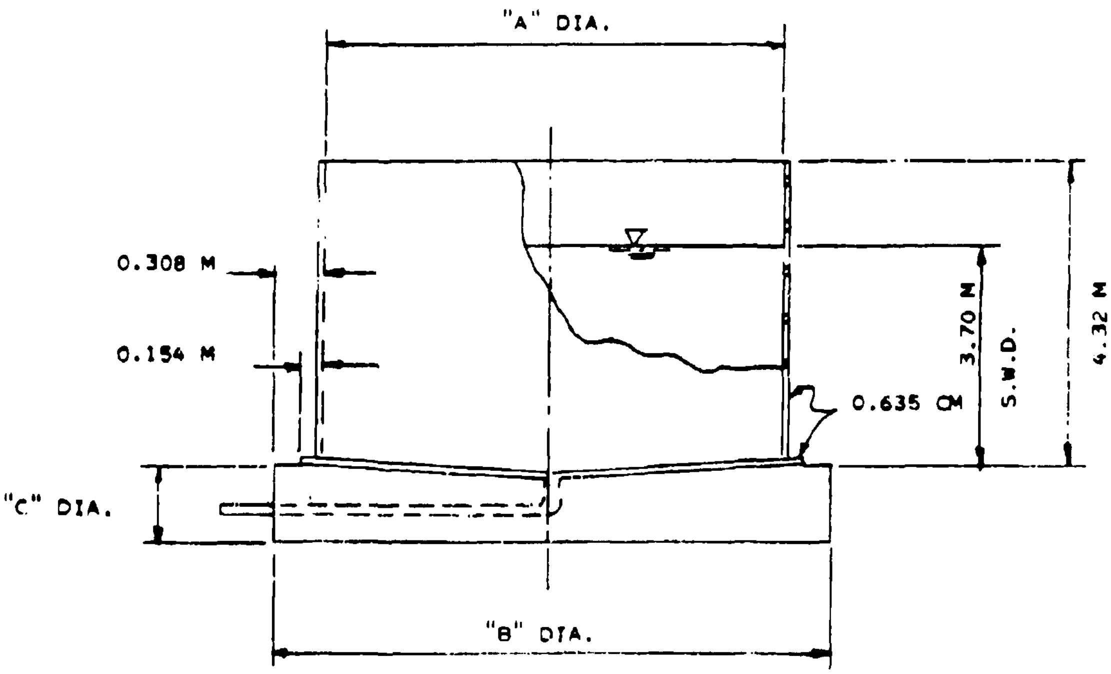


FIGURE 147

AEROBIC DIGESTION BASIN

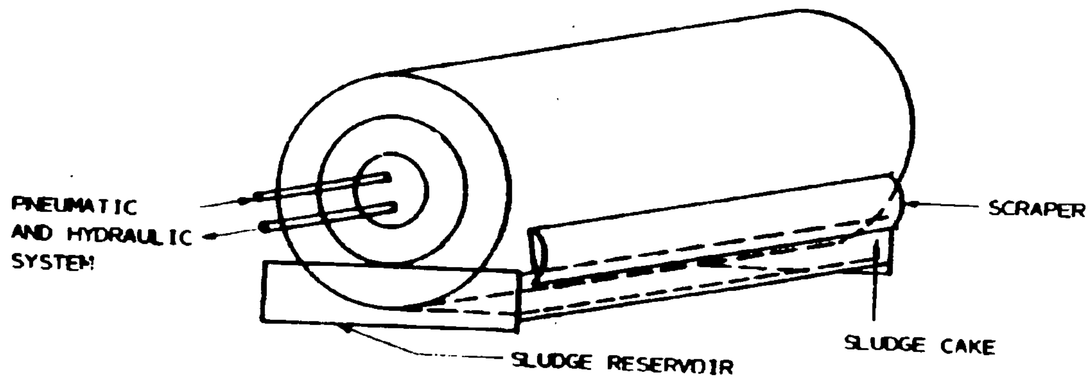


FIGURE 14A

VACUUM SLUDGE FILTRATION

Unit Z is an activated carbon module. The activated carbon unit is employed commonly for removal of color and organics from wastewater.

All treatment trains to be developed include flow measurement devices (Figure 149) a flow proportional sampling station, and if the size and complexity of the treatment plant justifies, an office-laboratory building.

SUBCATEGORY A 1 - OILSEED CRUSHING, EXCEPT OLIVE OIL, FOR DIRECT SOLVENT EXTRACTION AND PREPRESS SOLVENT EXTRACTION OPERATIONS

The process wastewaters generated from the solvent extraction of oilseed and by-product cake or meal represent a relatively minor waste load in comparison to the raw waste load generated by edible oil refineries (i.e., Subcategories A 5 through A 12) as average BOD and oil and grease concentrations for the former facilities average 311 and 252 mg/l, respectively. The average flow rate is 140 cu m/day (0.037 MGD).

Wastewater discharged from the solvent extraction process results from the following processes. 1) soybean oil degumming, 2) wastewater generated by wet scrubber systems, 3) steam condensates contaminated by oil, fatty acids or hexane solvent, and 4) in-plant cleanup of oil or miscella spillage.

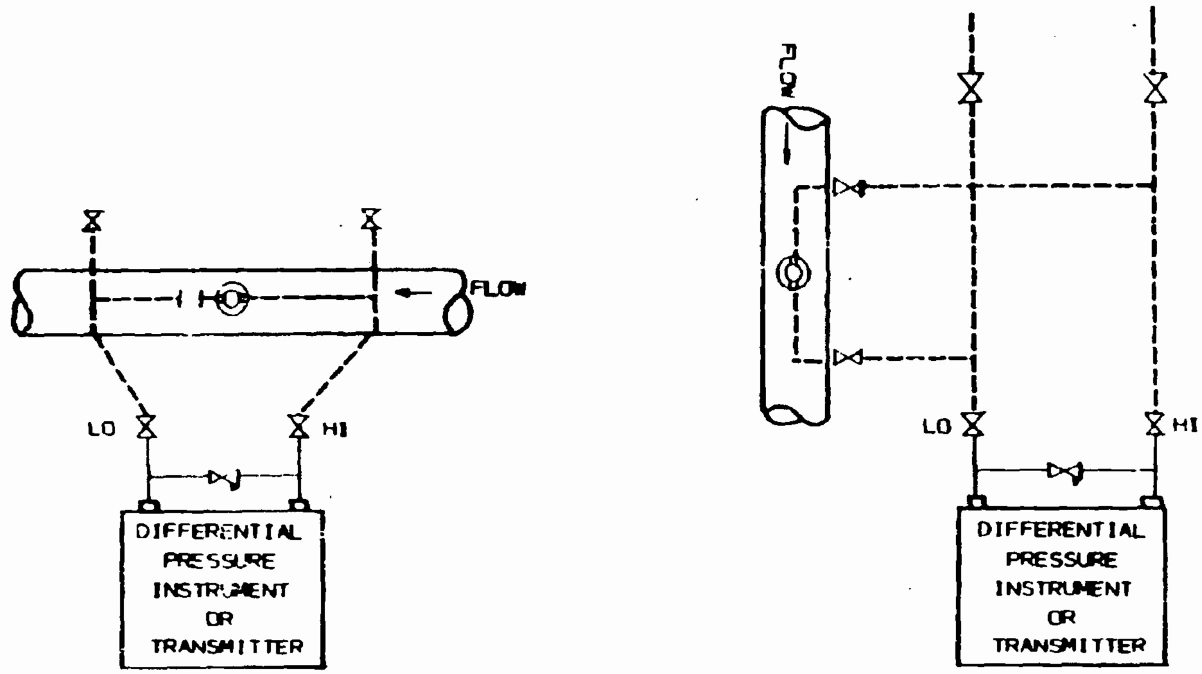
Existing In-Plant Technology

Wastewaters generated from the drying of wet lecithin in the degumming of soybean oil represents a major contribution to the total waste load of a soybean solvent extraction operation. At the present time the industry has not developed an economical in-plant method of reducing degumming waste loads.

Only one plant (75S-13) was observed to utilize a wet scrubber system for the in-plant reduction of air particulates in milling, handling, and unloading areas. Rockwell (21) reports that the use of dry cyclone systems is still the most common dust collection system used in the grain industry. At present, the industry has not developed a method for reducing the relatively high volume, low concentration wastes generated from wet scrubber systems. Existing treatment and control technology applicable to general cleanup and housekeeping practices consists of observance of in-plant water conservation methods through dry cleanup of floors and equipment. In practice, solid materials are removed by sweeping, vacuum or air cleaning. The use of water in oilseed milling areas is prohibited due to the nature of the product being processed, and for reasons of mold and rodent control.

End-of-Line Technology

Process wastewaters prior to discharge to a municipal sewer or treatment facility are commonly directed to a grease trap, sump decanter, or gravity separation and skimming unit. Becker (54) illustrates a sump decanter system in Figure 150.



HORIZONTAL FLOW

VERTICAL FLOW

FIGURE 149

FLOW MEASUREMENT SYSTEMS

DRAFT

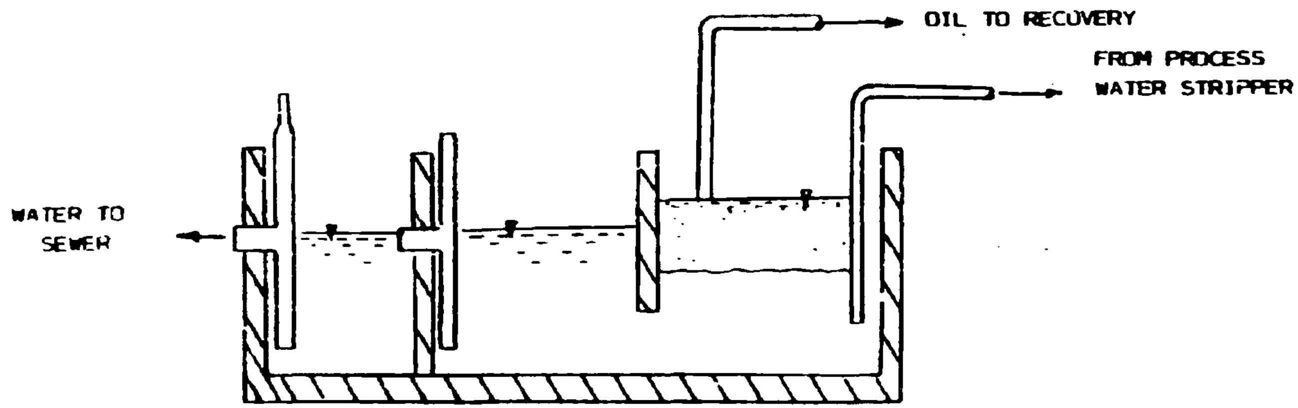


FIGURE 150

SUMP DECANTER SYSTEM

Floatable oils and sludges removed from grease traps and gravity separation basins are commonly trucked to landfill operations by either plant personnel or a contractor. A number of plants recover the floatable oils and pump them to a reprocessing system.

The raw process wastes generated from solvent extraction and prepress solvent extraction operations after the pretreatment step of gravity separation consist primarily of emulsified hydrocarbons and other associated compounds that are not readily separated by pretreatment practices. Results of plant visitations and verification sampling conducted during this study demonstrated that these process wastes, after pretreatment for the removal of floatable oils, are readily biodegradable in normal biological waste treatment systems. Plant visitations and historical data received from one South Central and three Midwest secondary treatment systems clearly indicate reasonable removal rates for BOD, suspended solids, and oil and grease. Table 96 presents a summary of these treatment systems and indicates treatment chains, the percent of BOD removal across the system, and final discharge data for each system. A more detailed discussion concerning the treatability of edible oil wastes is presented in this section for Subcategory A 5.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 1. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Separate discharge of process waters and non-contact water,

2. Gravity separation and skimming of the final process water effluent,

3. Floatable oils and sludges removed by the pretreatment step of gravity separation and skimming either hauled to landfill facilities by in-plant personnel or pumped to an oil reprocessing system.

The raw wastewater charcteristics after gravity separation and skimming were assumed to be as follows:

BOD	340 mg/l
SS	210 mg/l
O&G	380 mg/l
Flow	148 cu m/day (0.039 MGD)

Table 97 lists the pollutant effluent loading from the Subcategory A 1 plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

TABLE 96

FINAL DISCHARGE DATA FOR TREATMENT SYSTEMS HANDLING
SOLVENT EXTRACTION PROCESS WASTES

Plant	Production kkg/day	Flow cu m/day	Treatment[a] Chain	Percent BOD Efficiency Across System	Final Discharge BOD (mg/l)	SS (mg/l)	Oil & Grease (mg/l)	Reference
75S01[b]	635	1087	C,L,E,M,Cl_2	82.7	17	31	9	1972-73 Survey
75S01[b]	635	420	C,L,E,M,Cl_2	96.5	9	24	35	1973-74 Survey
75S02[c]	454	871	GT,(2)L	76.4	33	52	50	1972-73 Survey
75S02[c]	454	939	GT,(2)L	86.2	11	23	26	1973-74 Survey
75S13[d]	1189	1226	GT,(2)L	ND	10	38	ND	1972-73 Survey
75S13[d]	1500	1154	GT,(2)L	ND	13	94	37	1973-74 Survey
75S13[d]	1646	1097	GT,(2)L	ND	13.5	87	13.5	October 1974 Survey
75S13[d]	1443	1200	GT,(2)L	ND	23	70	ND	November 1974 Survey
75S11[e]	816	897	F,G,S,G,J, & L,N,Cl_2	96-99	40	50	1.0	November 1974 Survey

a) C = Equalization basin; L = Aerated lagoon; G = Caustic addition; J = Air flotation; N = Dual Media filtration
E = Clarifier; M = Stabilization pond; Cl_2 = Chlorination; GT = Grease trap; GS = Gravity, separation & skimming; ND = No data.

b) Treatment system handles boiler blowdown, storm water runoff, soybean oil degumming, and solvent extraction plant wastes.

c) Treatment system handles soybean oil degumming, solvent extraction process wastes, and cooling tower blowdown.

d) Treatment system handles cooling tower blowdown, caustic refining, feed mill elevator, storm water runoff, boiler blowdown, and solvent extraction plant wastes.

e) Treatment system handles raw edible oil refinery wastes and solvent extraction process wastes.

TABLE 97

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A 1

Treatment Train Alternative		Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
A 1-I	A	0.061	0.038	0.069	0	0	0
A 1-II	B_1BCKQY	0.0072	0.0090	0.0054	88.2	76.3	92.2
A 1-III	B_1BCKQYBN	0.0036	0.0045	0.0027	94.1	88.2	96.0
A 1-IV	BCL	0.0072	0.0090	0.0054	88.2	76.3	92.2
A 1-V	BCLBN	0.0036	0.0045	0.0027	94.1	88.2	96.0
A 1-VI	B_1BCJ	0.018	0.011	0.021	69.8	70.2	70.3
A 1-VII	B_1BCJKQY	0.0036	0.0045	0.0027	94.1	88.2	96.0
A 1-VIII	BCJL	0.0036	0.0045	0.0027	94.1	88.2	96.0

Alternative A 1-I - This alternative provides no additional treatment other than gravity separation and skimming.

Alternative A 1-II - Alternative A 1-I with the addition of a flow equalization basin, an activated sludge unit, secondary clarification, a sludge recirculating pump, a sludge thickening tank, and a sludge holding tank. Sludge is hauled to a landfill facility every twelve days. The activated sludge unit also includes a control house and one full time operator.

Alternative A 1-III - Alternative A 1-II with the addition of dual media pressure filtration with a pump station to generate sufficient head for the filter operation. A schematic diagram of Alternative A 1-III is presented in Figure 151.

Alternative A 1-IV - Alternative A 1-I with the additives of a flow equalization basin, an aerated lagoon with a settling pond, and one full time operator.

Alternative A 1-V - Alternative A 1-IV with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation. A schematic diagram of Alternative A 1-V is presented in Figure 152.

Alternative A 1-VI - Alternative A 1-I with the addition of a flow equalization basin and pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil re-processing system.

Alternative A 1-VII - Alternative A 1-VI with the addition of a complete mix activated sludge unit, secondary clarification, sludge recirculating pump, sludge thickening tank, and sludge holding tank. Sludge is hauled to a landfill every 30 days. The unit also includes a control house and one full time operator. Figure 153 presents a schematic diagram of treatment Alternative A 1-VII.

Alternative A 1-VIII - Alternative A 1-VI with the addition of an aerated lagoon with a settling pond and one full time operator. Figure 154 presents a schematic diagram of treatment Alternative A 1-VIII.

SUBCATEGORY A 2 - OILSEED CRUSHING, EXCEPT OLIVE OIL, BY MECHANICAL SCREW PRESS OPERATIONS

Existing and Potential In-Plant Technology

The extraction of vegetable oils from oilseeds by the mechanical screw press method results in a relatively small volume of wastewater generated, i.e., less than 4,000 liters (1000 gallons) per day. Because of the small volume of wastewater produced, the industry has not made an effort to

DRAFT

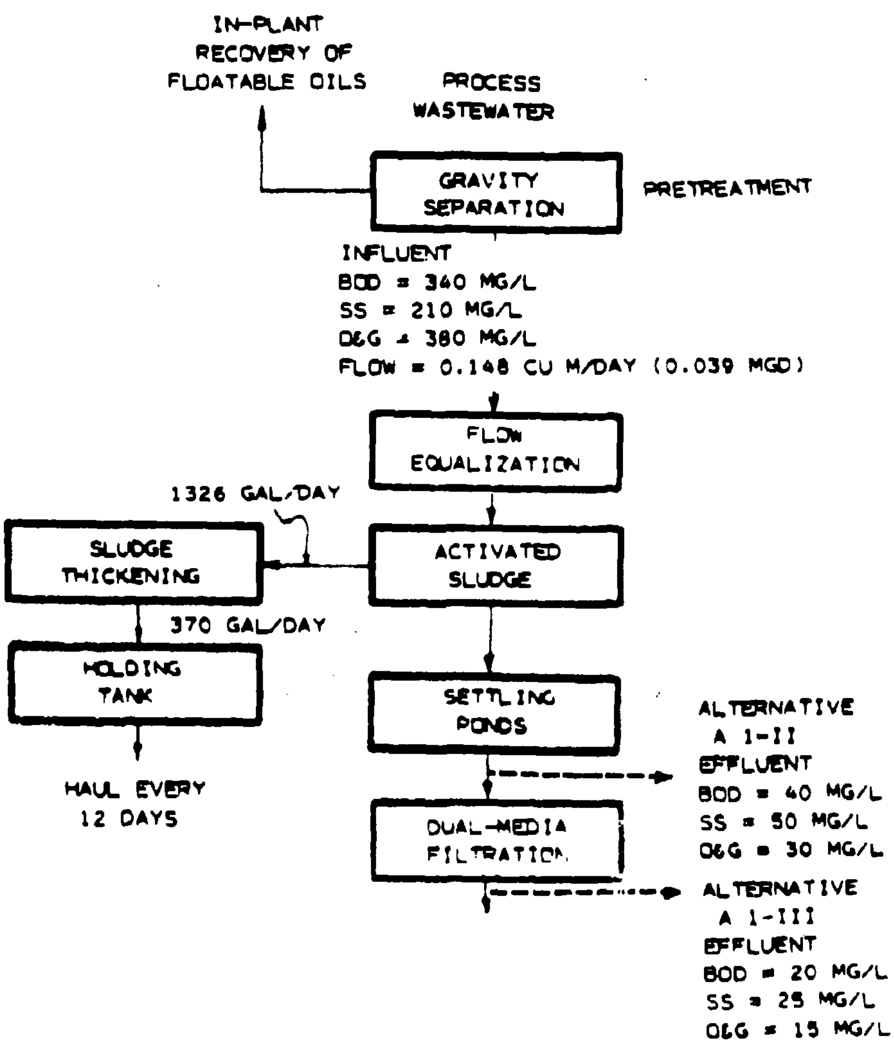


FIGURE 151

SUBCATEGORY A1
TREATMENT ALTERNATIVES II - III

DRAFT

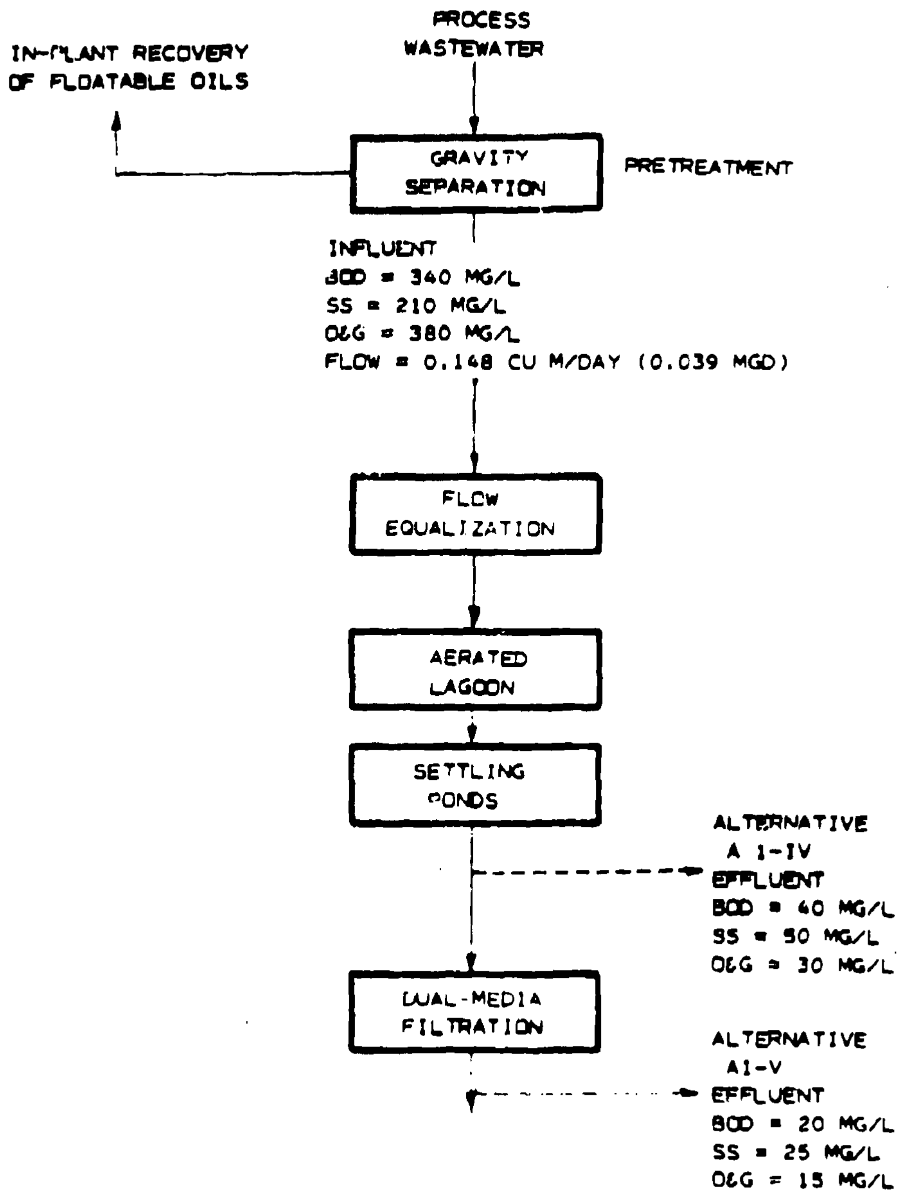


FIGURE 152

SUBCATEGORY A1
TREATMENT ALTERNATIVES IV - V

DRAFT

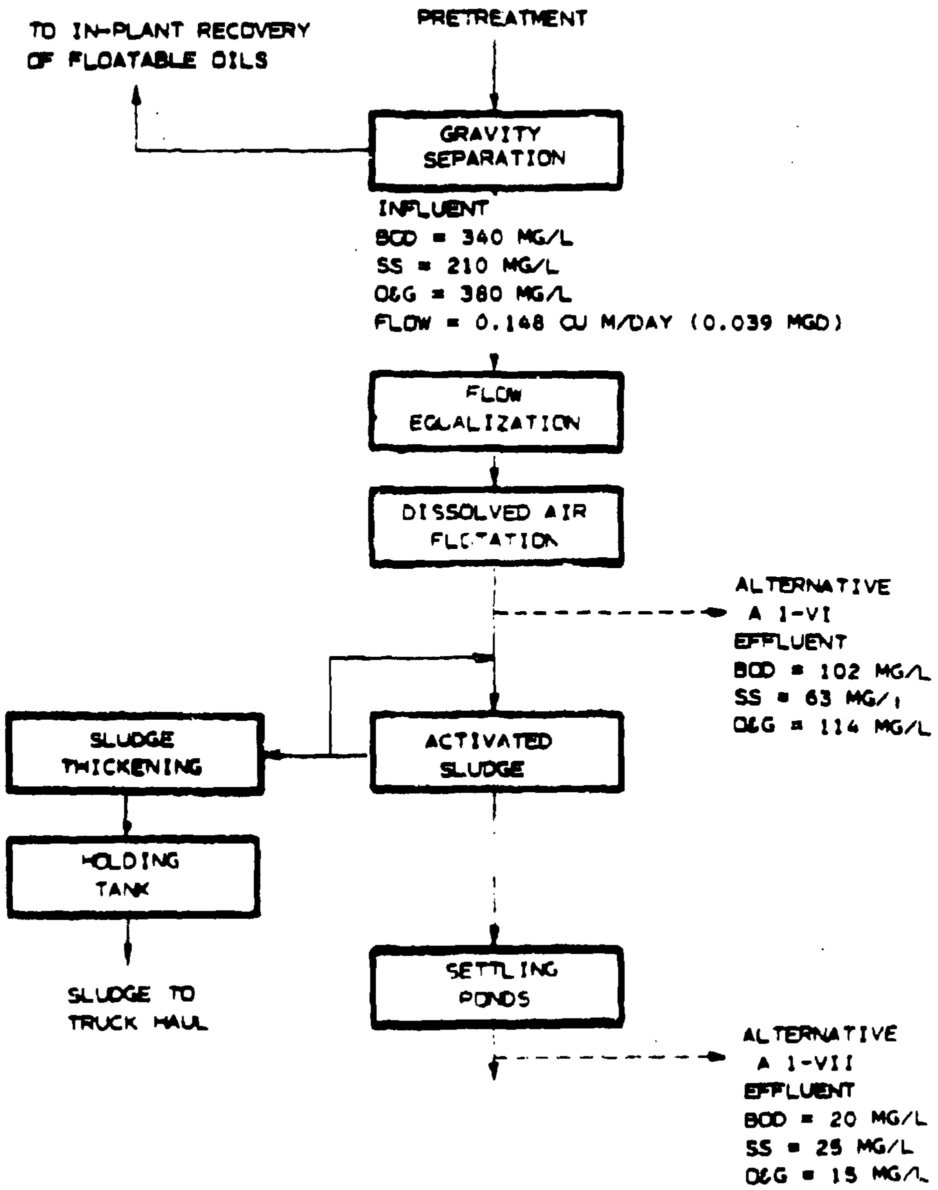


FIGURE 153
SUBCATEGORY A1
TREATMENT ALTERNATIVES VI - VII

DRAFT

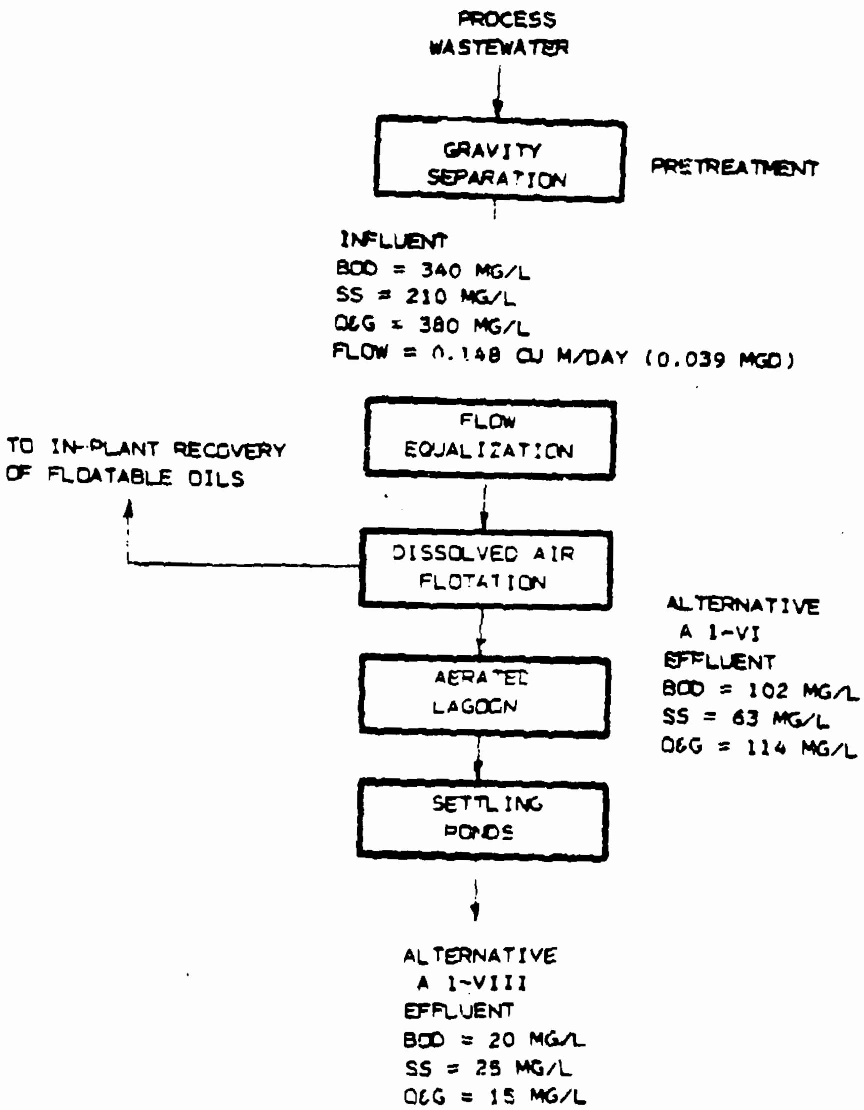


FIGURE 154

SUBCATEGORY A1
TREATMENT ALTERNATIVE VI - VIII

reduce the resulting waste load. The majority of process wastewaters generated from mechanical screw press operations results from two sources: contamination of steam condensates from steam cooking operations, and general floor washing and equipment cleanup of oil and miscella spillage. Existing treatment and control technology applicable to mechanical screw press facilities consists of observance of in-plant water use conservation through dry cleanup of floors and equipment. In practice, solid materials are removed by dry cleanup procedures such as floor sweeping and/or vacuuming. Containment devices are commonly utilized in oil storage areas for the entrapment of spillages. Dry cleanup of oil spills is presently practiced within the industry but does not presently receive widespread application. The majority of plants visited during the study utilized both wet and dry cleanup procedures. Plants which practiced wet cleanup generally employed high pressure, low volume hoses in their cleanup procedures to reduce water usage. Hoses are generally equipped with automatic shut-off valves.

End-of-Line Technology

The majority of plants visited discharged their small waste volume to municipal sewers or landfill facilities. A number of plants trucked their wastes to a nearby edible oil refinery where the oils were recovered in the acidulation process. These plants were observed to recycle their process wastewater into boiler feed makeup water.

Selection of Control and Treatment Technology

In Section V it was determined that it was unnecessary to develop a model plant for mechanical screw press operations due to the small volume of wastewater discharged per day. The most practical disposal of these wastes would be to municipal waste treatment systems, or by hauling to suitable land disposal sites for land application and disposal.

Alternative A 2-I - This alternative provides no additional treatment.

Alternative A 2-II - This alternative consists of a storage tank and truck hauling of the wastewater to a municipal sewage treatment facility or suitable land disposal site.

SUBCATEGORY A 3 - OLIVE OIL EXTRACTION BY HYDRAULIC PRESSING AND SOLVENT EXTRACTION

As discussed in Section III, there are only two olive oil processing plants in the United States and both are located in California. Furthermore, plant 79102 is the only plant which utilizes either the hydraulic press or solvent extraction processes for the recovery of olive oil. The control and treatment practices at the plant are presented below.

Existing In-Plant Technology

Plant effluent consists of centrifuge fruit water and a small amount of water which drains from cannery pits and culls during storage. Any equipment cleanup is done by dry processes resulting in no additional discharge of wastewater.

Potential In-Plant Technology

Examination of in-plant processes suggests no additional method or procedure to further reduce pollutant loads and wastewater volume for this industry.

End-of-Line Technology

Plant 79102 is presently achieving zero discharge of wastewater by collecting and truck hauling its effluent to a municipal treatment facility without adverse effects on the system. Biological treatment of similar olive oil wastewater at plant 79101 has been attempted and, although a 97 percent treatment efficiency was achieved, the initial high strength of the waste resulted in an average effluent BOD of 1300 mg/l. Since the ability of advanced waste treatment for the same or similar wastes has not been proven, biological treatment is not recommended as an alternative for olive oil process wastewater. However, due to the disposal practices of plant 79102 and the proven biodegradability of the waste at plant 79101, there is no reason to suspect that olive oil processing wastewater is inherently incompatible if discharged to a properly designed well-operated municipal treatment facility.

Selection of Control and Treatment Technology

In Section V the raw waste load of the model plant was presented as follows:

Flow	10.9 cu m/day (0.0029 MGD)
BOD	63,000 mg/l
SS	14,000 mg/l
FOG	3,220 mg/l
pH	5.1

Taking account of the basic olive oil production process and the fact that all olives are grown in California, it may be logically assumed that new olive oil plants using hydraulic press or solvent extraction will be located in areas with the same or similar conditions to those of California, i.e., locations near olive orchards and in rural areas where land is available and suitable for wastewater application. These conclusions lead to the following possible disposal alternatives.

Alternative A 3-I - This alternative consists of spray irrigating the process effluent. An area of 0.23 ha (0.6 acres) of land would be required. It is assumed that the effluent would not need to be pumped more than one-half mile. The overall benefit resulting from this alternative is a 100 percent reduction of process wastewater pollutants to navigable waters.

Alternative A 3-II - This alternative consists of four 0.10 ha (0.25 acre) ponds with a depth of two feet to retain the yearly effluent expected from the plant. The yearly net evaporation in the climates where olives are grown has been conservatively estimated at 0.86 meters (3.4 inches). The operation of the ponds would consist of completely filling the ponds, one at a time, so that wastewater in the first pond would be allowed to evaporate as the second was filled, the second pond allowed to evaporate as the third pond was filled and so on. In this way, the first pond would be dry at the time the fourth became full, and the filling cycle could continue. When dry, the ponds would be dredged periodically to remove accumulated sludge. The ponds would be lined to prevent percolation of wastewater into the fresh water aquifer.

Alternative A 3-III - This alternative consists of land application of the waste effluent and would require 0.4 ha (1.0 acres) of land. The land would be terraced with each terrace graded to level. Waste effluent would be piped onto the terraces (one terrace at a time) and the depth of coverage regulated to about 7.6 cm (3.0 in.). As a terrace dried, it would be plowed in preparation for the next application of waste material. This system is used extensively and effectively by wineries in the same area of California as a means of ultimate waste disposal.

SUBCATEGORY A 4 - OLIVE OIL EXTRACTION BY MECHANICAL SCREW PRESSING

As discussed in Section III, there are only two olive oil processing plants in the United States and both are located in California. Furthermore, plant 79101 is the only plant which utilizes the screw press process for the recovery of olive oil. The control and treatment practices of the plant are presented below.

Existing In-Plant Technology

Wastewater generation is minimized to some extent by the retention of fruit wash water until it becomes objectionable in quality.

Potential In-Plant Technology

There appears to be no technology which could be applied to decrease the quantity of wastewater generated from fruit washing or the centrifuge discharge since the water in wash tanks is commonly retained as long as possible already and since centrifuge discharge is a function of the amount of water contained in the fruit initially. The pollutant loadings in these two discharges are also a function of the raw material and cannot be significantly reduced through in-process controls.

Centrifuge sludge is the one area where improvement can be made. Since the sludge has such a high fats and oils concentration, a considerable portion of potential product is being wasted. Therefore, techniques such as solvent extraction might conceivably be utilized to remove a portion of the oil from the sludge.

General plant cleanup generated little water and need not be seriously considered as a means to substantially reduce the waste load.

End-of-Line Technology

At present plant 79101 is achieving zero discharge of all process wastewater by means of land application. Plant 79102, which generates a similar strength waste stream as plant 79101, is also achieving zero discharge of wastewater by collecting and truck hauling of its effluent to a municipal treatment facility. Biological treatment of olive oil wastewater at plant 79101 has been attempted and, although a 97 percent treatment efficiency was achieved, the initial high strength of the waste resulted in an average effluent BOD of 1300 mg/l. Since the ability of advanced waste treatment for the same or similar wastes has not been proven, biological treatment is not recommended as an alternative for olive oil process wastewater. However, due to the disposal practices of plant 79102 and the proven biodegradability of the waste at plant 79101, there is no reason to suspect that olive oil processing wastewater is inherently incompatible if discharged to a properly designed well-operated municipal treatment facility.

Selection of Control and Treatment Technology

The model plant for Subcategory A 4 was presented in Section V with the raw wastewater characteristics assumed to be as follows:

Flow	114 cu m/day (0.030 MGD)
BOD	30,000 mg/l
SS	57,000 mg/l
O&G	20,000 mg/l
pH	5.5

Since olives are grown solely in California, both olive oil manufacturing plants are located in close proximity to olive orchards in that state. It is therefore concluded that any new source olive oil manufacturer would locate in California in rural areas where land is readily available. These conclusions result in selection of the following recommended treatment alternatives as presented below.

Alternative A 4-I - This alternative consists of spray irrigation of the process effluent which would require 2.4 ha (6.0 acres) of land. It is assumed that the waste effluent would not have to be piped more than one half mile. The overall effect of this alternative is a 100 percent reduction of all pollutants from navigable waters.

Alternative A 4-II - This alternative consists of four, one acre, lined evaporation ponds with a depth of two feet. The evaporation to be expected from the ponds, based on conservative estimates from meteorological data for olive growing areas of California, is 0.86 m (34 in.) per year. This evaporation rate led to the selection of the two foot depth requirement. The system would operate by completely filling the ponds, one at a time, so that the first pond filled would be allowed to evaporate as the second was filled, the second allowed to evaporate as the third was filled, and so on. In this way the first pond would be dry at the time the fourth became full and the cycle continues. When dry, the ponds would be dredged to remove accumulated sludge. No discharge of process wastewaters to navigable waters would result.

Alternative A 4-III - This alternative consists of land application of the waste effluent and would require 1.6 ha (4.0 acres) of land. The land would be terraced with each terrace graded to level. Waste effluent would be piped onto the terraces (one terrace at a time) and the depth of coverage regulated to about 7.6 cm (3.0 in.). As a terrace dried it would be plowed in preparation for the next application of wastewater. This system is used extensively and effectively by wineries in the same area of California as a means of ultimate waste disposal.

SUBCATEGORY A 5, PROCESSING OF EDIBLE OIL BY CAUSTIC REFINING METHODS ONLY

The following discussion of existing and potential in-plant treatment and control technology may be generally applied to subcategories A 5 through A 12. Table 98 presents a summary of the present in-plant treatment and control technology for the edible oil refining industry. The principle source of process wastewater generation for Subcategory A 5, edible oil refineries, is the caustic refining operation itself, tank car cleaning, material storage and handling, and general department cleanup. Non-contact cooling water is not included within the definition of process wastewater.

In-Plant Technology

The centrifuged wash waters containing sodium soaps, free fatty acids, phospholipids, and residual oils from the unit process of caustic refining represent a major contribution to the total waste load of an edible oil refinery. Data compiled from six caustic refining operations found BOD and oil and grease concentrations to average 6,900 and 5,000 mg/l, respectively. Currently, the edible oils industry has not developed an economical in-plant method of reducing these caustic refining waste loads.

TABLE 98

SUMMARY OF PRESENT INPLANT CONTROL AND TREATMENT CONTROL TECHNOLOGY FOR THE EDIBLE OIL REFINING INDUSTRY

Waste Water Source	In-Plant Control	Remarks
1. Receiving and storage (including tank cleaning and storage tanks)	1a. SPCC regulations as required under EPA title 40.	1a. Covering spill preventation, containment and recovery.
	1b. Recirculation of tank car cleaning solution.	
	1c. Development of a systematic tank car wash procedures with emphasis on reduction of water volume.	1c. Steam cleaning may be used as a viable alternative.
2. General Departmental sources including floor wash, in-plant leaks, accidental spills, and pump failure, and seal leakage.	2a. General: Improved maintenance and house-keeping pratices; improved operator awareness and training.	2a. Reduction of BOD suspended solids, and oil and grease levels; plants should undertake a program to identify sources of in-plant generation of wastewater and encourage employee participation in reduction effort.
	2b. Wet cleanup: Departmentalized containment basins; inplant spill plans; reduction of water usage to absolute minimum by use of low volume high pressure nozzle hoses and standardized cleanup procedures. Establishment of oil recovery systems for resale as inedible oil products.	2b. Departmental localization of spills is highly desirable to reduce the impact of emulsification as wastes are combined prior to treatment, therefore reducing the cost of final treatment.
	2c. Dry cleanup: Maximum implementation of dry cleanup procedures; vacuum cleaning, sweeping, dry chemical adsorption of spill material.	2c. Presently practiced but not commonly applied throughout the industry. Implementation of dry cleanup substantially reduces end-of-line treatment costs.
3. Caustic Refining	3. No controls presently recommended.	

Waste Water Source	In-Plant Control	Remarks
4. Soapstock Acidulation	4. No controls presently recommended.	
5. Bleaching	5a. Dry cleanup of spent bleaching adsorbent.	5a. Elimination of this discharge point will significantly reduce concentrations of BOD, suspended solids, greases and oils in the final waste loads.
	5b. Recirculation of contact cooling water from barometric condenser.	
	5c. Recovery of oil from filter cake to be sold as an inedible oil product.	5c. Technology to date has not established economic feasibility for all plants.
6. Hydrogenation	6. Dry cleanup of filter press.	6. Reduce or eliminate discharges of catalyst, i.e., nickel.
7. Winterization	7. No controls presently recommended.	
8. Deodorization	8 Installation of distillate recovery systems in the barometric condenser systems.	8 Reduction in entrainment of fatty materials on cooling tower grillate and tower basin resulting in fewer manual cleaning operations of cooling tower.
9. Plasticizing & Packaging Operations	9. Clean-in-Place equipment with containment and recirculation.	
10. Non-Contact Cooling Water	10. Recycle and reuse. Separation of non-contact cooling water from process wastes.	10. Essential in the reduction of total plant water usage.
11. Process Waste Final Effluent	11a. pH monitoring and adjustment where necessary	11a. Where desirable or necessary.
	11b. Flow equalization where necessary	11b. Important where variability may induce upset of treatment train or municipal treatment facility.
	11c. Gravity separation and skimming for the removal of floatable oils.	11c. Essential pretreatment before discharge into biological systems.

Wash waters discharged from the cleaning of tank cars is a major source of wastewater generation for all edible oil refineries. Tank cars are cleaned to remove and recover crude oils and fats that adhere to the walls of the tank car. Tank car washing is commonly accomplished by the use of a mechanical rotating-head spray assembly that applies a detergent solution followed by rinse water to the tank car interior. Wastewater from this operation may represent once through water use or the wash water may be recycled with makeup water. BOD and oil and grease concentrations for tank car cleaning operations at five edible oil refineries averaged 2950 mg/l and 930 mg/l, respectively. Currently, the industry commonly practices recirculation of caustic tank car cleaning solutions to reduce waste loading. In addition, several plants have established systematic tank car washing procedures with the emphasis on reducing the volume of water used to wash each car. An alternative method utilizing steam cleaning has been found effective for a limited number of facilities. Wastewater from tank car cleaning is commonly collected in sloped drains that empty into baffled gravity separation basins. Floatable oils generally are recovered for resale as an inedible oil product, and the resulting wastewater is discharged to final gravity separation facilities, skimming devices, and pH control facilities.

Another major source of wastewater generation occurs in conjunction with receiving, storage, and transfer areas within the plant. Waste waters from these areas result from general cleanup procedures, accidental spills, valve or tank leakages, and/or pump failures. BOD and oil and grease concentrations from transfer and storage areas average 8,000 mg/l and 4 200 mg/l, respectively. Existing treatment and control technology applicable to receiving, storage, and transfer areas consists of observance of in-plant water use conservation through dry cleanup of floors and equipment. In practice, solid materials are removed by dry cleanup procedures such as floor sweeping and/or vacuuming. Containment devices are commonly utilized in oil storage areas for the entrapment of spillages. Plants which utilize strictly wet cleanup procedures find that the final waste treatment of oil spills is most difficult when these wastes are combined with emulsified contaminants from other areas of the plant. Dry cleanup of oil spills is presently practiced within the industry but does not presently receive widespread application. The majority of plants visited during the study utilized both wet and dry cleanup procedures. Plants which practiced wet cleanup generally employed high pressure, low volume hoses in their cleanup procedures to reduce water usage. Hoses are generally equipped with automatic shut-off valves.

<u>Potential In-Plant Technology</u>

Potential in-plant control and treatment technology would include improvements in general plant maintenance and housekeeping practices with maximization of dry cleanup procedures (i.e., vacuum cleaning, and the utilization of dry chemical absorption) where feasible.

The effect of these measures would substantially reduce and minimize potential pollutant loading resulting from the process. The industry may also very advantageously adopt an industry-wide approach toward improvement of operator awareness regarding general dry cleanup procedures, and pollution control methods. In addition, individual plants may well develop a program to identify sources of in-plant wastewater generation and encourage employee participation in reducing water usage and related wastewater generation. Each plant should establish methods and procedures for the localization and convenient cleanup of oil spills and seal or valve leakages. The establishment of revetments or spillage containment structures in tank storage areas in all cases would provide for positive control of accidentally spilled materials. Dry cleanup is much preferred in comparison to wet cleanup procedures. These measures would significantly reduce both the amounts of floatable oils in the total wastewater and the additional emulsification of oil and water discharged to final treatment which occurs where wet cleanup is employed. The localization of oil spills by the installation of spill containment structures and departmental catch basins will improve the effectiveness and reduce the cost of subsequent final treatment.

<u>End-of-Line Treatment Technology</u>

The combined raw wastes from edible oil refineries after the pretreatment steps of gravity separation, skimming, and pH control consist primarily of emulsified hydrocarbons, triglycerides, sterol esters, fatty acids, compound lipids, and other associated substances that are not readily separated by pretreatment practices. All edible oil refining plants presently provide the aforementioned pretreatment measures. Grinkevich (99) has reported some typical ranges of pollutant concentrations for edible oil refining wastewaters as follows:

BOD	500-6,700 mg/l
SS	540-5,850 mg/l
Oil and Grease	300-4,200 mg/l

Results of plant visitations and verification sampling conducted during this study demonstrated that these process wastes, after pretreatment of floatable oils, are readily biodegradable in normal biological wastetreatment systems. Plant visitations and historical data received from two identical secondary treatment systems (plants 75F-10, 75F-11) in the south central United States indicate that both facilities are achieving high sustained removals of BOD, suspended solids, and oil and grease by aerated lagoons preceded by gravity separation, skimming, pH control, and dissolved air flotation. Each of these systems also has dual media filtration and chlorination after secondary treatment with a final discharge of 40 mg/l BOD; 50 mg/l suspended solids; 1.0 mg/l oil and grease; and a pH range of 7 to 8. Percent removals of BOD were 96 to 99 percent; suspended solids, 99 percent; and oil and grease, 99.9 percent. Table 99 presents the existing unit treatment chain and design features for plant

TABLE 99

EXISTING TREATMENT CHAIN AND MAJOR DESIGN FACTORS OF PLANT 75F-10
FOR THE BIOLOGICAL TREATMENT OF EDIBLE OIL REFINERY WASTES

Number	Treatment Unit	Significant Design Features
1	First pH mix tank	8.2 l/sec (130 gpm) capacity, adjust the raw waste pH of 1.5 to 3 to insure adequate separation of oil and water for gravity separation.
2	Flow equalization tank	851.6 cu m (225,000 gallon) capacity.
3	Skimming tank	1135.5 cu m (300,000 gallon) capacity operating at a fixed level for continuous mechanical skimming. Recovered oil will be pumped to a oil holding tank, 37.8 cu m (10,000 gallon) capacity. Here steam and gravity will be used to separate oil and water with the water being sent back to the flow equalization tank.
4	Second pH mix tank	Anhydrous ammonia addition with automatic pH control and alarm equipment to raise the pH to 7.
5	Dissolved air flotation (2 units) with chemical addition.	Retention time, along with the ratios of lime, alum, and polyelectrolytes are varied to produce the maximum amount of pollutant reduction. 68.1 cu m (18,000 gallon) capacity each.
6	Aerated lagoon (2 units)	4542 cu m (1.2 million gallon) capacity, with five 14.9 kw (20 hp) floating surface aerators and a five to six day retention time per lagoon.
7	Stabilization lagoon	Same design as above but without surface aerators (overall retention time in the three basins is 15 to 18 days)
8	Dual media filter with chlorination before and after	Suspended solids and bacteria removal. No data on retention time dosages or design.
9	Final Effluent	BOD, 40 mg/l; SS, 50 mg/l; Oil and Grease 1.0 mg/l; Total Phosphorus, 9 mg/l; Nickel, 0.02 mg/l; pH, 7 - 8.

75F-10. The treatment efficiency data for oil and grease compiled from plant 75F-10 are considerably higher than those reported by Loehr (100) for several Midwest municipalities. The following total grease removal efficiencies were reported by Loehr for municipal activated sludge units: 84 percent, Topeka, Kansas; 85.7 percent, Cleveland, Ohio; and 94 percent, Madison, Wisconsin. Progressive grease removals indicated by the Topeka, Kansas, study were 45 percent by primary treatment; 75 percent by secondary treatment; and 84 percent by complete treatment. Average removals of BOD and suspended solids were 85 and 82 percent respectively. Results of this study also indicated a reasonably reliable correlation between oil and grease and suspended solids concentrations in the biologically treated final effluent.

Presently over 95 percent of the edible oil refineries within the United States discharge their process wastewaters into municipal sewage systems. As concluded by this study, pretreatment technology for the edible oils industry involves gravity separation of floatable fats, oils, and greases, and pH control of the remaining wastewaters. Treatment of the resulting wastewaters in municipal systems after such pretreatment is reported to be accomplished without difficulty. In fact, it is the industry's contention that joint treatment of edible oil refinery wastes with domestic sewage is the most efficient and economical method of wastewater tre ment.

The treatability studies by McCarty (101) give further support to the biodegradability of edible oil refining wastes. Edible oil processing and soap manufacturing wastes were combined on a one to one ratio on a COD basis with domestic waste in a laboratory scale activated sludge unit. Results of the study indicated that mixed wastes occurred at normal operating efficiencies of 60 to 80 percent for oil and grease removal, with normal sludge digestion and with no significant adverse effect on oxygen transfer. Adams and Eckenfelder (102) report that biological treatment of oil and greases of vegetable and animal origin is the best means for reducing the oil content of these wastes to acceptable levels before final discharge to receiving waters. They also note that pretreatment precautions be observed to remove floating and non-emulsified oils and greases before subsequent discharge to a treatment facility. Occasionally, pH neutralization is necessary before discharge to the biological system. Adams and Eckenfelder also report the reduction of a pretreated influent of hexane extractible content ranging from 500 to 1500 mg/l to an effluent level of less than 15 mg/l using either aerated lagoons or activated sludge facilities (97 to 99 percent efficiencies). In addition, no abnormal behavior was observed in sludge handling processes such as gravity and flotation thickening, stabilization by aerobic digestion, or by dewatering using vacuum or pressure filtration. Watson et al (103) reports on the performance of a pretreatment facility in Champaign, Illinois, treating the combined wastes from an edible oils refinery and a margarine, salad dressing, and cheese processing

DRAFT

TABLE 100

EXISTING TREATMENT CHAIN AND MAJOR DESIGN FACTORS FOR THE EDIBLE OILS-MARGARINE, SALAD DRESSING AND CHEESE PRETREAMENT FACILITIES AT CHAMPAIGN, ILLINOIS

Number	Treatment Unit	Significant Design Features
1	(2) lift stations	Cheese Plant, two 7.5 kw, 850 l/min (10 hp, 225 gpm) pumps. Oil Plant, two 5.6 kw, 945 l/min (7.5 hp, 250 gm) pumps
2	Surge tank	Capacity 302 cu m (80,000 gallons) minimum detention time at average flow--1.5 hours maximum detention time at average flow--4.5 hr
3	Flotation clarifier	Capacity 288 cu m (76,000 gallons) air pressurization on recycle, surface settling rate, 58 square M (625 square feet), 50 percent recycle, average flow.
4	Grease storage tank	Heated, capacity 68 cu m (18,000 gallon)
5	Aeration basin	Capacity 8,600 cu m (2.27 million gallons); detention, 4.5 days at average flow; aeration, 3.5 kw, 224 cu m/min (4.75 hp, 8,000 scfm) and six floating aerators totaling 157 kw (210 hp)
6	Final clarifier	Capacity, 379 cu m (100,000 gallons); surface settling rate, 11 cu m/day/sq m (270 gpd/sq ft)
7	Aerobic digestor	Capacity 1,400 cu m (368,000 gallons); three 20 cu m/min (50 hp, 700 scfm) blowers
8	(2) sludge lagoons	Located at Champaign-Urbana sanitary district site. Each lagoon is 0.405 ha (1 acre) x 2.4 M (8 ft) deep

operation. The Champaign pretreatment facility was reported to typically operate within the following ranges of removal efficiencies: BOD, 96.4 to 99.4 percent; suspended solids 90 to 95 percent; and oil and grease 93 to 99.5 percent with about 72 percent being removed in primary treatment and about 25 percent removed by the secondary unit. In order that the plant could meet the municipal ordinances of 200 mg/l BOD, 200 mg/l SS, and 100 mg/l of fats, oil and greases, the design features listed in Table 100 were adopted for the Champaign plant based upon a 1980 waste loading capacity.

Selections of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 5. The model plant was developed to include the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization,
2. Gravity separation and skimming,
3. In-plant oil recovery system,
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were taken as follows:

BOD	6,600 mg/l
SS	3,600 mg/l
Oil and Grease	3,500 mg/l
Flow	314 cu m/day (0.083 MGD)

Table 101 lists the pollutant effluent loading from the Subcategory A 5 plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 5-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

Alternative A 5-II - Alternative A 5-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclaimation system for dewatering, and recovery of inedible oils.

Alternative A 5-III - Alternative A 5-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every seven days. The activated sludge unit also includes a control house and two full time operators.

Alternative A 5-IV - Alternative A 5-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

TABLE 101

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
A 5-I A	4.59	2.49	2.39	0	0	0
A 5-II BJ	1.37	0.75	0.73	70.1	70.0	69.5
A 5-III BJKQSY	0.069	0.069	0.069	98.5	97.2	97.1
A 5-IV BJKQSYBN	0.035	0.035	0.014	99.2	99.2	99.4
A 5-V BJKQSYBNZ	0.021	0.017	0.007	99.5	99.6	99.7
A 5-VI BJL	0.069	0.069	0.069	98.5	97.2	97.1
A 5-VII BJLBN	0.035	0.035	0.014	99.2	99.2	99.4
A 5-VIII BJLBNZ	0.021	0.017	0.007	99.5	99.6	99.7

Alternative A 5-V - Alternative A 5-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 5-V is presented in Figure 155.

Alternative A 5-VI - Alternative A 5-II with the addition of an aerated lagoon including a settling pond.

Alternative A 5-VII - Alternative A 5-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 5-VIII - Alternative A 5-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 5-VIII is presented in Figure 156.

SUBCATEGORY A 6 - PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING AND ACIDULATION METHODS

The existing and potential in-plant treatment and control technology and existing end-of-line technology for Subcategory A 6, Edible Oil Refineries, are essentially as those discussed in Subcategory A 5 and outlined in Table 98.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 6. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	7,600 mg/l
SS	3,400 mg/l
O&G	3,000 mg/l
Flow	534 cu m/day (0.141 MGD)

Table 102 lists the pollutant effluent loading from the Subcategory A 6 model plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 6-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

DRAFT

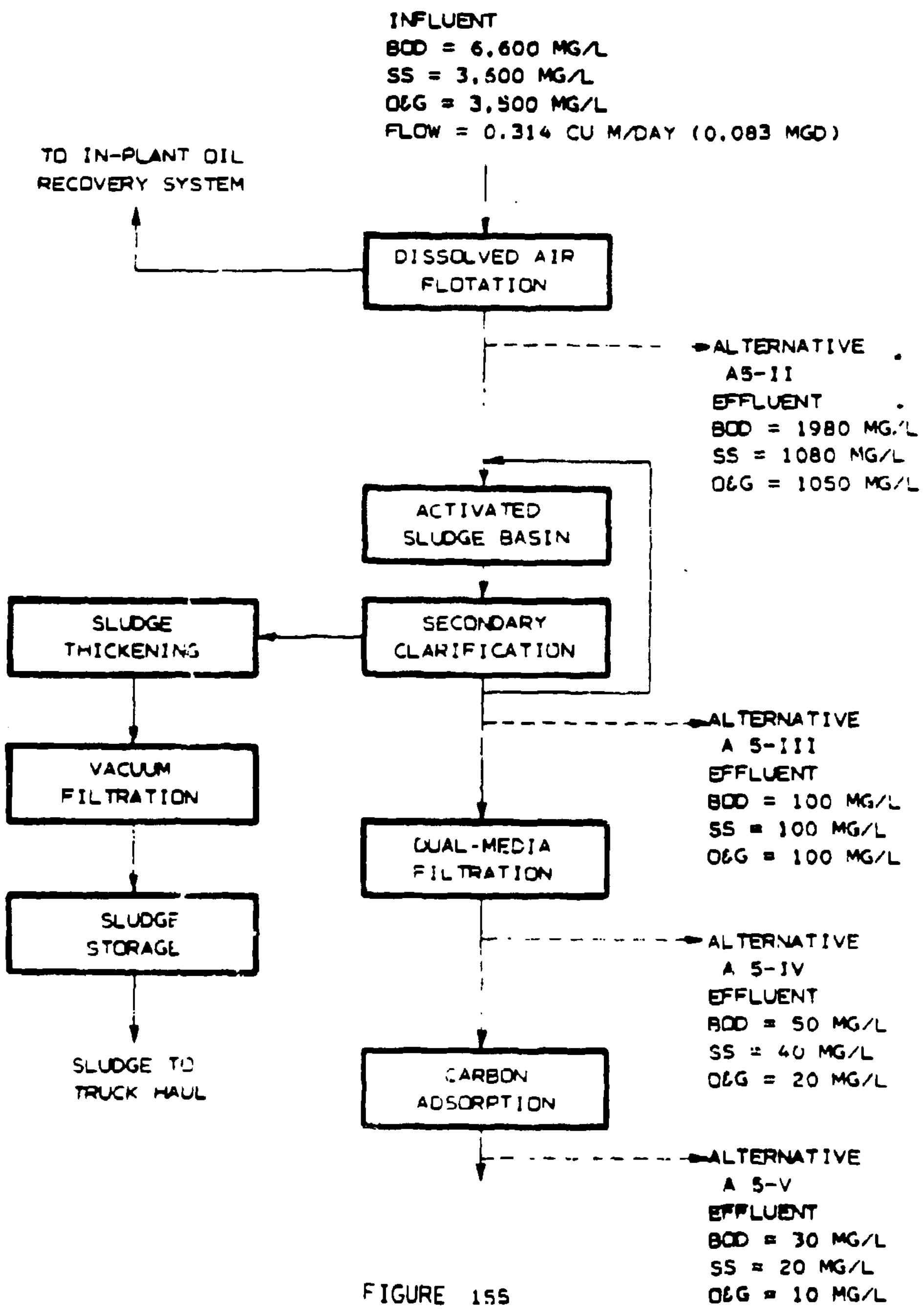


FIGURE 155

SUBCATEGORY A5
TREATMENT ALTERNATIVES II THROUGH V

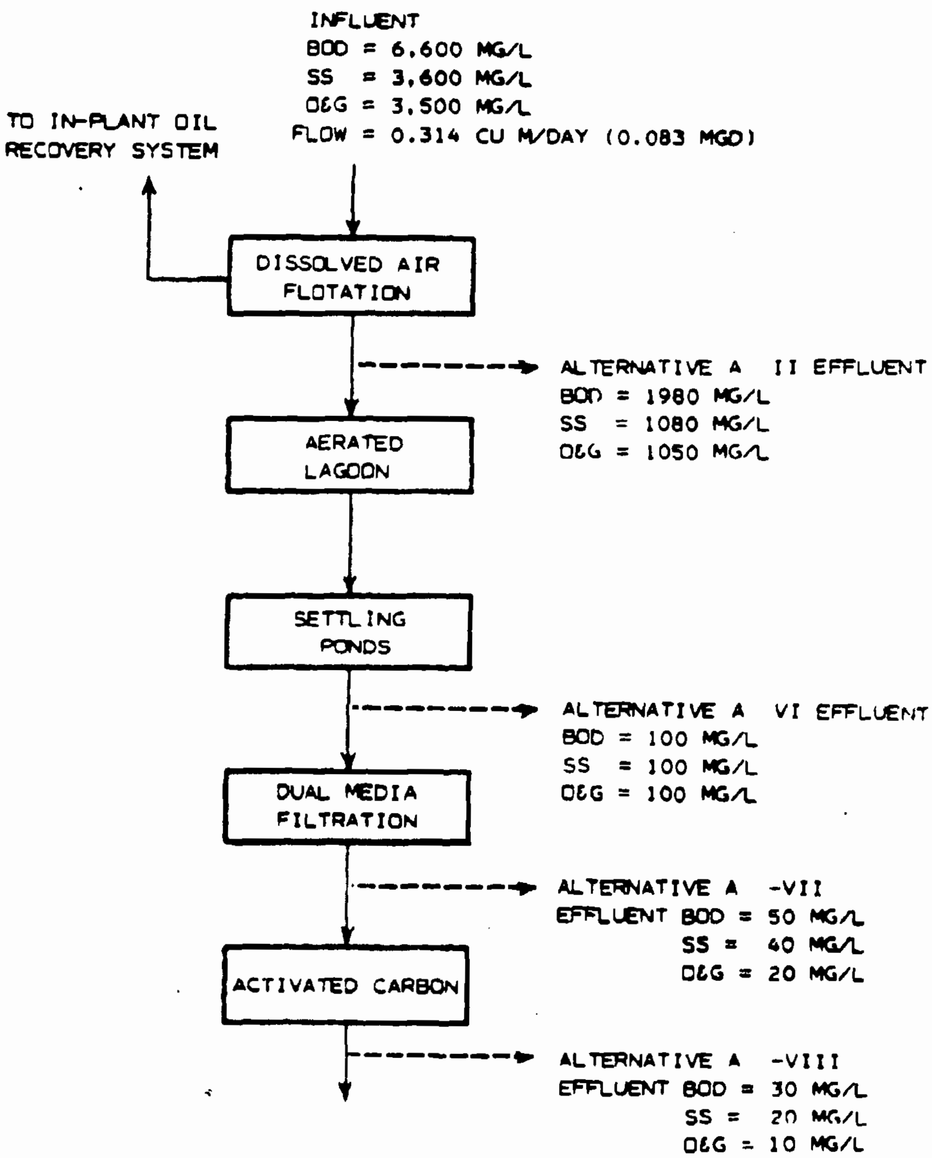


FIGURE 156

SUBCATEGORY A5
TREATMENT ALTERNATIVES VI THROUGH VIII

DRAFT

TABLE 102

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A6

Treatment Train Alternatives	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent F, O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent F, O&G Reduction
A6-I A	8.95	4.03	3.51	0	0	0
A6-II B,J	2.68	1.21	1.05	70	70	70
A6-III BJKQSY	0.134	0.121	0.105	98.5	97.0	97.0
A6-IV BJKQSYBN	0.067	0.061	0.023	99.2	98.5	99.3
A6-V BJKQSYBNZ	0.035	0.030	0.012	99.6	99.3	99.6
A6-VI BJL	0.134	0.121	0.053	98.5	97.0	97.0
A6-VII BJLBN	0.067	0.061	0.023	99.2	98.5	99.3
A6-VIII BJLBNZ	0.035	0.030	0.012	99.6	99.3	99.6

Alternative A 6 - II - Alternative A 6 -I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 6 - III - Alternative A 6-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every four days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 6 - IV - Alternative A 6-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

Alternative A 6-V - Alternative A 6-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 6-V is presented in Figure 157.

Alternative A 6-VI - Alternative A 6-II with the addition of an aerated lagoon including a settling pond.

Alternative A 6-VII - Alternative A 6-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 6-VIII - Alternative A 6-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 6-VIII is presented in Figure 158.

SUBCATEGORY A 7 PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING, ACIDULATION, OIL PROCESSING, AND DEODORIZATION METHODS

The existing and potential in-plant treatment and control and end-of-line treatment technologies for Subcategory A 7 are essentially as those discussed in Subcategory A 5 and outlined in Table 98 with the addition of the following discussion of in-plant technology for the unit processes of oil processing and deodorization.

In-Plant Technology

Oil processing includes the wastewaters generated from the unit processes of bleaching, hydrogenation, and winterization.

In general, the majority of bleaching operations visited practiced dry cleanup of the spent bleaching absorbent. However, most plants discharge a significant portion of the absorbent to the sewer during floor washing operations. In the hydrogenation process, the industry commonly utilizes dry cleanup of the spent nickel catalyst from the filter press area. However, a few plants discharge small amounts of catalyst to the sewer during

DRAFT

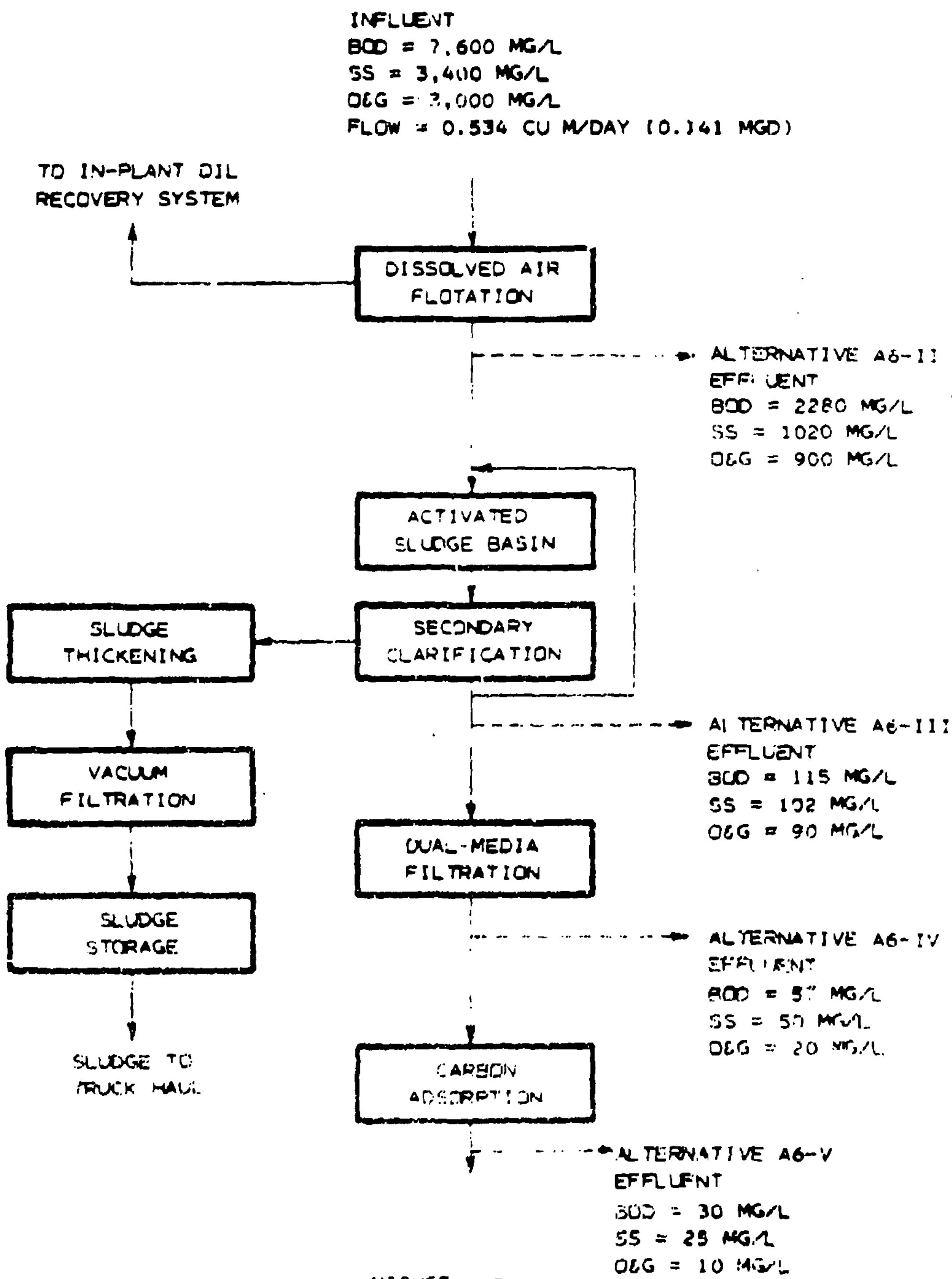


FIGURE 157

SUBCATEGORY A6
TREATMENT ALTERNATIVES II THRU V

DRAFT

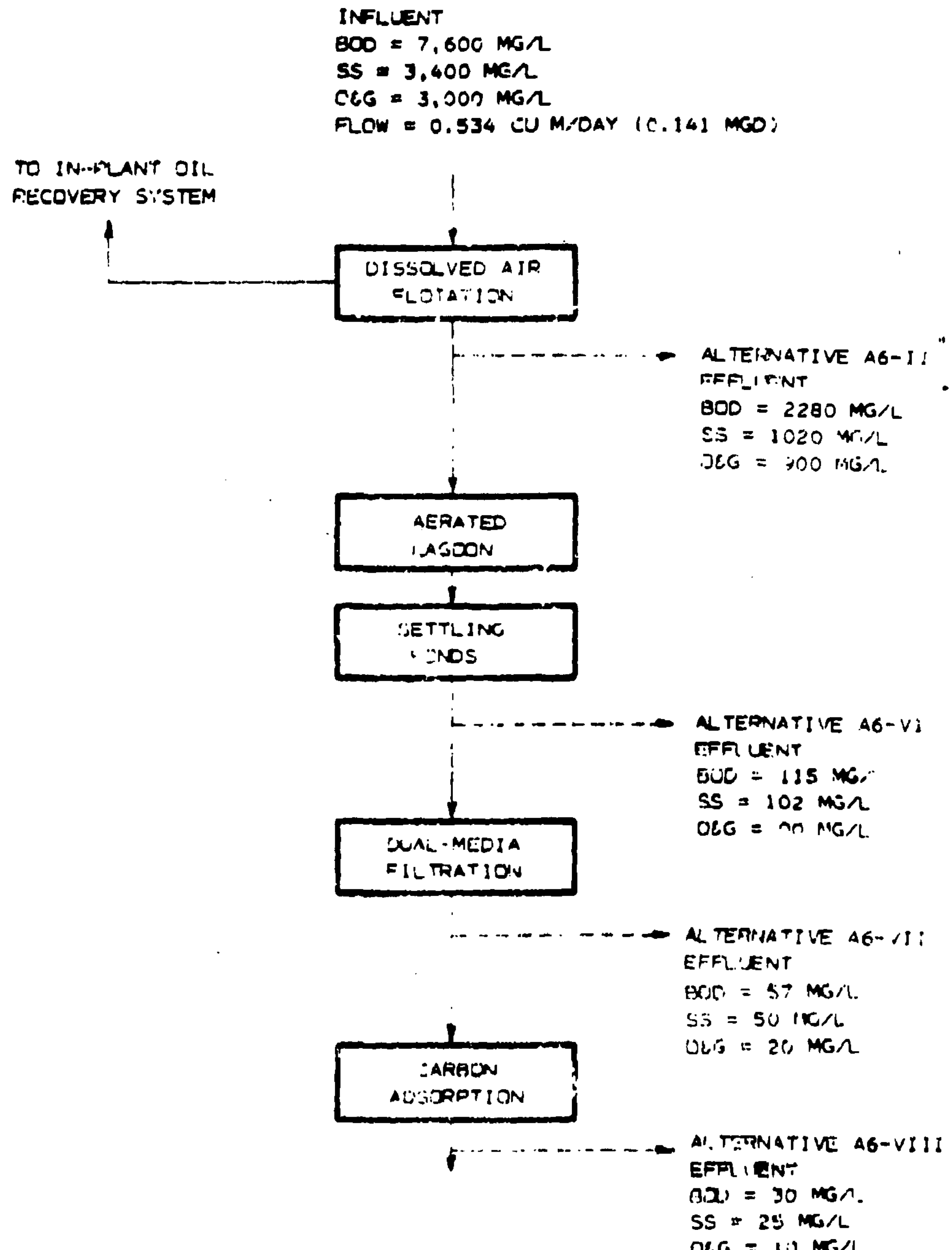


FIGURE 158

SUBCATEGORY A6
TREATMENT ALTERNATIVES VI THRU VIII

floor washing operations. A small number of plants have developed the technology for recovering nickel from the spent catalyst, but this procedure is not widely applied throughout the industry. In the unit process of deodorization, fatty materials are concentrated within the deodorizer stripping steam and are removed by barometric condenser water where they are eventually deposited in the cooling tower basin and subsequent blowdown. Distillate recovery systems are commonly employed by the industry to reduce the concentrations of these materials in the wastewater discharge from the contact cooling tower. The distillate recovery system utilizes a liquid oil spray which condenses the fatty materials before they reach the barometric condenser, thus removing approximately 90 to 95 percent of the waste distillates. The recovered distillate is sold as a by-product.

Potential In-Plant Technology

Potential in-plant technology would include improvement in general housekeeping practices, in the bleaching and hydrogenation processing areas, maximizing dry cleanup procedures were possible. The industry may advantageously develop a program toward improvement of operator awareness regarding general dry cleanup procedures and pollution control methods in the aforementioned processing areas.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 7. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	6,400 mg/l
SS	3,100 mg/l
O&G	1,500 mg/l
Flow	1,147 cu m/day (0.303 MGD)

Table 103 lists the pollutant effluent loading from the Subcategory A 7 model plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 7-1 - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

TABLE 103

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A7

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent F, O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent F, O&G Reduction
A7-I A	16.09	7.84	3.93	0	0	0
A7-II B,J	4.85	2.35	1.13	69.8	70.0	71.3
A7-III BJKQSY	0.252	0.252	0.252	98.4	96.8	93.6
A7-IV BJKQSYBN	0.126	0.126	0.051	99.2	98.4	98.7
A7-V BJKQSYBNZ	0.076	0.063	0.025	99.5	99.2	99.4
A7-VI BJL	0.252	0.252	0.252	98.4	96.8	93.6
A7-VII BJLBN	0.126	0.126	0.051	99.2	98.4	98.7
A7-VIII BJLBNZ	0.076	0.063	0.025	99.5	99.2	99.4

Alternative A 7-II - Alternative A 7-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 7-III - Alternative A 7-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every ten days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 7-IV - Alternative A 7-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

Alternative A 7-V - Alternative A 7-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 7-V is presented in Figure 159.

Alternative A 7-VI - Alternative A 7-II with the addition of an aerated lagoon including a settling pond. The aerated lagoon unit also includes a control house with two full-time operators.

Alternative A 7-VII - Alternative A 7-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 7-VIII - Alternative A 7-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 7-VIII is presented in Figure 160.

SUBCATEGORY 8 - PROCESSING OF EDIBLE OILS UTILIZING CAUSTIC REFINING, OIL PROCESSING, AND DEODORIZATION

The existing and potential in-plant treatment and control technology and end-of-line treatment technology for Subcategory A 8 are essentially as those previously outlined in Table 98 and discussed in edible oil refinery Subcategories A 5 and A 7.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 8. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

DRAFT

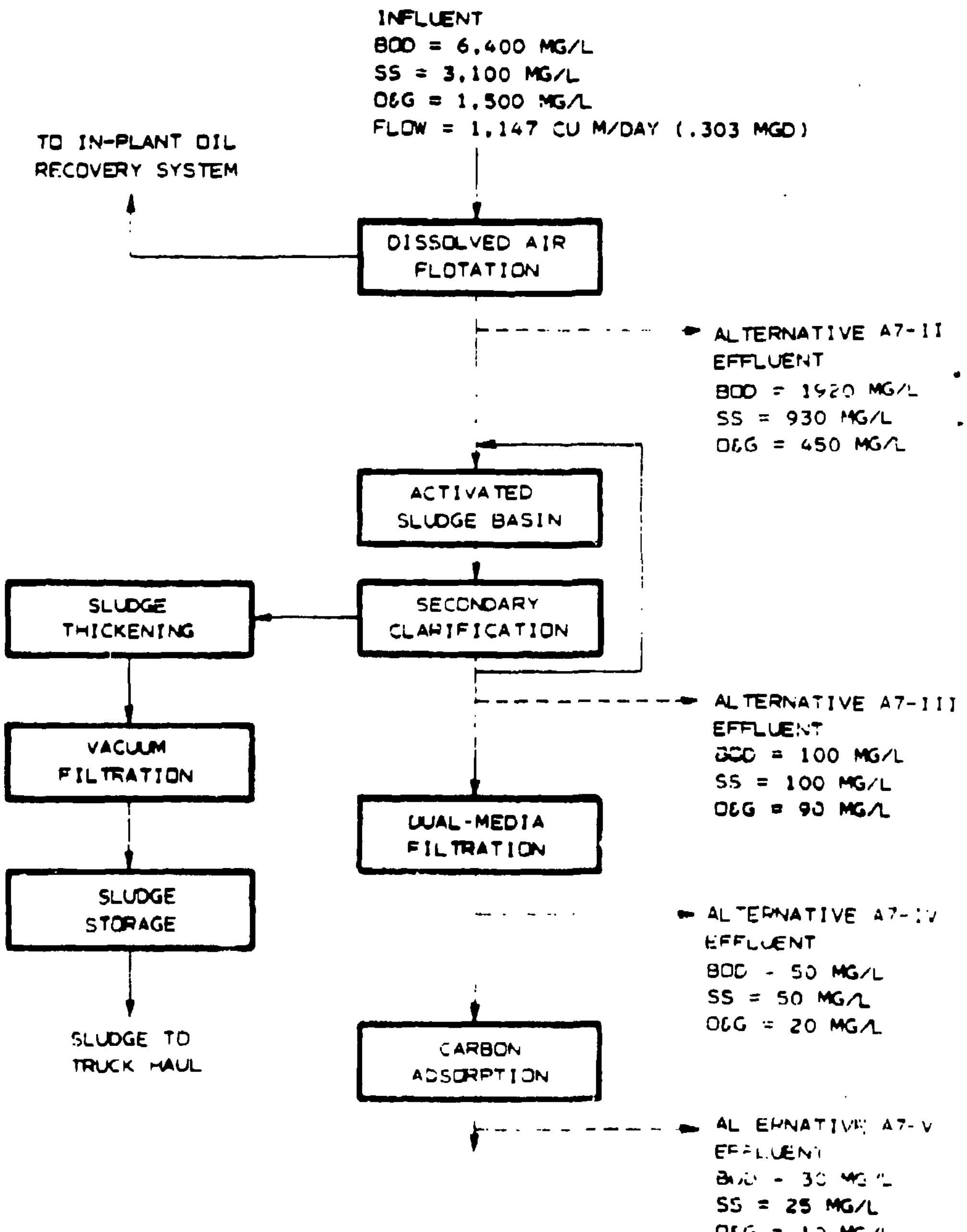


FIGURE 159

SUBCATEGORY A7
TREATMENT ALTERNATIVES II THRU V

DRAFT

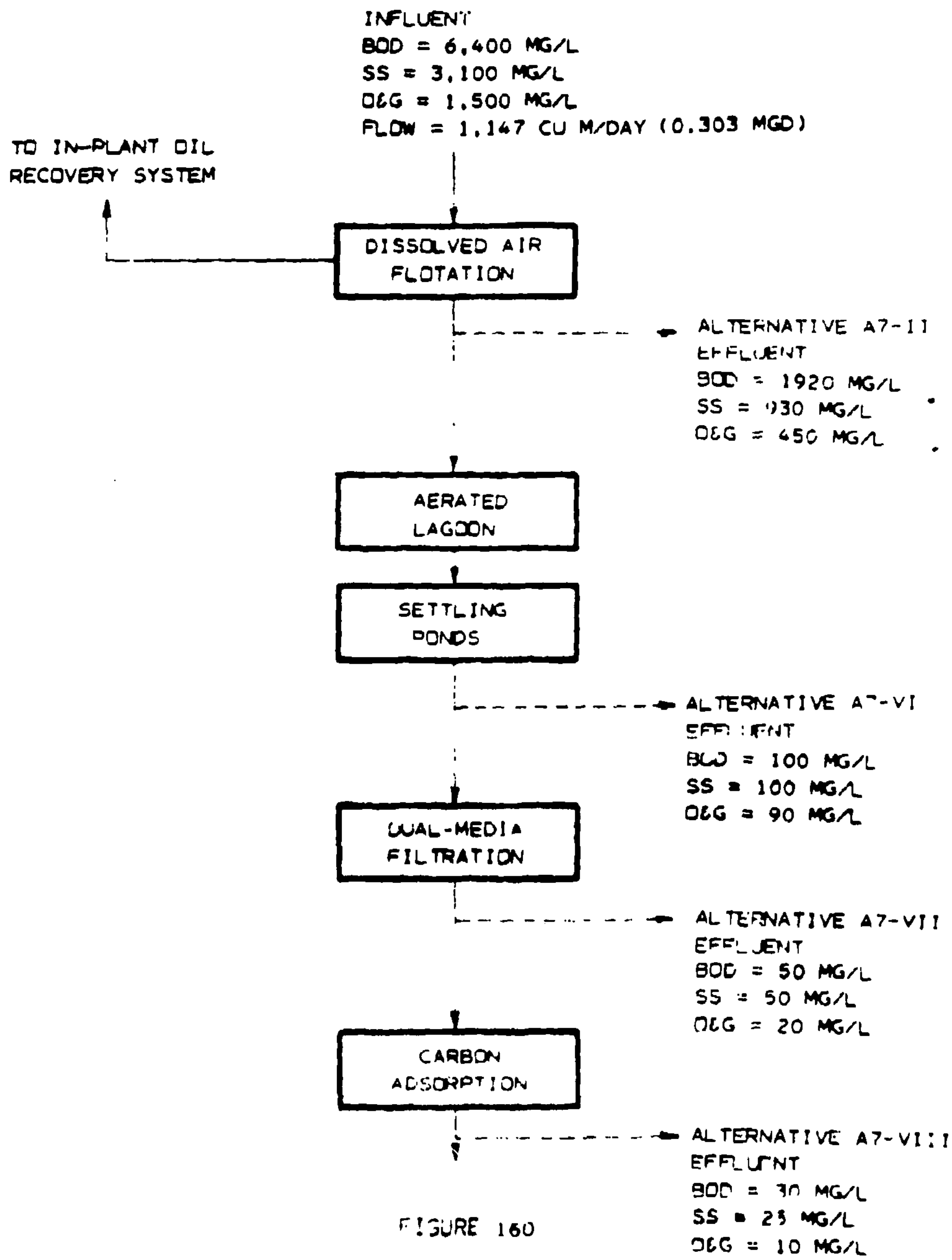


FIGURE 160

SUBCATEGORY A7
TREATMENT ALTERNATIVES VI THRU VII

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	5,700 mg/l
SS	3,100 mg/l
O&G	1,400 mg/l
Flow	927 cu m/day (0.245 MGD)

Table 104 lists the pollutant effluent loading from the Subcategory A 8 model plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 8-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

Alternative A 8-II - Alternative A 8-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 8-III - Alternative A 8-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every seven days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 8-IV - Alternative A 8-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

Alternative A 8-V - Alternative A 8-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 8-V is presented in Figure 161.

Alternative A 8-VI - Alternative A 8-II with the addition of an aerated lagoon including a settling pond. The aerated lagoon unit also includes a control house with two full-time operators.

Alternative A 8-VII - Alternative A 8-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 8-VIII - Alternative A 8-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 8-VIII is presented in Figure 162.

TABLE 104

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A8

Treatment Train Alternatives	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
A8-I A	11.73	6.30	2.81	0	0	0
A8-II B,J	3.53	1.90	0.859	69.9	69.8	69.4
A8-III BJKQSY	0.204	0.204	0.102	98.3	96.8	[illegible]5.4
A8-IV BJKQSYBN	0.102	0.102	0.041	99.1	98.4	[illegible].2
A8-V BJKQSYBNZ	0.051	0.051	0.020	99.6	99.2	99.3
A8-VI BJL	0.204	0.204	0.102	98.3	96.8	96.4
A8-VII BJLBN	0.10[illegible]	0.102	0.041	99.1	98.4	98.5
A8-VIII BJLBNZ	0.051	0.051	0.020	99.6	99.2	99.3

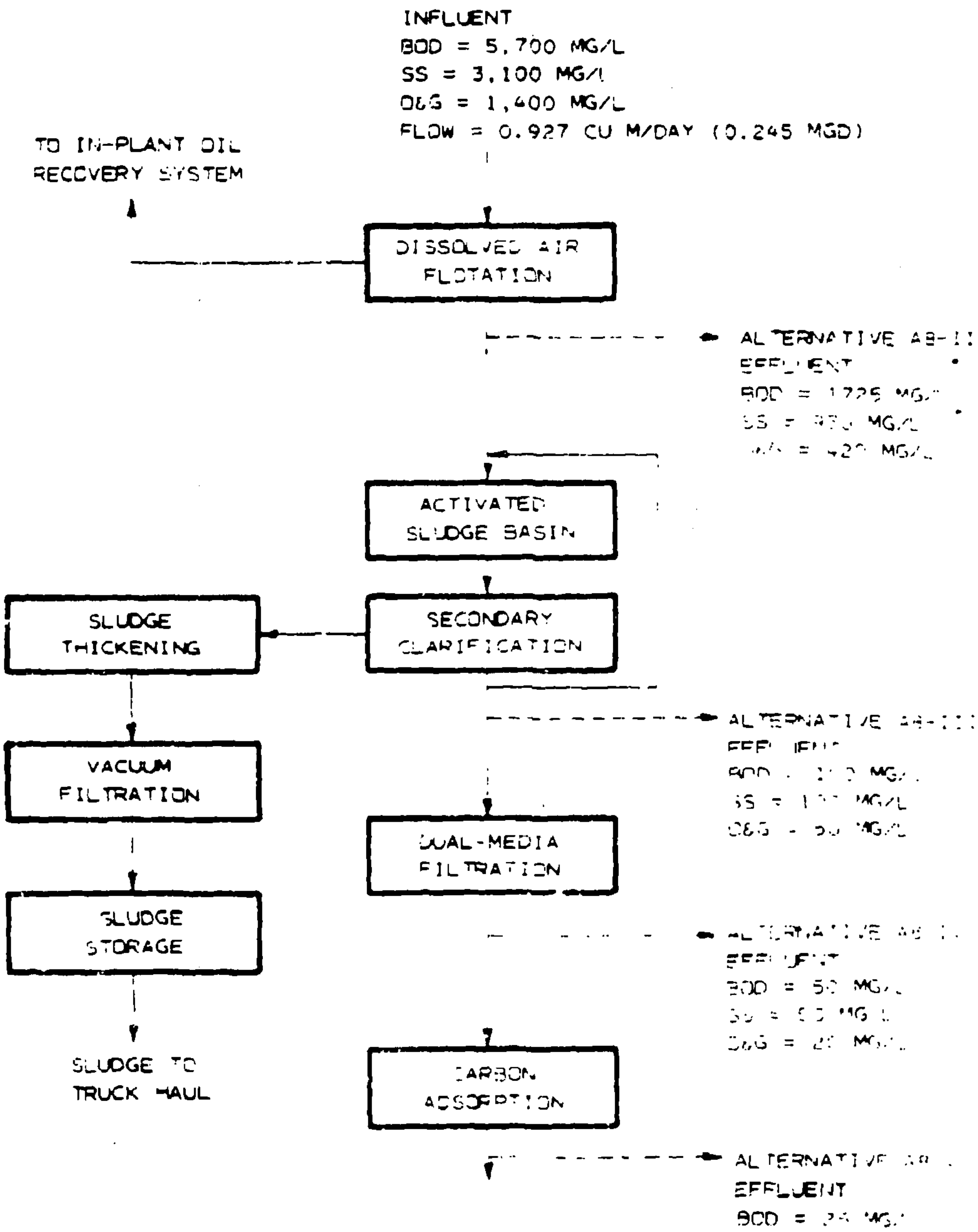


FIGURE 161

SUBCATEGORY A8
TREATMENT ALTERNATIVES II THRU .

DRAFT

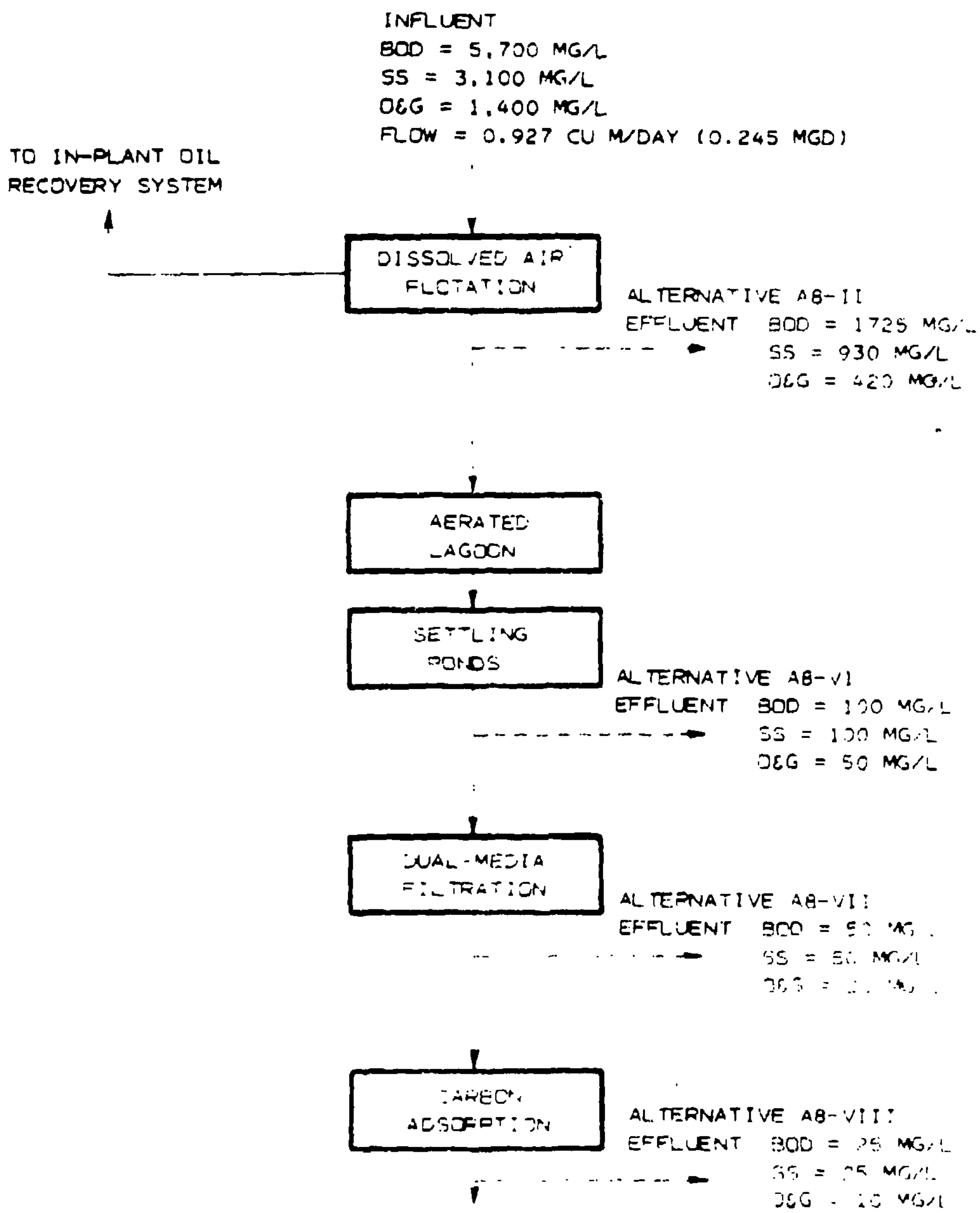


FIGURE 162

SUBCATEGORY A8
TREATMENT ALTERNATIVES VI THRU VIII

DRAFT

SUBCATEGORY A 9 PROCESSING OF EDIBLE OILS UTILIZING CAUSTIC REFINING, ACIDULATION, OIL PROCESSING, DEODORIZATION METHODS, AND THE PRODUCTION OF SHORTENING AND TABLE OILS

The existing and potential in-plant treatment and control and end-of-line treatment technologies for Subcategory A 9 are essentially those previously outlined in Table 98 and discussed in edible oil refinery Subcategories A 5 and A 7. A detailed discussion of the existing and potential in-plant treatment and control technology for the processing of shortening and table oils is presented in Subcategory A 14.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 9. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	5,900 mg/l
SS	3,000 mg/l
O&G	1,500 mg/l
Flow	1,321 cu m/day (0.349 MGD)

Table 105 lists the pollutant effluent loading from the Subcategory A 9 model plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 9-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

Alternative A 9-II - Alternative A 9-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 9-III - Alternative A 9-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every nine days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 9-IV - Alternative A 9-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

DRAFT

TABLE 105

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A9

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent F, O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent F, O&G Reduction
A9-I A	17.12	8.68	4.35	0	0	0
A9-II B,J	5.15	2.62	1.31	70.0	70.0	70.0
A9-III BJKQSY	0.262	0.262	0.131	98.5	97.0	97.0
A9-IV BJKQSYBN	0.131	0.131	0.058	99.2	98.5	98.6
A9-V BJKQSYBNZ	0.073	0.073	0.029	99.6	99.2	99.3
A9-VI BJL	0.262	0.262	0.131	98.5	97.0	97.0
A9-VII BJLBN	0.131	0.131	0.058	99.2	98.5	98.6
A9-VIII BJLBNZ	0.073	0.073	0.029	99.6	99.2	99.3

DRAFT

Alternative A 9-V - Alternative A 9-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 9-V is presented in Figure 163.

Alternative A 9-VI - Alternative A 9-II with the addition of an aerated lagoon including a settling pond. The aerated lagoon also includes a control house and two full-timer operators.

Alternative A 9-VII - Alternative A 9-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 9-VIII - Alternative A 9-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 9-VIII is presented in Figure 164.

SUBCATEGORY A 10 PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING, OIL PROCESSING, DEODORIZATION METHODS, AND THE PLASTICIZING AND PACKAGING OF SHORTENING AND TABLE OILS

The existing and potential in-plant treatment and control technology and existing end-of-line technology for Subcategory A 10 refineries are essentially as those previously outlined in Table 98 and discussed in detail in edible oil refinery Subcategories A 5, A 7, and A 14.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 10. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	5,250 mg/l
SS	3,000 mg/l
O&G	1,300 mg/l
Flow	1,101 cu m/day (0.291 MGD)

Table 106 lists the pollutant effluent loading from the Subcategory A 10 model plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 10-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

DRAFT

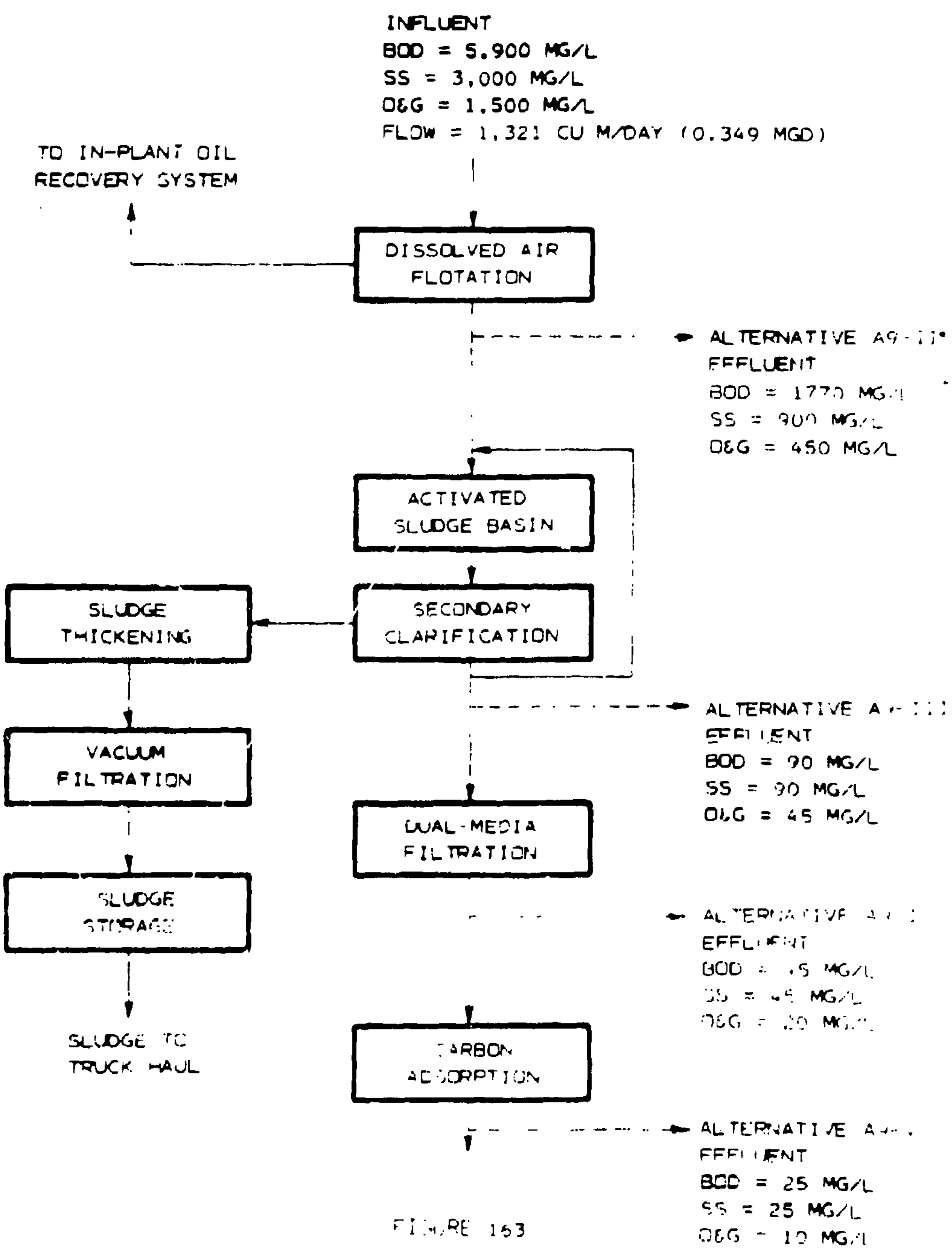


FIGURE 163

SUBCATEGORY A9
TREATMENT ALTERNATIVES II THRU V

DRAFT

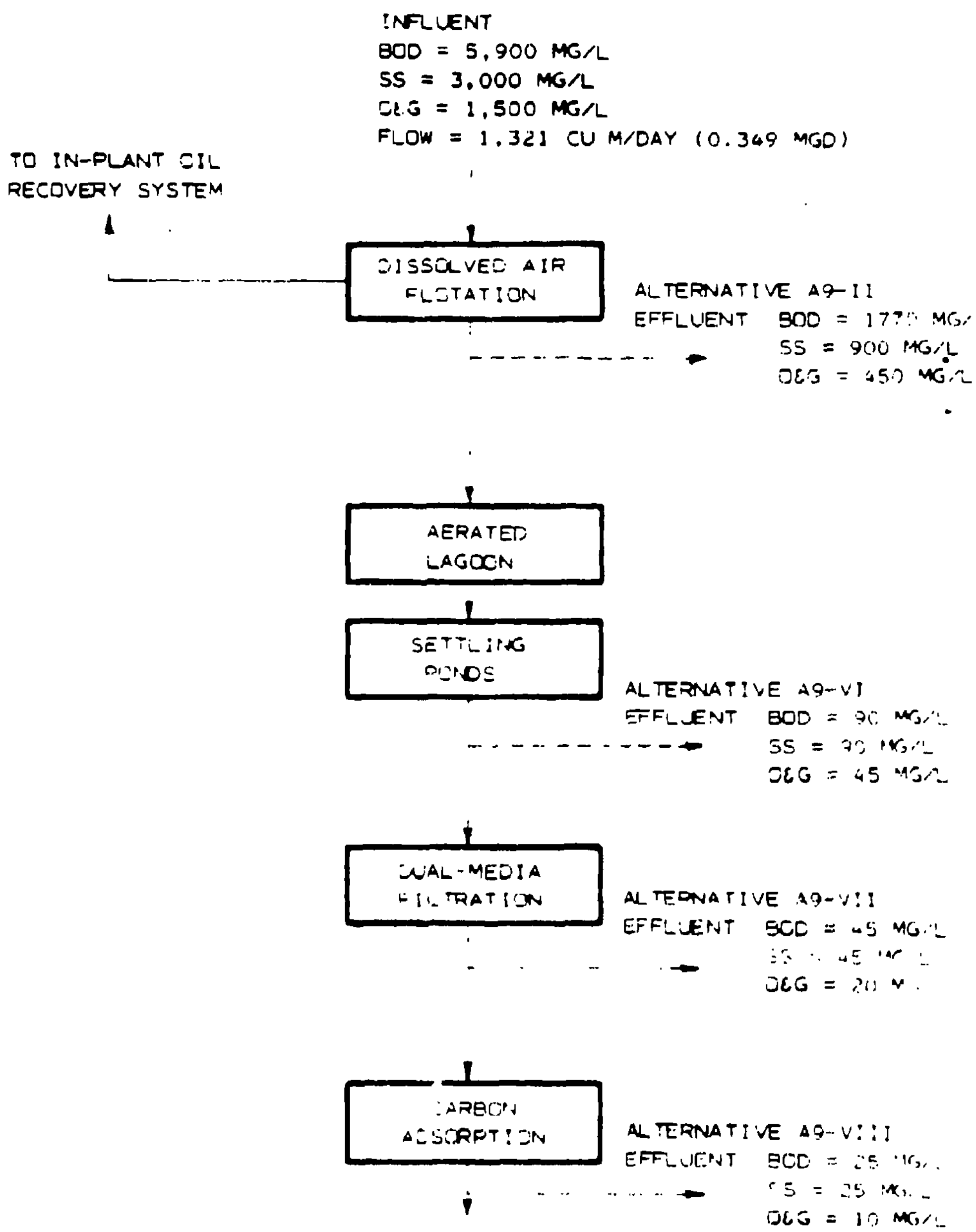


FIGURE 164

SUBCATEGORY A9
TREATMENT ALTERNATIVES VI THRU VIII

DRAFT

TABLE 106

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A10

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent F, O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent F, O&G Reduction
A10-I A	12.76	7.14	3.23	0	0	0
A10-II B,J	3.82	2.18	0.947	70.0	69.5	70.0
A10-III BJKQSY	0.194	0.219	0.097	98.5	96.9	97.0
A10-IV BJKQSYBN	0.097	0.109	0.048	99.2	98.5	98.5
A10-V BJKQSYBNZ	0.048	0.056	0.024	99.6	99.2	99.2
A10-VI BJL	0.194	0.219	0.097	98.5	96.9	97.0
A10-VII BJLBN	0.097	0.109	0.048	99.2	98.5	98.5
A10-VIII BJLBNZ	0.048	0.056	0.024	99.5	99.2	99.2

DRAFT

Alternative A 10-II - Alternative A 10-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 10-III - Alternative A 10-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every six days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 10-IV- Alternative A 10-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

Alternative A 10-V - Alternative A 10-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 10-V is presented in Figure 165.

Alternative A 10-VI - Alternative A 10-II with the addition of an aerated lagoon including a settling pond. The aerated lagoon also includes a control house with two full-time operators.

Alternative A 10-VII - Alternative A 10-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 10-VIII - Alternative A 10-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 10-VIII is presented in Figure 166.

SUBCATEGORY A 11 - PROCESSING OF EDIBLE OILS BY CAUSTIC REFINING, ACIDULATION, OIL PROCESSING, DEODORIZATION [illegible], AND THE PLASTICIZING AND PACKAGING OF SHORTENINGS, TABLE OILS, AND MARGARINE

The existing and potential in-plant treatment and control and existing end-of-line technologies for Subcategory A 11 refineries are essentially as those previously outlined in Table 98 and discussed in detail in edible oil refinery Subcategories A 5, A 7, A 13 and A 14.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 11. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

DRAFT

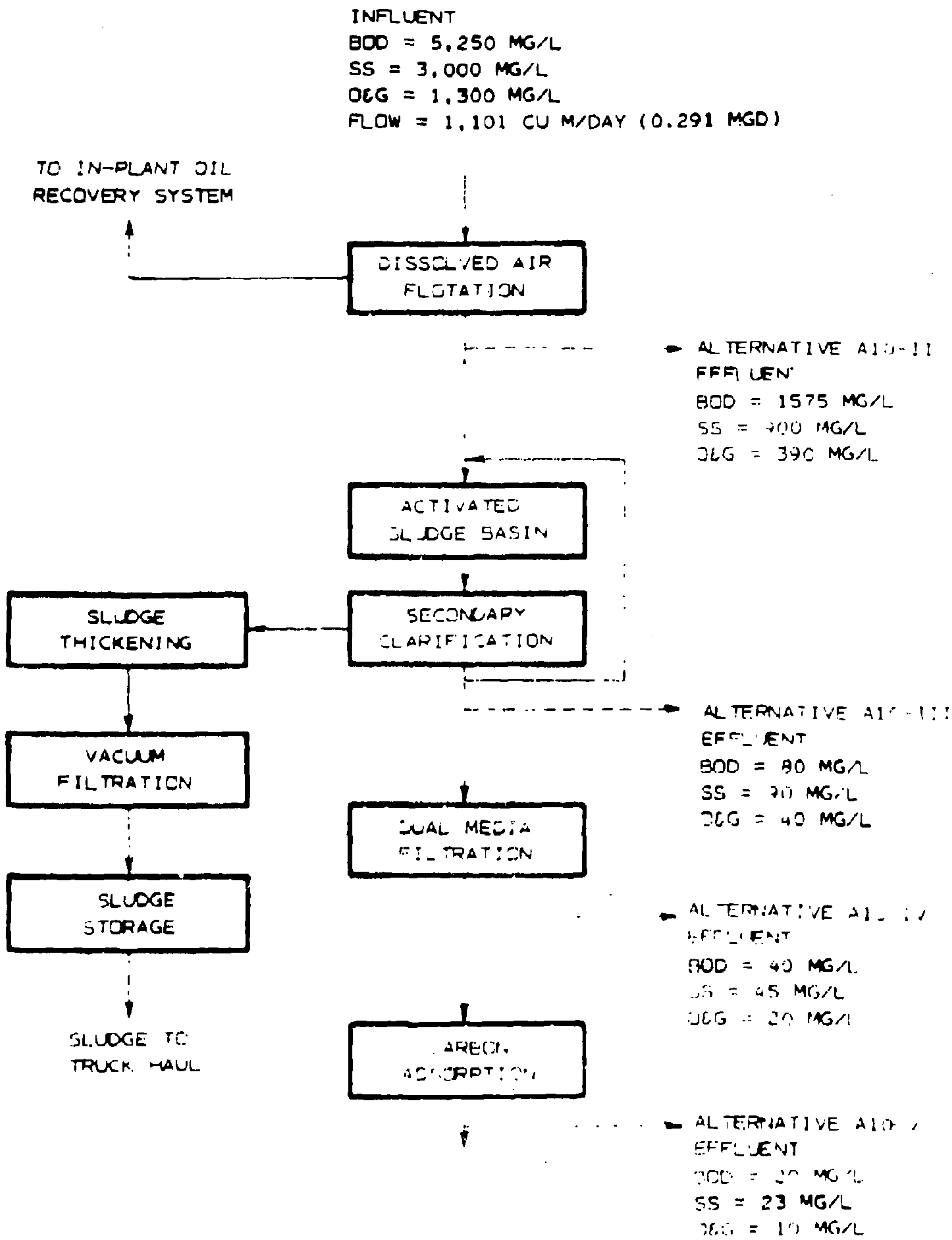


FIGURE 165

SUBCATEGORY A1
TREATMENT ALTERNATIVES II THRU V

DRAFT

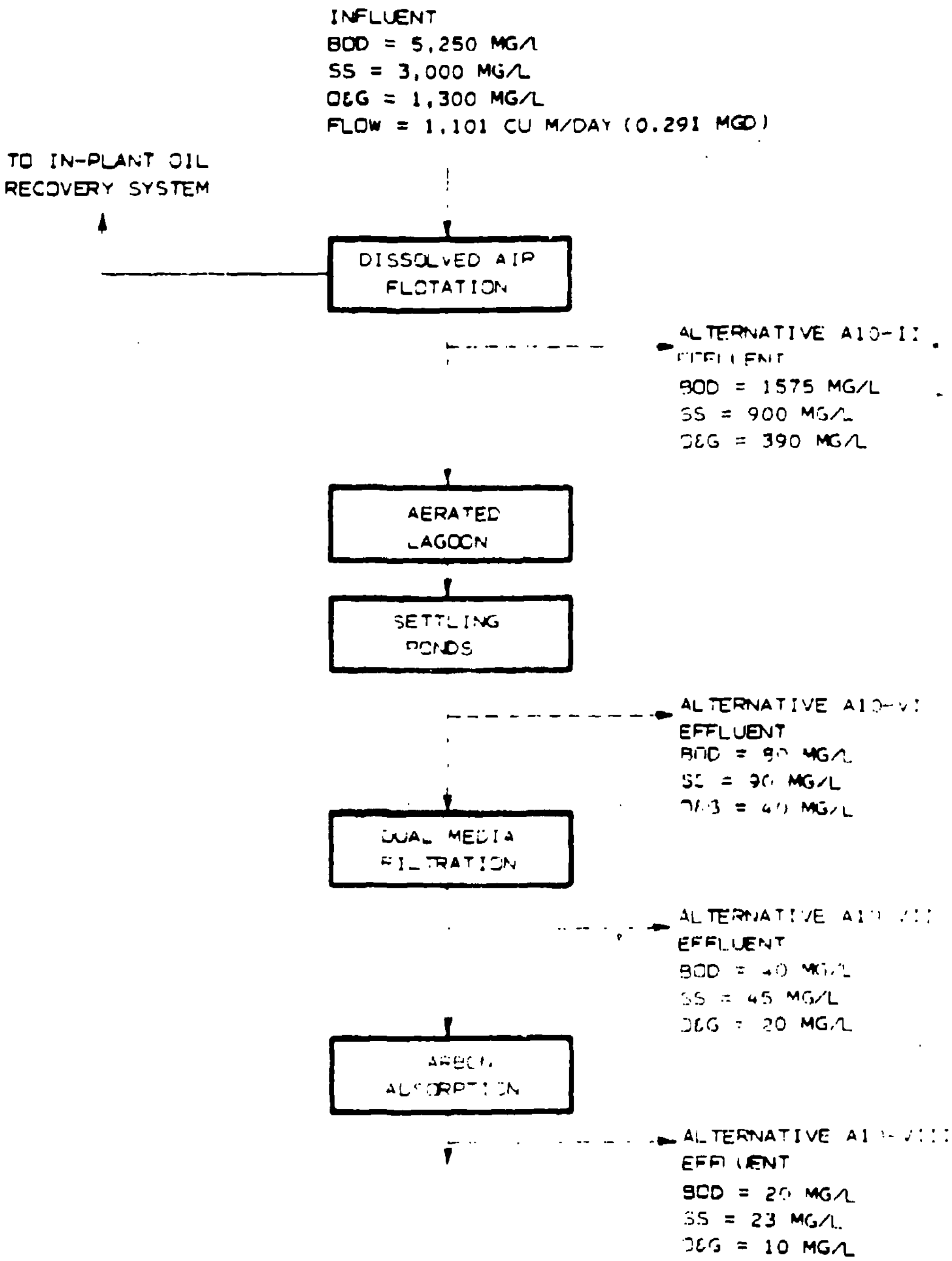


FIGURE 165

SUBCATEGORY A10
TREATMENT ALTERNATIVES II THRU VIII

DRAFT

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	6,900 mg/l
SS	3,200 mg/l
O&G	2,800 mg/l
Flow	1,574 cu m/day (0.416 MGD)

Table 107 lists the pollutant effluent loading from the Subcategory A 11 model plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 11-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

Alternative A 11-II - Alternative A 11-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 11-III - Alternative A 11-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every eight days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 11-IV - Alternative A 11-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

Alternative A 11-V - Alternative A 11-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 11-V is presented in Figure 167.

Alternative A 11-VI - Alternative A 11-II with the addition of an aerated lagoon including a settling pond. The aerated lagoon also includes a control house and two operators.

Alternative A 11-VII - Alternative A 11-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 11-VIII - Alternative A 11-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 11-VIII is presented in Figure 168.

DRAFT

TABLE 107

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A11

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
A11-I A	20.57	10.98	9.95	0	0	0
A11-II B,J	6.14	3.33	2.92	70.1	69.7	70.6
A11-III BJKQSY	0.312	0.347	0.295	98.5	97.2	97.0
A11-IV BJKQSYBN	0.156	0.174	0.069	99.2	98.4	99.3
A11-V BJKQSYBNZ	0.076	0.087	0.035	99.6	99.2	99.6
A11-VI BJL	0.312	0.347	0.295	98.5	97.2	97.0
A11-VII BJLBN	0.156	0.174	0.069	99.2	98.4	99.3
A11-VIII BJLBNZ	0.076	0.087	0.035	99.6	99.2	99.6

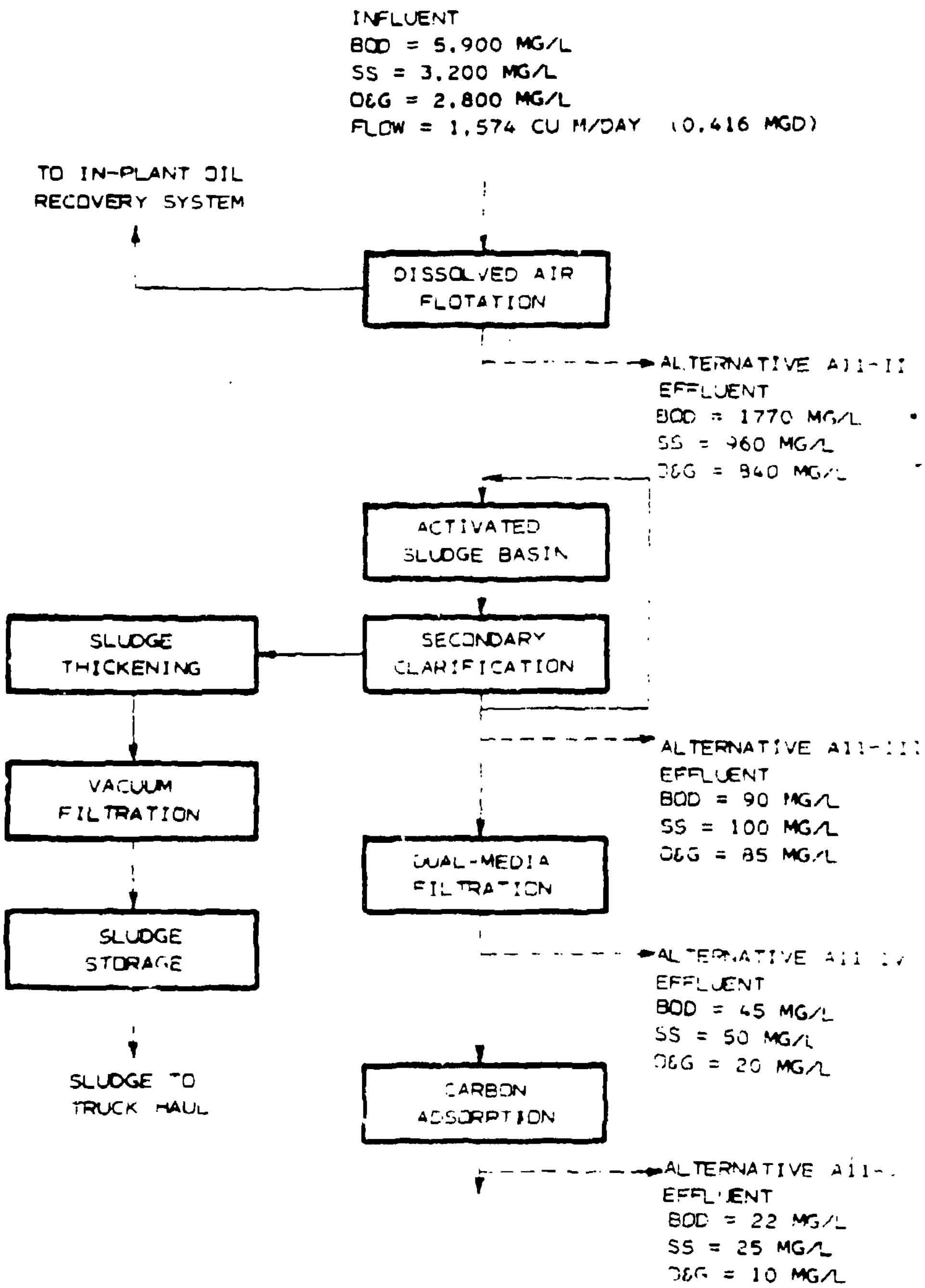


FIGURE 167

SUBCATEGORY A11
TREATMENT ALTERNATIVES II THRU V

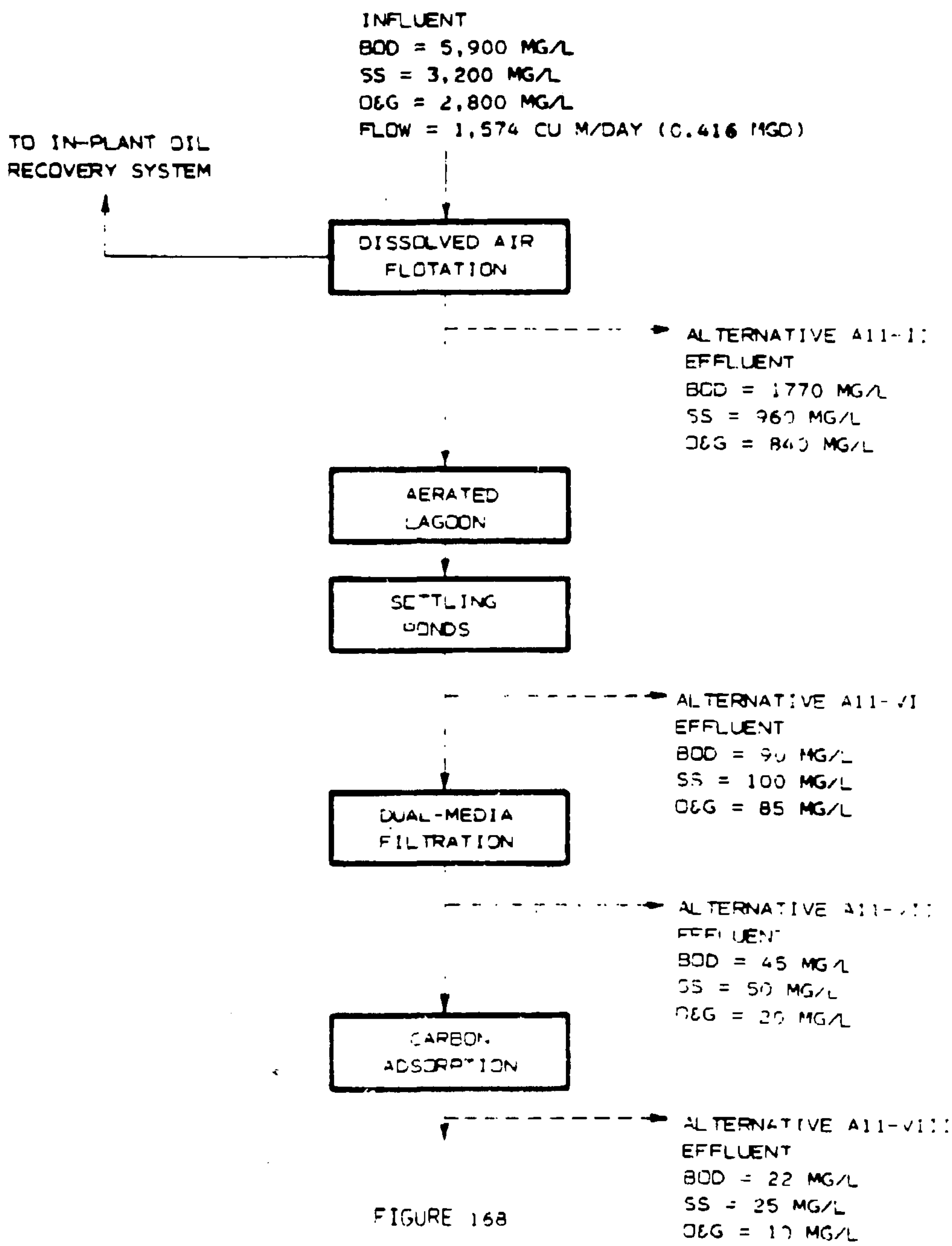


FIGURE 168

SUBCATEGORY A11
TREATMENT ALTERNATIVES VI THRU VIII

DRAFT

SUBCATEGORY A 12 - PROCESSING OF EDIBLE OILS BY CAUSTIC REFINERY, OIL PROCESSING METHOD, AND THE PLASTICIZATION AND PACKAGING OF SHORTENING, TABLE OILS, AND MARGARINE

The existing and potential in-plant treatment and control and existing end-of-line technologies for Subcategory A 12 refineries are essentially as those previously outlined in Table 98 and discussed in detail in edible oil refining Subcategories A 5, A 7, A 13, and A 14.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 12. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	5,400 mg/l
SS	3,200 mg/l
O&G	3,000 mg/l
Flow	1,355 cu m/day (0.358 MGD)

Table 108 lists the pollutant effluent loading from the Subcategory A 12 model plant and the estimated operating efficiencies of each of the eight treatment trains selected for this subcategory.

Alternative A 12-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

Alternative A 12-II - Alternative A 12-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 12-III - Alternative A 12-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every five days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 12-IV- Alternative A 12-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

DRAFT

TABLE 108

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A12

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
A12-I A	16.20	9.44	8.83	0	0	0
A12-II B,J	4.84	2.87	2.69	70.1	69.6	69.5
A12-III BJKQSY	0.239	0.287	0.269	98.5	97.0	97.0
A12-IV BJKQSYBN	0.119	0.143	0.060	99.3	98.5	99.3
A12-V BJKQSYBNZ	0.060	0.072	0.030	99.5	99.2	99.6
A12-VI BJL	0.239	0.287	0.269	98.5	97.0	97.0
A12-VIII BJLBN	0.119	0.143	0.060	99.3	98.5	99.3
A12-VIII BJLBNZ	0.060	0.072	0.030	99.6	99.2	99.6

Alternative A 12-V - Alternative A 12-IV with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 12-V is presented in Figure 169.

Alternative A 12-VI - Alternative A 12-II with the addition of an aerated lagoon including a settling pond. The aerated lagoon unit also includes a control house and two full-time operators.

Alternative A 12-VII - Alternative A 12-VI with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation.

Alternative A 12-VIII - Alternative A 12-VII with the addition of activated carbon before final discharge. A schematic diagram of Alternative A 12-VIII is presented in Figure 170.

SUBCATEGORY A 13 - PLASTICIZING AND PACKAGING OF MARGARINE

Existing In-Plant Technology

The wastewaters generated from equipment cleanup, sanitation, and floor washing, represents the major wasteload contribution to margarine processing operations as reported average pollutant concentrations for BOD were 1437 mg/l; oil and grease, 1760 mg/l; and flow volume of 170 cu m/day (0.045 MGD). Information received from the National Association of Margarine Manufacturers indicates that all plants utilize clean-in-place (CIP) systems for equipment cleanup. Most plants commonly practice the recycling of caustic or acid rinse waters, and sanitation solutions, thereby limiting the CIP system wastewater discharge. During floor cleanup, the industry commonly utilizes high pressure, low volume hoses with automatic shut-off valves for the reduction of water usage.

Potential In-Plant Technology

The quantity of wastewater produced by clean-in-place systems could be reduced by the further recycling of the final chlorine rinse to be used as the initial rinse water. Improved equipment connections in packaging practices could result in decreased pollutant loading of wastewaters by decreasing the amount of spills in the packaging area. The establishment of dry cleanup procedures such as the wiping down of equipment before cleaning would reduce pollutant waste loads.

Existing In-Plant Technology

There presently exists no complete treatment system handling margarine processing wastes alone. Watson, et. al. (103) reports upon the performance of a pretreatment facility in Champaign, Illinois treating the combined wastes from an edible oils refinery and a margarine, salad dressing, and cheese processing operation. The Champaign pretreatment facility was re-

DRAFT

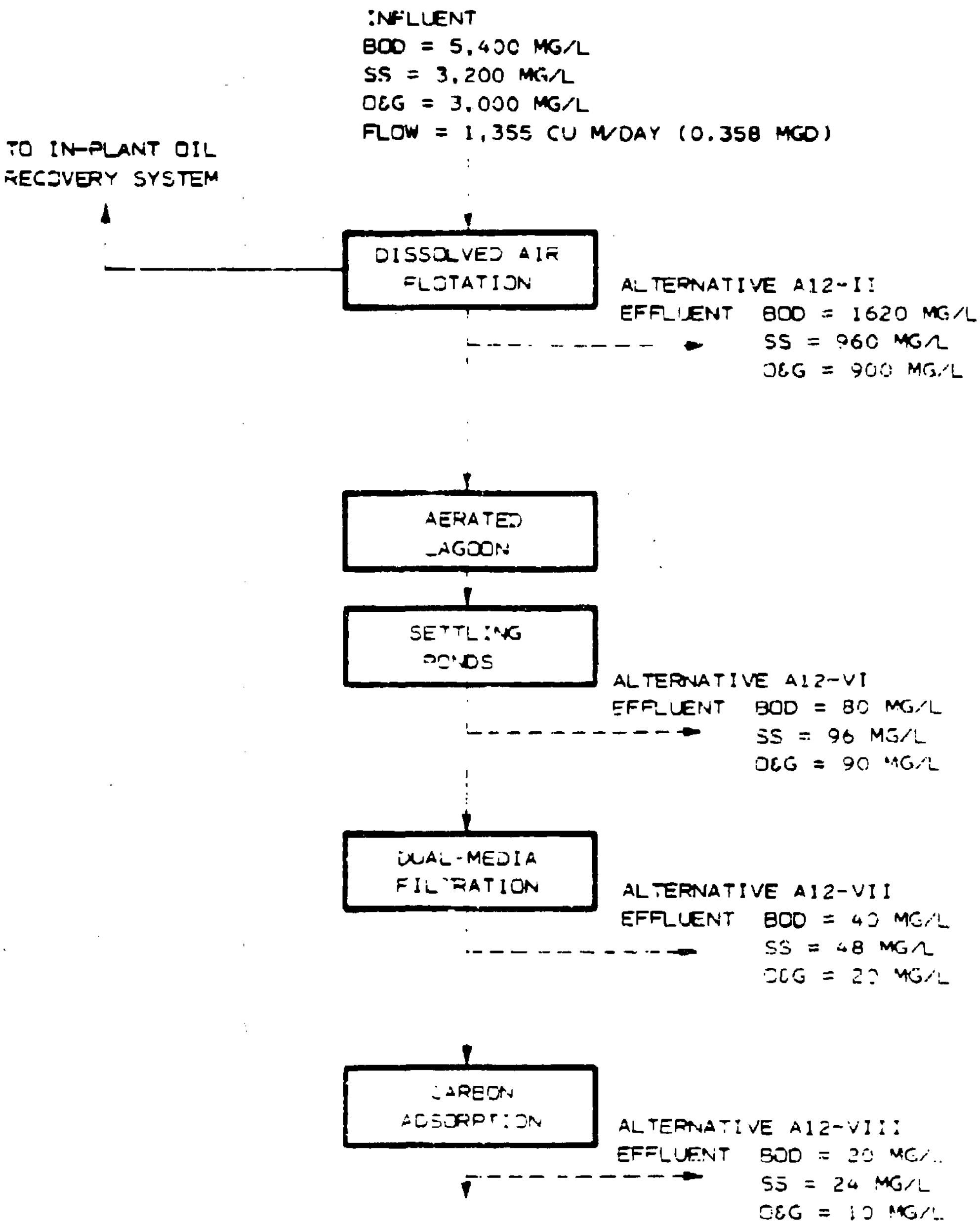


FIGURE 170

SUBCATEGORY A12
TREATMENT ALTERNATIVES VI THRU VIII

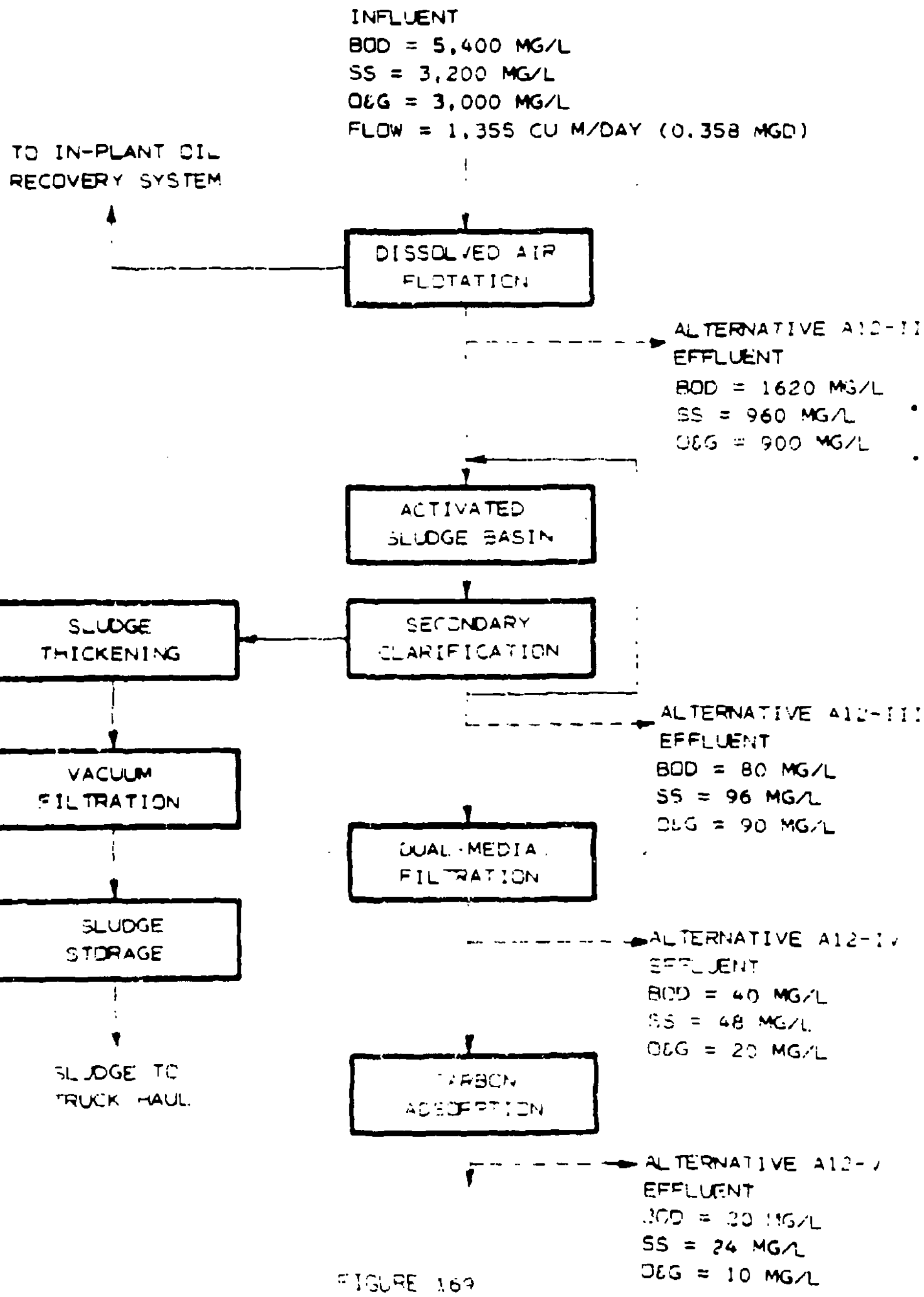


FIGURE 169

SUBCATEGORY A12
TREATMENT ALTERNATIVES II THRU V

ported to typically operate within the following ranges of removal efficiencies: BOD 96.4 to 99.4 percent; suspended solids 90 to 93 percent; and oil and grease 93 to 99.5 percent with about 72 percent being removed in primary treatment and about 25 percent removed by the secondary unit. In order that the plant could meet the municipal ordinaces of 200 mg/l BOD, 200 mg/l SS, and 100 mg/l of fats, oil and greases, the design features listed in Table 100 were adopted for the Champaign plant based upon a 1980 waste loading capacity.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 13. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

BOD	2,600 mg/l
SS	1,800 mg/l
O&G	3,900 mg/l
Flow	340 cu m/day (0.09 MGD)

Table 109 lists the pollutant effluent loading from the Subcategory A 13 model plant and the estimated operating efficiencies of each of the six treatment trains selected for this subcategory.

Alternative A 13-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

Alternative A 13-II - Alternative A 13-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 13-III - Alternative A 13-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every twenty days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 13-IV- Alternative A 13-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation. A schematic diagram of Alternative A 13-IV is presented in Figure 171.

TABLE 109

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A13

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
A13-I A	3.92	2.72	5.81	0	0	0
A13-II B,J	1.17	0.811	1.75	70.1	70.1	70.0
A13-III BJKQSY	0.060	0.075	0.075	98.5	97.2	98.7
A13-IV BJKQSYBN	0.030	0.037	0.037	99.2	98.6	99.4
A13-V BJL	0.060	0.075	0.075	99.2	97.2	98.7
A13-VI BJLBN	0.030	0.037	0.037	99.2	98.6	99.4

DRAFT

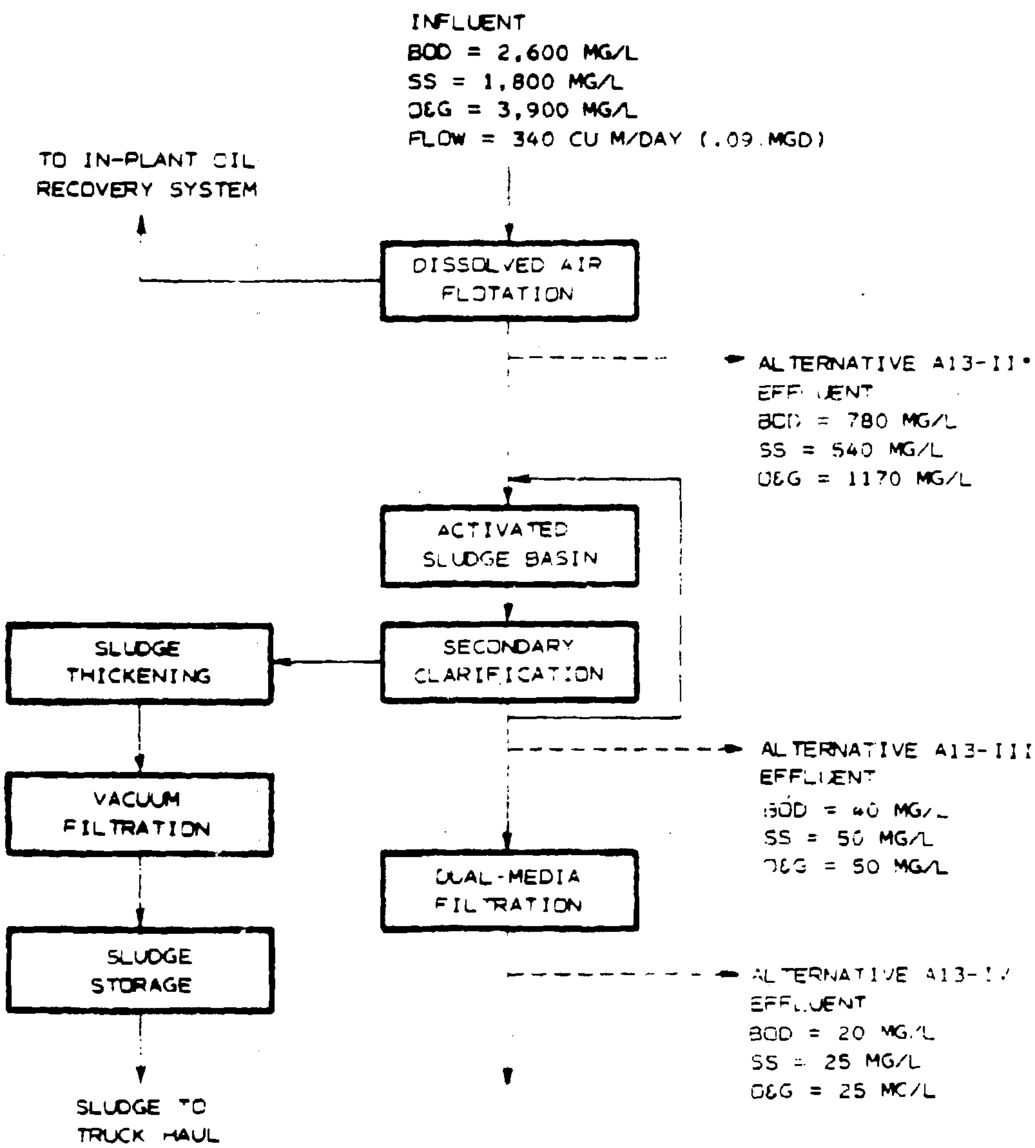


FIGURE 171

SUBCATEGORY A13
TREATMENT ALTERNATIVES II THRU IV

Alternative A 13-V - Alternative A 13-II with the addition of an aerated lagoon including a settling pond. The aerated lagoon also includes one full-time operator.

Alternative A 13-VI - Alternative A 13-V with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation. A schematic diagram of Alternative A 13-VI is presented in Figure 172.

SUBCATEGORY A 14 - PLASTICIZING AND PACKAGING OF SHORTENING AND TABLE OILS

Existing In-Plant Technology

The wastewater generated from equipment cleanup and periodic floor washing procedures represents a relatively insignificant waste load contribution to the total waste load of an edible oil refinery. In general, filling equipment is wiped clean before being subjected to cleaning solutions. Accidental spills result in infrequent floor washing operations. The industry commonly separates their non-contact water discharge from its process waters with the non-contact water being recycled.

Potential In-Plant Technology

Because of the small volumes of water used and the relatively insignficant waste load resulting from shortening and table oil packaging, no recommendations are made for the further reduction of waste strengths or volumes.

End-of-Line Technology

No known end-of-line treatment system presently exists for the packaging of shortening and table oils alone. All present plasticizing and packaging wastes are handled by municipal treatment.

Selection of Control and Treatment Technology

In Section V, a hypothetical model plant was developed for Subcategory A 14. It was assumed that the model plant provided the following treatment units before final discharge to a treatment facility:

1. Surge control and/or flow equalization.
2. Gravity separation and skimming.
3. In-plant oil recovery system.
4. pH control.

The raw wastewater characteristics after gravity separation, skimming, and pH control were assumed to be as follows:

DRAFT

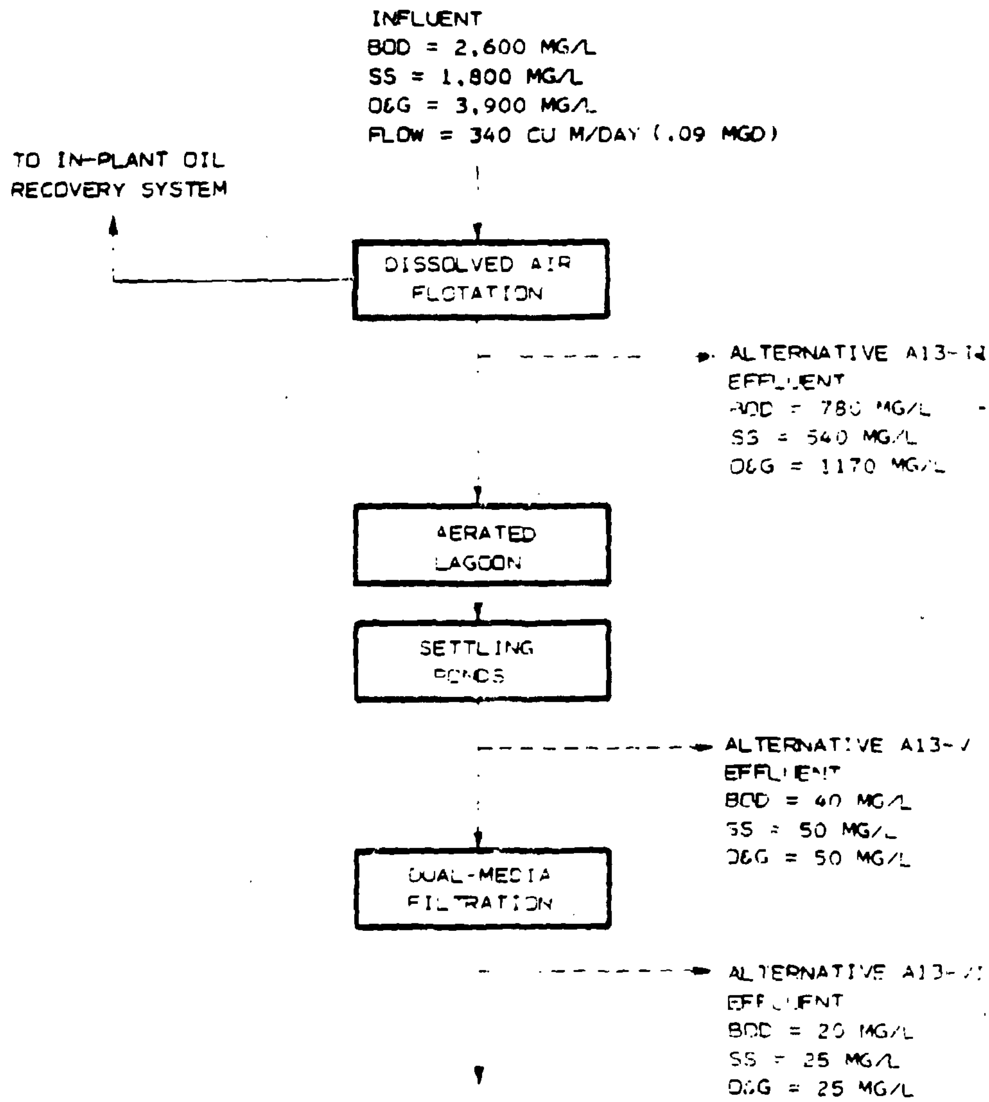


FIGURE -2

SUBCATEGORY 13
TREATMENT ALTERNATIVES V THRU VI

BOD	1,500 mg/l
SS	1,100 mg/l
O&G	550 mg/l
Flow	87 cu m/day (0.023 MGD)

Table 110 lists the pollutant effluent loading from the Subcategory A 14 model plant and the estimated operating efficiencies of each of the six treatment trains selected for this subcategory.

Alternative A 14-I - This alternative provides no additional treatment other than gravity separation, skimming, and pH control.

Alternative A 14-II - Alternative A 14-I with the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

Alternative A 14-III - Alternative A 14-II with the addition of activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every five days. The activated sludge unit also includes a control house and two full-time operators.

Alternative A 14-IV - Alternative A 14-III with the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation. A schematic diagram of Alternative A 14-IV is presented in Figure 173.

Alternative A 14-V - Alternative A 14-IV with the addition of an aerated lagoon including a settling pond. The aerated lagoon also includes one half-time operator.

Alternative A 14-VI - Alternative A 14-V with the addition of dual media pressure filtration and a pump station to generate sufficient head for filter operation. A schematic diagram of Alternative A 14-VI is presented in Figure 174.

SUBCATEGORY A 15 - OLIVE OIL REFINING

As discussed in Section V, there is only one olive oil plant in the United States which refines olive oil by the caustic refining process. The control and treatment practices at the plant are presented below.

Existing In-Plant Technology

As discussed in Section V the quantity of wastewater discharged from the caustic refining of olive oil is approximately 1100 l/day (300 gal/day). All equipment is wiped clean, thereby generating no additional wastewater.

TABLE 110

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

DRAFT

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
A 14-IA	0.56	0.42	0.21	0	0	0
A 14-IIBKQSV	0.029	0.038	0.021	94.8	90.9	90.0
A 14-IIIBXQSVN	0.015	0.015	0.008	97.3	96.4	96.2
A 14-IVBKQSVNZ	0.008	0.008	0.004	98.6	98.1	98.1
A 14-VBL	0.029	0.038	0.021	94.8	90.9	90.0
A 14-VIBLN	0.015	0.015	0.008	97.3	96.4	96.2
A 14-VIIBLNZ	0.008	0.008	0.004	98.6	98.1	98.1

DRAFT

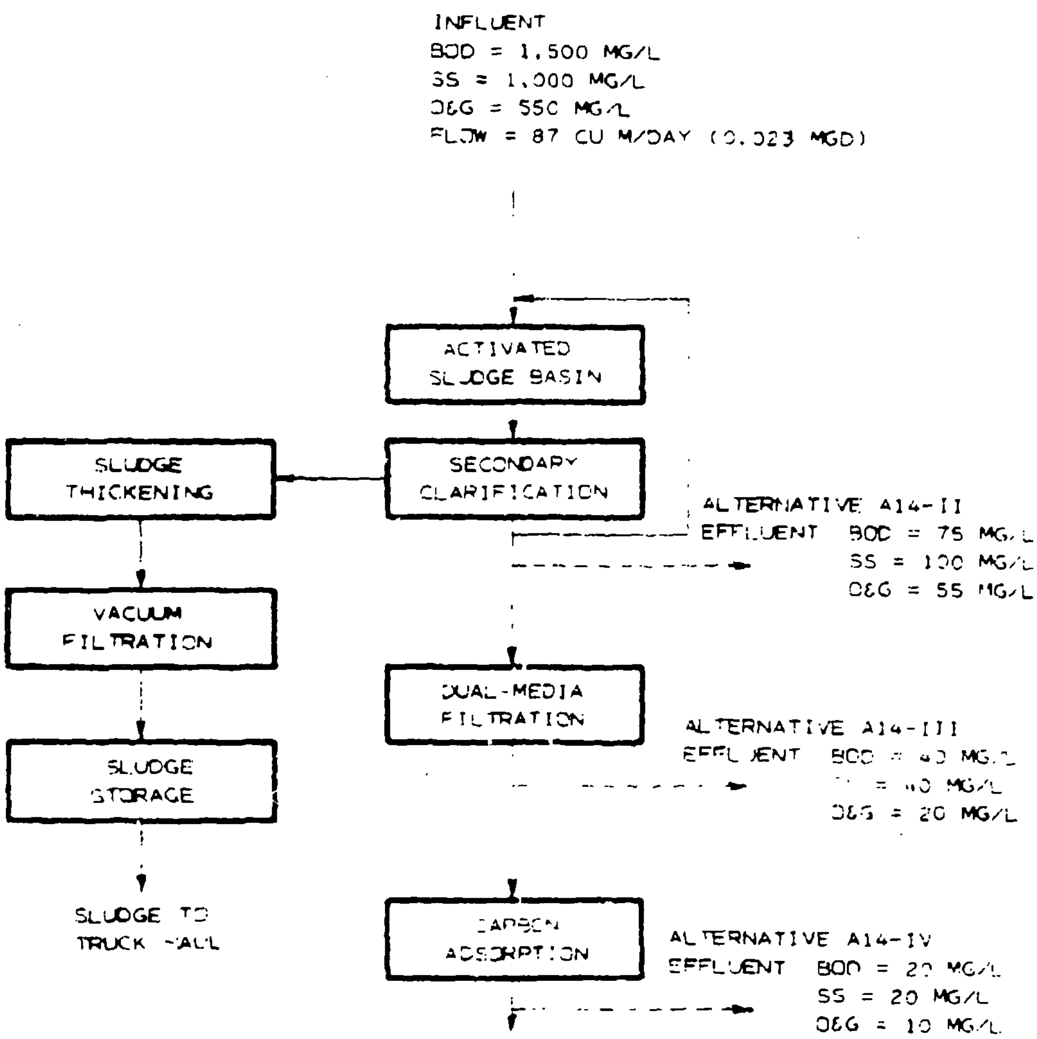


FIGURE 173

SUBCATEGORY A14
TREATMENT ALTERNATIVES II THRU IV

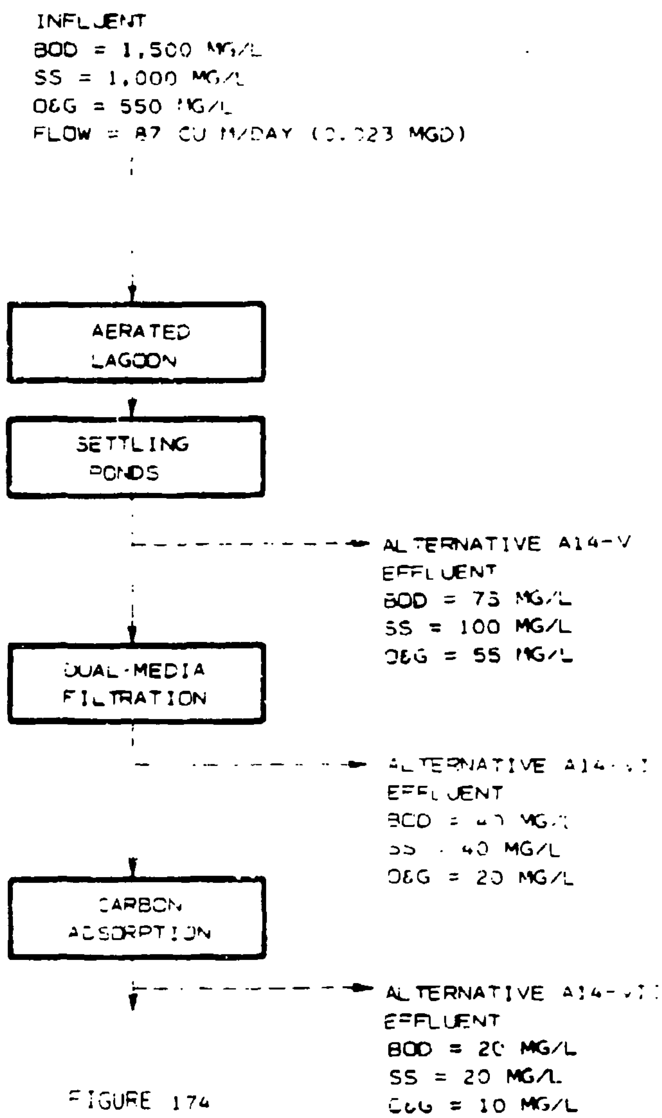


FIGURE 174

SUBCATEGORY A14
TREATMENT ALTERNATIVES V THRU VII

Potential In-Plant Technology

Examination of in-plant process suggests no additional method or procedure to further reduce pollutant loads and wastewater volume for this subcategory.

End-of-Line Technology

At present, the wastewater is hauled weekly to a municipal treatment facility with no apparent adverse effects on the treatment system. However, the wastewater flow is considered too small to warrant recommendation of biological treatment as a viable treatment alternative for this subcategory.

Selection of Control and Treatment Technology

The model plant for this subcategory was presented in Section V and had the following wastewater characteristics:

Flow	1100 l/day (300 gal/day)
BOD	5700 mg/l
SS	296 mg/l
FOG	195 mg/l

Three treatment alternatives were selected for this subcategory and are discussed below.

Alternative A 15-I - This alternative consists of spray irrigation of the wastewater which would require 240 sq m (2600 sq ft) of land. The overall benefit of this alternative is a 100 percent reduction of pollutants to navigable waters.

Alternative A 15-II - This alternative consists of land spreading of the effluent. The daily wastewater would be allowed to flow onto a 0.05 ha (0.12 acre) plot of land at a depth of 7.6 cm (3 in). The land would be disced monthly. The overall benefit of this alternative is a pollutant reduction to navigable waters of 100 percent.

Alternative A 15-III - This alternative consists of hauling the wastewater to a municipal treatment system or to an approved land disposal site.

SUBCATEGORY A 16 - NEW LARGE MALT BEVERAGE BREWERIES

The discussion in this section applies also to breweries in subcategories A 17 and A 18, unless otherwise noted.

In-Plant Technology

In-plant technology for waste reduction relates directly to those waste streams discussed in Section V.

DRAFT

Existing In-Plant Technology - Spent grain liquor consists of liquid from dewatering screens and wet grain presses. In order to eliminate this waste some plants feed wet spent grain into gas fired rotary dryers; however, because of the high moisture content of the wet spent grain (80 to 90 percent) fuel costs associated with this method of recovery can be quite high. Plant 82A16 centrifuges spent grain liquor and returns it to the brewing process. Although this alternative eliminates spent grain liquor as a source of waste, the decision to return it to the process stream affects the taste of the final product. This method, therefore, can not be recommended for all brewers. If spent grain liquor is to be discharged, several methods, all of which are primarily directed toward reducing concentrations of suspended solids, exist for reducing the levels of waste. Any solids produced would then be returned to grains drying. Many plants use vibrating screens. Centrifuges have been shown to decrease suspended solids from 8 to 0.4 percent while producing a 25 percent cake. Plant 82A58 has taken spent grain liquor and passed it through a hydra-sieve. Reverse osmosis and vacuum filtration were tested by Plant 82F04 but were found unfeasible.

As explained in Section V, lost beer is generated from filler-closers, can and bottle crushers, and keg dumps. This beer may be wholly or partially collected and sent to multiple effect evaporators as it is at plant 82A16. Waste beer at plant 82A61 is collected and fed to a submerged combustion concentrator. The more volatile alcohol is evaporated and the residue added to spent grains. This procedure leads to a 50 to 60 percent reduction in BOD loading from waste beer. In general, waste reduction through beer recovery involves first the collection then the disposal of lost beer. In terms of economy, rejected cans and bottles are most easily recovered, followed by lost beer from keg dumping which might be collected prior to reaching floor drains, and finally beer on the floor around fillers and seamers which is most effectively recovered by originally designing separate drainage and collection systems.

Alkaline wastes are generated in the brew house and in packaging, the latter resulting from caustic solutions used in bottle washers. In some bottle washers caustic may be used until exhausted, and sewered as often as once per week, but in many plants caustic is reclaimed. In this procedure caustic and label pulp are pumped to holding tanks, screened, readjusted in make-up tanks, and returned to the soaker. At periods ranging from four to six months the contents of the soaker is sewered. Some plants may add a final holding tank from which caustic is metered to the sewer system.

Brewhouse caustic is not contaminated with label pulp. This caustic may be dumped every two to four weeks or readjusted and reused for longer periods. Here again, holding tanks may be utilized to prevent shock loadings to treatment systems. Sulfuric acid may be added to lower the pH, or carbon dioxide gas may be mixed with the caustic in recarbonation pits to produce the same effect.

As described in Section V, spent hops, trub, and yeast may be hauled away by truck or added to spent grains as an alternative to discharge to sewers.

Suspended solids resulting from the discharge of diatomaceous earth may amount to as much as 4400 kg (9800 lb) per day in a large brewery such as plant 82F04. Alternatives to discharge are decant tanks or vacuum and pressure filters, with the resulting cake being hauled by truck.

Potential In-Plant Technology - Foree (104) reports that the stabilization of brewery press liquor by the submerged anaerobic filter process results in COD removals of 90 percent at loading rates up to 6400 kg/cu m (400 lbs/cu ft) per day, however, no cost data was presented. Stein (58) tested the use of the submerged combustion evaporator for concentrating brewery spent grain liquor. Due to the high fuel cost associated with the evaporator it was considered not to be an economically viable alternative to conventional multiple effect evaporation.

Other waste reduction possibilities are total effluent pH control, hydraulic equalization, and screening prior discharge. These are common methods of operation for those breweries maintaining treatment systems.

End-of-Line Technology

Knowledge of present waste treatment practices is limited to those two breweries treating their own wastes, and to those municipal systems that receive a substantial part of their flow from breweries. Schwartz and Jones (105) reported the effects of brewery waste on nine municipal treatment systems receiving more than ten percent of their total wastes from breweries and the method of treatment of each of the breweries is itemized in Table 111. The performance of plants utilizing trickling filters for complete secondary treatment has been below standard; low BOD removal efficiencies and odor problems caused two of the facilities to convert to variations of the activated sludge process. The use of trickling filters after primary clarification can achieve 45 to 60 percent BOD removal although odor may still be a problem. Eight of the nine plants use some form of the activated sludge process. Sludge bulking has been a major problem with plug-flow and conventional activated sludge systems, although the Kraus process has controlled this problem to some degree. The complete mix activated sludge system, operated at about 0.25 to 0.30 kg BOD/kg/MLSS, should help maintain adequate dissolved oxygen levels throughout the aeration basins. In a pilot plant study, Schwartz and Jones (105) found that the sludge could be treated aerobically without odor problems.

During the course of this study each of the two breweries that treat their own wastes were visited and sampled. A flow diagram for the waste treatment system at plant 82A43 is shown in Figure 175. Mean operating values for significant parameters over a six month period are as follows:

DRAFT

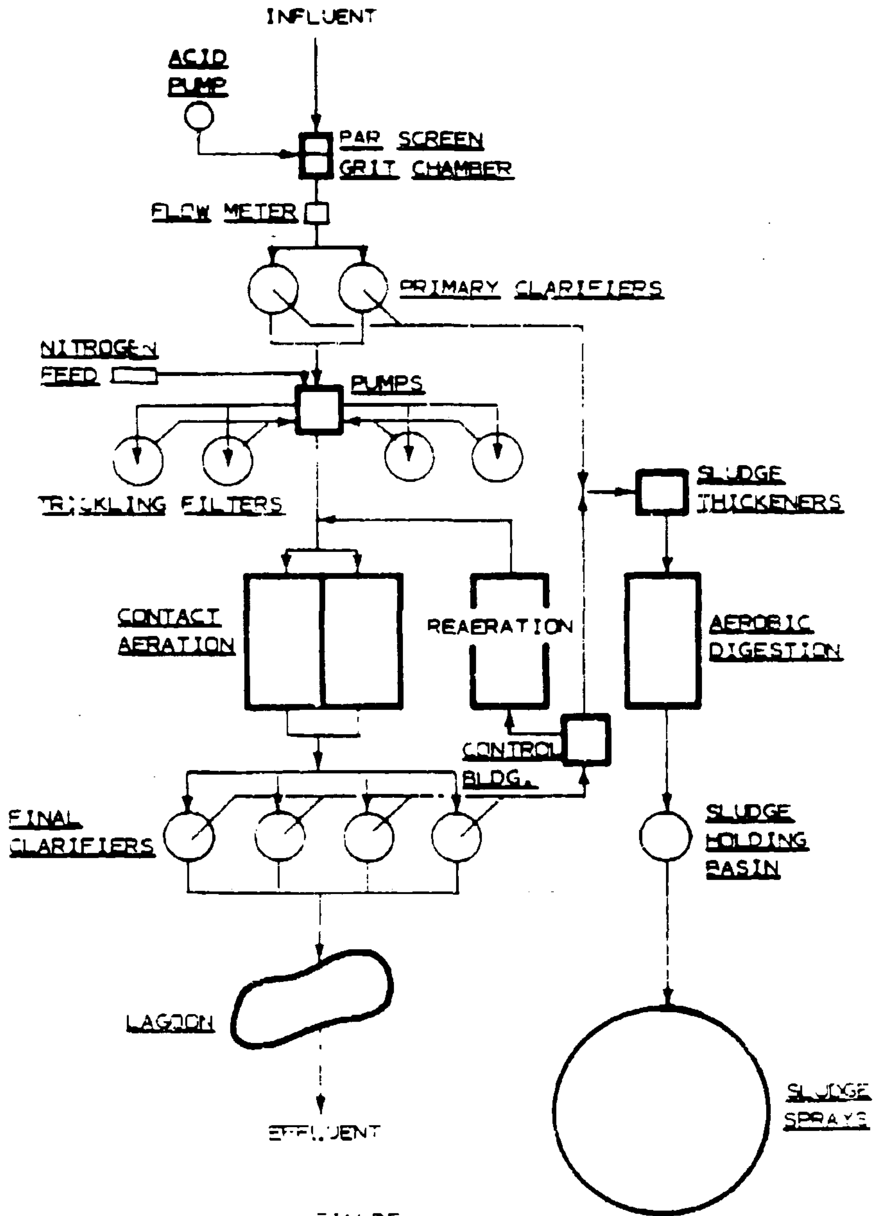


FIGURE 175

CONTROL AND TREATMENT

PLANT 32A43

DRAFT

TABLE 111

WASTE TREATMENT PLANTS HANDLING BREWERY WASTES

Treatment Plant (Brewery)	Waste Treatment Sequence	Sludge Disposal Sequence	Total Flow, mgd	Brewery Flow, mgd	Approximate Treatment Efficiencies, percent: BOD	Approximate Treatment Efficiencies, percent: Suspended Solids
A	Clarifier roughing filter, activated sludge (contact stabilization), clarifier, chlorination	Aerobic digestion sludge lagoon	2.65	2.65	80-85	30-70
B	Grit chamber, clarifier, activated sludge (Kraus process), clarifier, chlorination	Storage, flotation, vacuum filtration, land disposal	4.6	3.4	90	85-90
C	Settling basin activated sludge (Kraus process), settling basin	Anaerobic digestion, drying beds, land disposal	6.65	1.2	94	92
D	Grit chamber, settling basin, activated sludge (Kraus process), settling basin, chlorination	Flotation, anaerobic digestion sludge lagoon	0.70	0.35	90	---
E	Pretreatment (brewery wastes) equalization basin, clarifier, roughing filter, clarifier, trickling filters, clarifier, lagoons	Thickener anaerobic digestion drying beds, land disposal	8.5	0.85	60-70	35-60

DRAFT

TABLE 111 (CONT'D)

F	Equalization basins, clarifier, roughing filter, activated sludge, (conventional), clarifiers, chlorination	Flotation, thickeners, vacuum filters, land disposal	3.2	3.2	---	---
G	Clarifiers, trickling filters, activated sludge, settiing basins	Anaerobic digestion drying beds, kiln drying, sale as fertilizer	20	1.5	---	---
H	Grit chamber, clarifiers, roughing filters, activated sludge (contact stabilization), clarifiers, lagoon	Aerobic digestion sludge lagoons, spray irrigation	1.0	1.0	95	95
I	Clarifiers, activated sludge (complete mix), clarifiers, chlorination	Thickeners, spray irrigation	*9.6	*5.6	90+	---

* Design Values

	Influent Loading (kg/day)	Percent Removal	Effluent Concentration (mg/l)
BOD	11,100 (24,600 lb)	97.3	56
Suspended Solids	3,940 (8,690 lb)	89.3	78

Due to excellent in-plant control no equalization was required. Both caustic and decant are metered into the treatment system. Wastes from spent grain liquor were eliminated by direct drying in gas fired rotary dryers, thus contributing to lower than mean waste loading compared to other new large breweries. Primary clarification removed settleable solids before roughing filters. No phosphorus adjustment was required The trickling filters were operating at about 45 percent BOD removal at hydraulic loading of 44 l/sq m (1 gpm/sq ft) with no objectionable odor. At the time of the visit, the reaeration basin was operated as a contact basin. BOD removal through final clarification was approximately 90 percent. Approximately 5.4 kkg (6 ton) of sludge per day was being spray irrigated over a 32 ha (80 acre) acre. Design loadings presented by McWhorter (106) are given in Table 112. A flow diagram for the waste treatment system at plant 82A16 is shown in Figure 176. Mean operating values for significant parameters over a one year period are as follows:

	Influent Loading (kg/day)	Percent Removal	Effluent Concentration (mg/l)
BOD	10,800 (23,800 lb)	94.6	48
Suspended Solids	3,170 (7,000 lb)	87.7	32

Due to excellent in-plant control, the raw waste BOD ratio delivered to the treatment system is approximately 17 percent of the mean for other new large breweries. The treatment system is a high rate activated sludge plant using a modification of the Hatfield process. Equalization is provided by a surge basin with four hours detention time. During plant visitation, the effluent from the surge tank by-passed the primary clarifier and entered the stabilization section of the aeration basin. Loading rate for aeration is 21.3 kg/cu m/day (1.23 lb/cu ft/day). Thirty percent of the sludge from secondary clarifiers is returned to the aeration basins. Waste activated sludge is concentrated to 5.5 percent solids in dissolved air flotation cells and dewatered on vacuum filters used alternatively at 38 kg/sq m/hr (7.5 lb/sq ft/hr). Ferric chloride and lime are added to produce a filtered sludge containing 18 percent solids. During the visitation, filtrate was being returned to the primary clarifier after decanting. Approximately 12 kkg (13 ton) of sludge per day is hauled by truck and spread on company property.

DRAFT

TABLE 112

TREATMENT PLANT DESIGN UNIT LOADINGS

Primary Clarifier	Surface Loading	665 gpd/sq ft
	Weir Loading	5820 gpd/ft
	Detention	1.9 hr
Trickling Filters	BOD Loading	300 lb/1000 cu ft
	Hydraulic Loading Including Recirculation	
	Minimum	1 gpm/sq ft
	Maximum	2 gpm/sq ft
Activated Sludge	BOD Loading	100 lb/1000 cu ft
	Aeration Capacity	1.5 lb O_2/lb BOD
	Return Sludge Rate	50 percent
	BOD/MLSS Ratio	0.38
	MLSS Concentration	
	Contact Basin	2000 mg/l
	Reaeration Basin	6000 mg/l
	Detention	
	Contact Basin	4.9 hr
	Reaeration Basin	14.5 hr
Final Clarifier	Surface Loading	509 gpd/sq ft
	Weir Loading	5950 gpd/sq ft
	Detention	3.7 hr
Polishing Lagoon	BOD Loading	50 lb/day/acre
	Detention	15 days
Aerobic Digestion	Solids Retention	10 days
	MLSS Concentration	15,000 mg/l
Sludge Spray Disposal	Liquid Loading	1 inch depth/application
	Solids Loading	0.1 lb/sq ft/application
	Application Interval	1 to 7 weeks

DRAFT

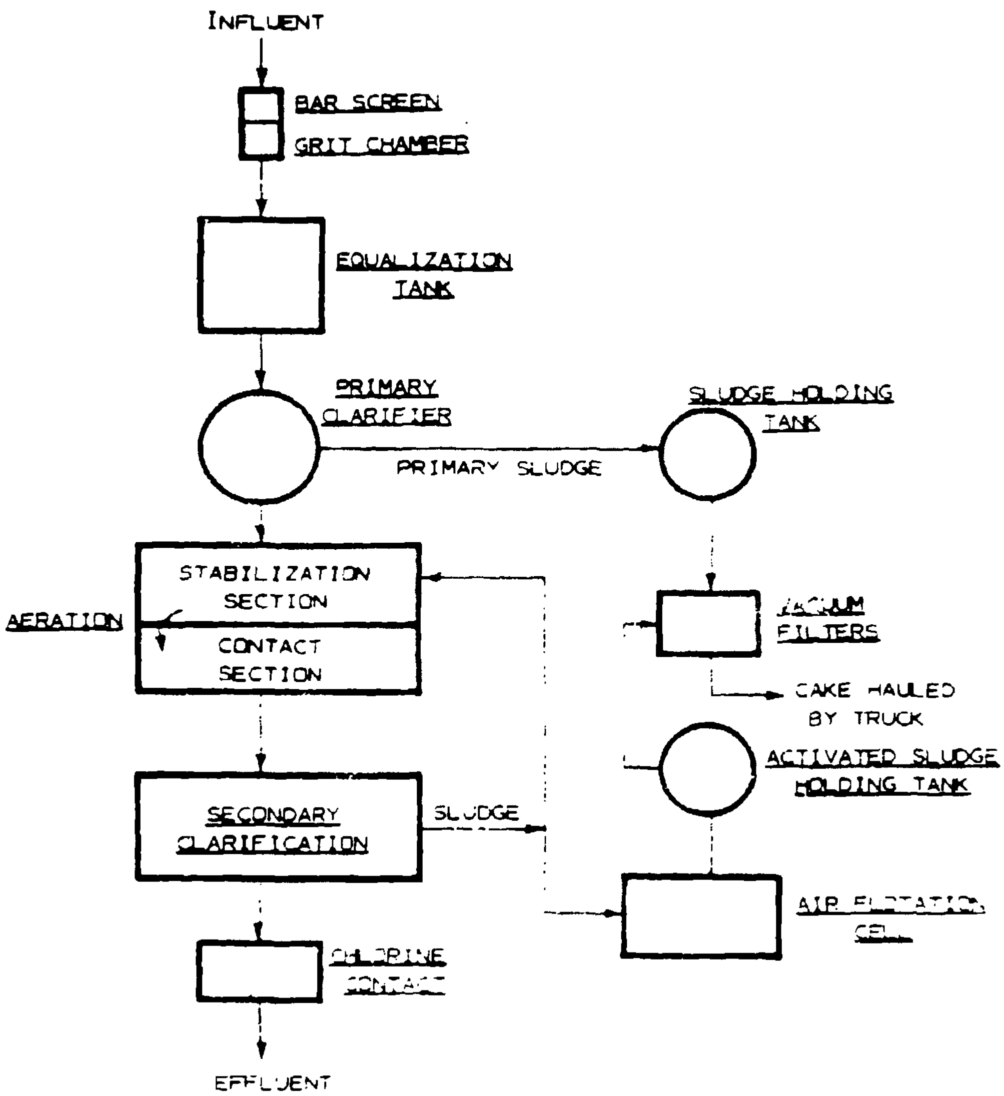


FIGURE 176

CONTROL AND TREATMENT

PLANT 82A16

Windell (107) reports that dried sludge is a suitable ingredient when substituted into animal feeds. In 1975 plant 82A16 will install a sludge drying evaporator using vegetable oil as a carrier liquid. The oil will then be removed by centrifuging so that the sludge can be used as animal feed.

Potential technology for brewery waste is centered around the control of sludge bulking caused by filamentous organisms. Eckenfelder (108 109) has reported the advantages of oxygen aeration in the activated sludge system in order to maintain F:M ratios conducive to brewery waste. Lewis (110) has reported on tests at plant 82A16 to apply pure oxygen treatment through ceramic diffusers. At present, a biogrowth problem has halted their consideration for use until further research is completed.

SELECTION OF CONTROL AND TREATMENT TECHNOLOGY

In Section V a model plant was developed for new breweries. The raw waste was assumed to be as follows:

Flow (MGD)	2.2
BOD (mg/l)	1900
SS (mg/l)	700
Total KN	40
pH	2 to 12

Table 113 lists the effluent loading and the estimated operating efficiency of each of the thirteen treatment trains for this subcategory as illustrated in Figures 177 and 178.

Alternative A 16-I - This alternative involves no added control or treatment. The efficiency of BOD and suspended solids removal is zero.

Alternative A 16-II - This alternative consists of a screen and grit chamber, pumping station, diffused air flow equalization with twenty-four hour detention time, pH adjustment, nutrient addition, aerated lagoons, settling ponds, land at $1650 (1972) per acre, and sludge removal once every five years. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 16-II is a BOD reduction of 97.4 percent and a suspended solids reduction of 90.0 percent.

Alternative A 16-III - This alternative adds dual media filtration to the treatment modules in Alternative A 16-II. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 16-III is a BOD reduction of 98.7 percent and a suspended solids reduction of 95.0 percent.

Alternative A 16-IV - This alternative adds activated carbon to the treatment modules in Alternative A 16-III. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall

DRAFT

TABLE 113

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

Subcategory A 16

Treatment Train Alternative		Effluent BOD (kg/cu m)	Effluent SS (kg/cu m)	Percent BOD Reduction	Percent SS Reduction
A 16-I	A	10.55	3.89	0	0
A 16-II	E1BCFHL	0.28	0.39	97.4	90.0
A 16-III	E1BCFHLBN	0.14	0.19	98.7	95.0
A 16-IV	E1BCFHLBNZ	0.07	0.09	99.4	97.6
A 16-V	B1E1BCFHKQRSY	0.28	0.39	97.4	90.0
A 16-VI	B1E1BCFHKQRSYBN	0.14	0.19	98.7	95.0
A 16-VII	B1E1BCFHKQRSYBNZ	0.07	0.09	99.4	97.6
A 16-VIII	B1E1BCFHKQRYU	0.28	0.39	97.4	90.0
A 16-IX	B1E1BCFHKQRYUBN	0.14	0.19	98.7	95.0
A 16-X	B1E1BCFHKQRYURBNZ	0.07	0.09	99.4	97.6
A 16-XI	B1E1BCFHKQRT	0.28	0.39	97.4	90.0
A 16-XII	B1E1BCFHKQRTBN	0.14	0.19	98.7	95.0
A 16-XIII	B1E1BCFHKQRTBNZ	0.07	0.09	99.4	97.6

DRAFT

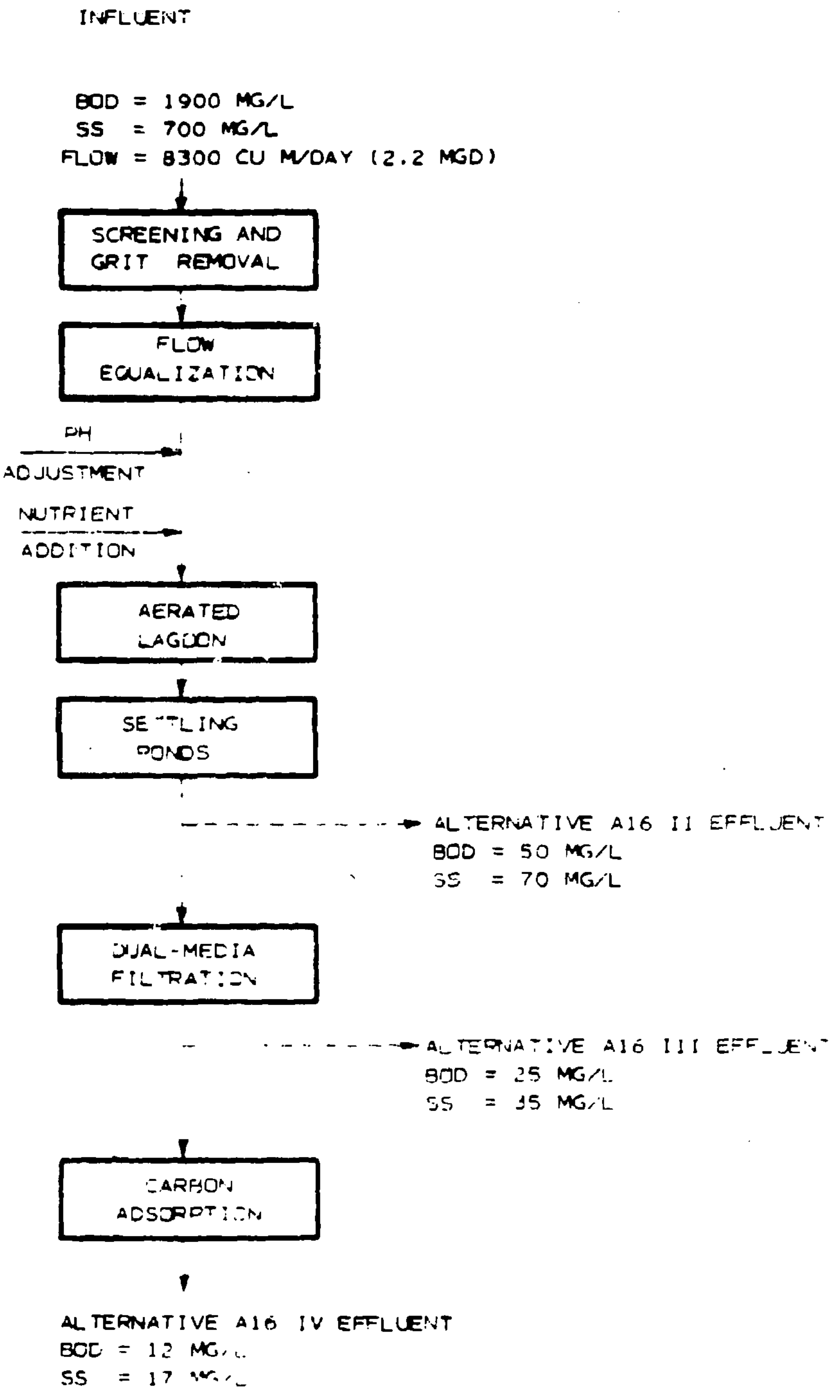


FIGURE [illegible]

SUBCATEGORY A16
TREATMENT ALTERNATIVES II THROUGH IV

DRAFT

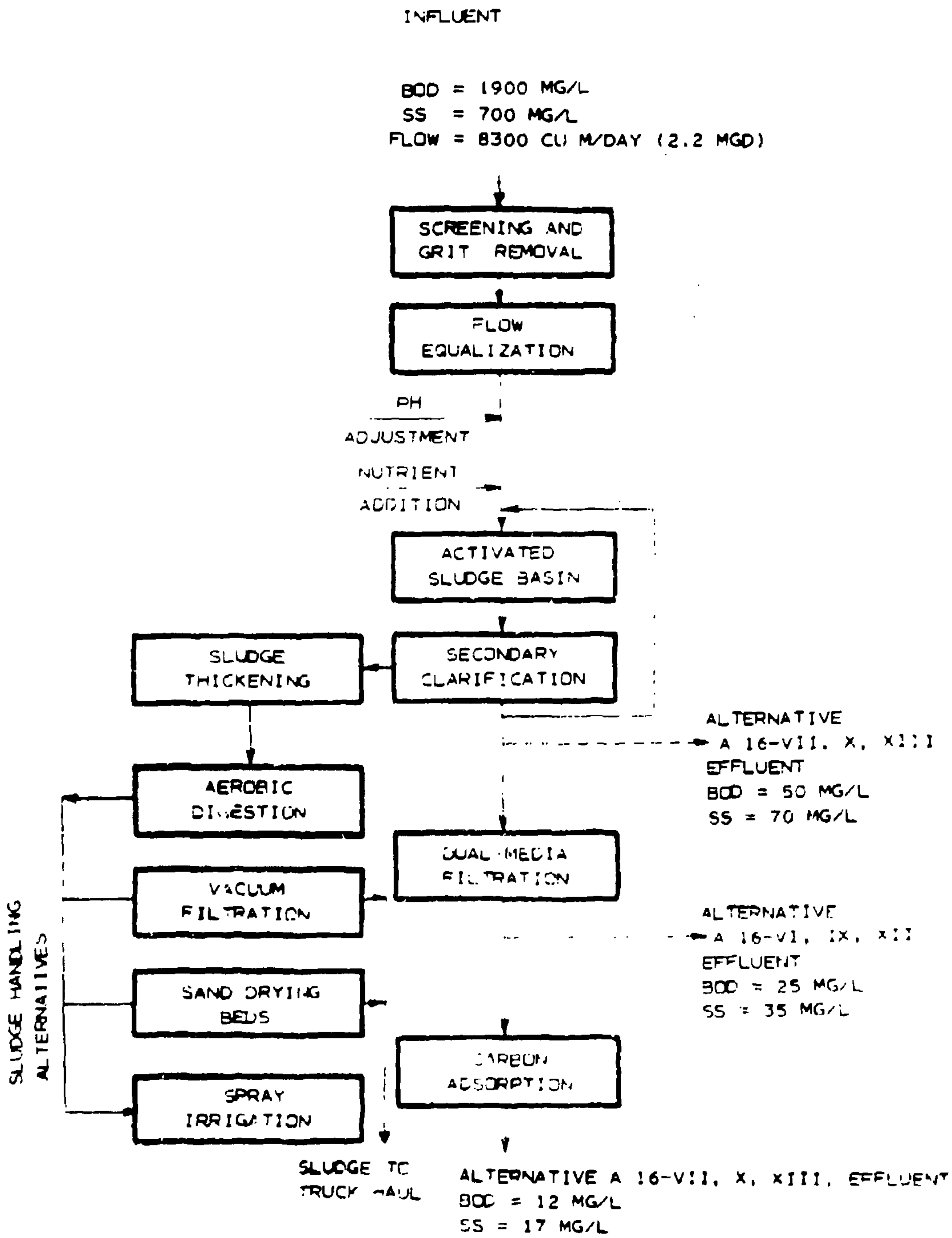


FIGURE 178

SUBCATEGORY A16
TREATMENT ALTERNATIVES A16-V THROUGH A16-XIII

effect of Alternative A 16-IV is a BOD reduction of 99.4 percent and a suspended solids reduction of 97.6 percent.

Alternative A 16-V - This alternative consists of a screen and grit chamber, pumping station, diffused air flow equalization with twenty-four hour detention time, pH adjustment, nutrient addition, complete mix activated sludge system with fixed surface aerators, secondary clarifiers, control house, sludge thickening producing two percent solids, aerobic digestion producing a 3.5 percent solids, vacuum filtration producing 15 percent solids, sludge storage, and truck hauling. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 16-V is a BOD reduction of 97.4 percent and a suspended solids reduction of 90.0 percent.

Alternative A 16-VI - This alternative adds dual media filtration to the treatment modules in Alternative A 16-V. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids The overall effect of Alternative A 16-VI is a BOD reduction of 98.7 percent and a suspended solids reduction of 95.0 percent.

Alternative A 16-VII - This alternative adds activated carbon to the treatment modules in Alternative A 16-VI. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 16-VII is a BOD reduction of 99.4 percent and a suspended solids reduction of 97.6 percent.

Alternative A 16-VIII - This alternative replaces vacuum filtration in Alternative A 16-V with sludge storage and spray irrigation at the rate of 5000 gal[illegible]etric acre/day with land at $1660/acre. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 16-VIII is a BOD reduction of 97.4 percent and a suspended solids reduction of 90.0 percent.

Alternative A 16-IX - This alternative adds dual media filtration to the treatment modules in Alternative A 16-VIII. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 16-IX is a BOD reduction of 98.7 percent and a suspended solids reduction of 95.0 percent.

Alternative A 16-X - This alternative adds activated carbon to the treatment modules in Alternative A 16-IX. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 16-X is a BOD reduction of 99.4 percent and a suspended solids reduction of 97.6 percent.

Alternative A 16-XI - This alternative replaces vacuum filtration in Alternative A 16-V with sand drying beds at a land cost of $8300/acre. Dried sludge is trucked. The predicted effluent concentrations are

50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 16-XI is a BOD reduction of 97.4 percent and a suspended solids reduction of 97.4 percent.

Alternative A 16-XII - This alternative adds dual media filtration to the treatment modules in alternative A 16-XI. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative I is a BOD reduction of 98.7 percent and a suspended solids reduction of 95.0 percent.

Alternative A 16-XIII - This alternative adds activated carbon to the treatment modules in Alternative A 16-XII. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 16-XIII is a BOD reduction of 99.4 percent and a suspended solids reduction of 97.6 percent.

SUBCATEGORY A 17 - OLD LARGE MALT BEVERAGE BREWERIES

In-plant technology for this subcategory is the same as that for Subcategory A 16. No breweries in this subcategory operate end-of-line treatment systems.

Selection of Control and Treatment

In Section V a model plant was developed for old large breweries. The raw waste was assumed to be as follows:

Flow (MGD)	7.5
BOD (mg/l)	1700
SS (mg/l)	670
Total KN	34
pH	2 to 12

Table 114 lists the effluent loading and the estimated operating efficiency of each of the ten treatment trains for this subcategory as illustrated in Figures 179 and 180.

Alternative A 17-I - This alternative involves no added control or treatment. The efficiency of BOD and suspended solids removal is zero.

Alternative A 17-II - This alternative consists of a screen and grit chamber, pumping station, diffused air flow equalization with twenty-four hour detention time, pH adjustment, nutrient addition, aerated lagoons, settling ponds, and sludge removal once every five years. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 17-II is a BOD reduction of 97.0 percent and a suspended solids reduction of 89.5 percent.

DRAFT

TABLE 114

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

Subcategory A 17

Treatment Train Alternative		Effluent BOD (kg/cu m)	Effluent SS (kg/cu m)	Percent BOD Reduction	Percent SS Reduction
A 17-I	A	16.56	7.32	0	0
A 17-II	E1BCFHL	0.55	0.76	97.0	89.5
A 17-III	E1BCFHLBN	0.27	0.38	98.5	94.7
A 17-IV	E1BCFHLBNZ	0.13	0.19	99.3	97.5
A 17-V	B1E1BCFHKQRSY	0.55	0.76	97.0	89.5
A 17-VI	B1E1BCFHKQRSYBN	0.27	0.38	98.5	94.7
A 17-VII	B1E1BCFHKQRSYBNZ	0.13	0.19	99.3	97.5
A 17-VIII	B1E1BCFHKQRYU	0.55	0.76	97.0	89.5
A 17-IX	B1E1BCFHKQRYUBN	0.27	0.38	98.5	94.7
A 17-X	B1E1BCFHKQRYURBNZ	0.13	0.19	99.3	97.5

DRAFT

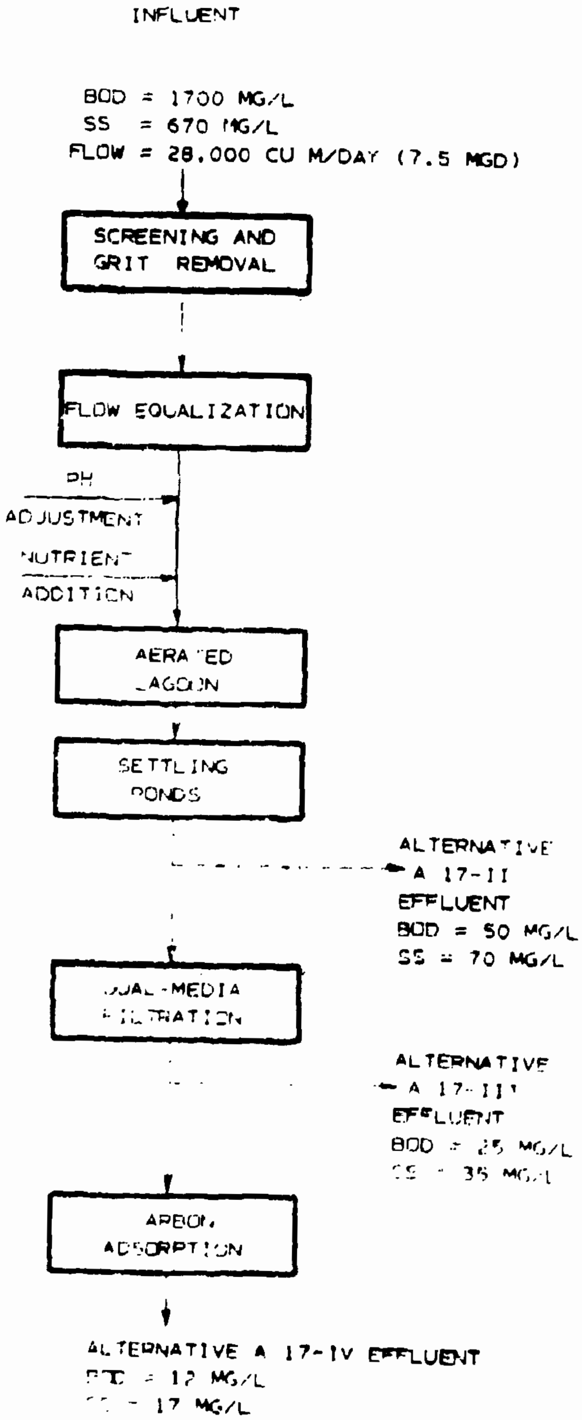


FIGURE [illegible]

SUBCATEGORY A17
TREATMENT ALTERNATIVES II THROUGH IV

DRAFT

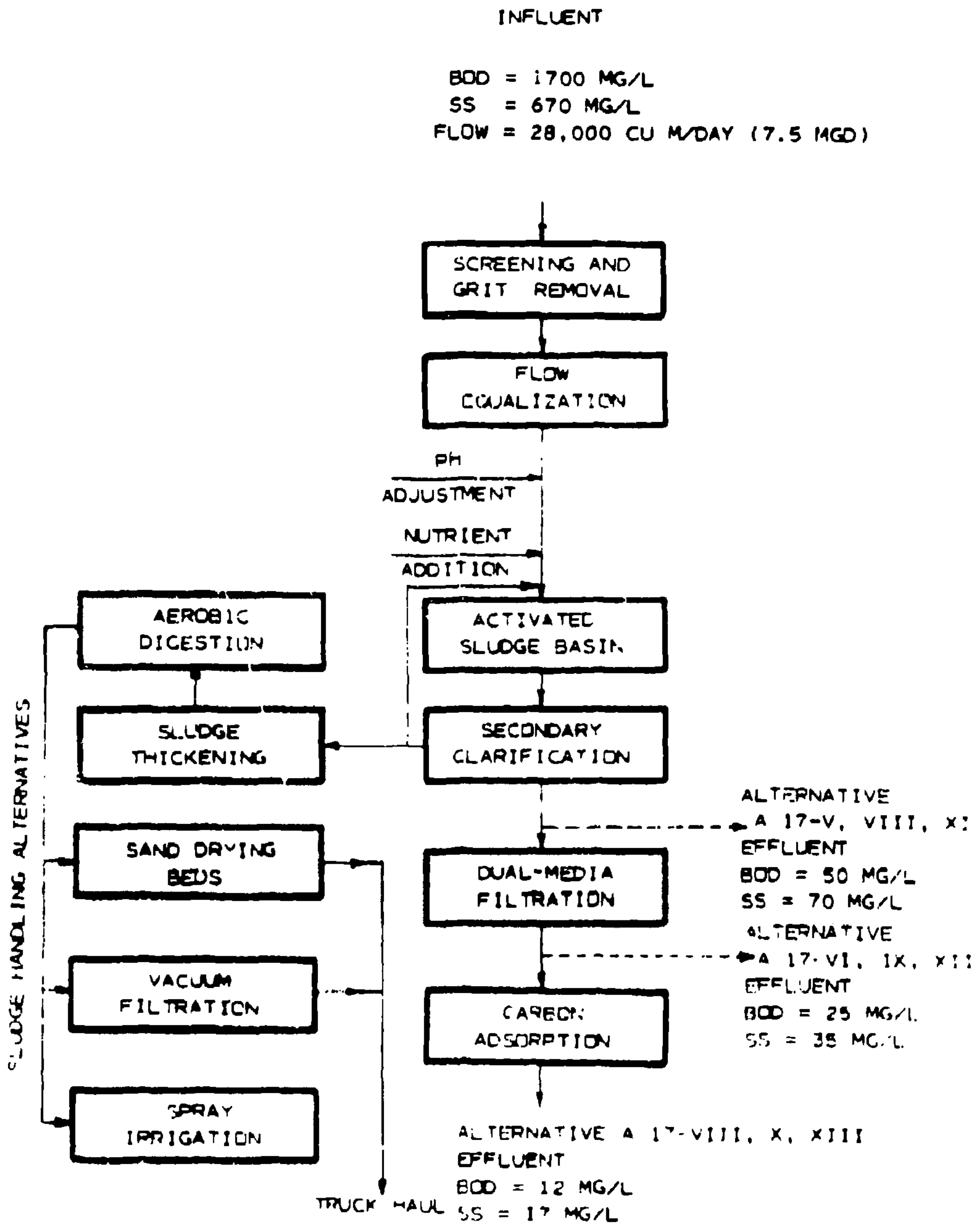


FIGURE 190

SUBCATEGORY A 17
TREATMENT ALTERNATIVES V THROUGH XIII

Alternative A 17-III - This alternative adds dual media filtration to the treatment modules in Alternative A 17-II. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 17-III is a BOD reduction of 98.5 percent and a suspended solids reduction of 94.7 percent.

Alternative A 17-IV - This alternative adds activated carbon to the treatment modules in Alternative A 17-III. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 17-IV is a BOD reduction of 99.3 percent and a suspended solids reduction of 97.5 percent.

Alternative A 17-V - This alternative consists of a screen and grit chamber, pumping station, diffused air flow equalization with twenty-four hour detention time, pH adjustment, nutrient addition, complete mix activated sludge system with fixed surface aerators, secondary clarifiers, control house, sludge thickening producing two percent solids, aerobic digestion producing 3.5 percent solids, vacuum filtration producing 15 percent solids, sludge storage, truck hauling, and land at $20,000 per acre. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 17-V is a BOD reduction of 97.0 percent and a suspended solids reduction of 89.5 percent.

Alternative A 17-VI - This alternative adds dual media filtration to the treatment modules in Alternative A 17-V. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 17-VI is a BOD reduction of 98.5 percent and a suspended solids reduction of 94.7 percent.

Alternative A 17-VII - This alternative adds activated carbon to the treatment modules in Alternative A 17-VI. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 17-VII is a BOD reduction of 99.3 percent and a suspended solids reduction of 97.5 percent.

Alternative A 17-VIII - This alternative replaces vacuum filtration in Alternative A 17-V with sludge storage and spray irrigation at the rate of 5000 gal/acre/day. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 17-VIII is a BOD reduction of 97.0 percent and a suspended solids reduction of 89.5 percent.

Alternative A 17-IX - This alternative adds dual media filtration to the treatment modules in Alternative A 17-VIII. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 17 is a BOD reduction of 98.5 percent and a suspended solids reduction of 94.7 percent.

Alternative A 17-X - This alternative adds activated carbon to the treatment modules in Alternative A 17-IX. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 17-X is a BOD reduction of 99.3 percent and a suspended solids reduction of 97.5 percent.

Sandbed drying was not deemed to be an economically feasible alternative due to the large volume of sludge produced.

SUBCATEGORY A 18 - ALL OTHER MALT BEVERAGE BREWERIES

In-plant technology for this subcategory is the same as that for Subcategory A 16. No breweries in this subcategory operate end-of-line treatment systems.

Selection of Control and Treatment Technology

In Section V a model plant was developed for all other breweries not included in Subcategories A 16 or A 17. The raw waste was assumed to be as follows:

Flow (MGD)	1.2
BOD (mg/l)	1400
SS (mg/l)	640
Total KN	28
pH	2 to 12

Table 115 lists the effluent loading and the estimated operating efficiency of each of the thirteen treatment trains for this subcategory as illustrated in Figures 181 and 182.

Alternative A 18-I - This alternative involves no added control or treatment. The efficiency of BOD and suspended solids removal is zero.

Alternative A 18-II - This alternative consists of a screen and grit chamber, pumping station, diffused air flow equalization with twenty-four hour detention time, pH adjustment, nutrient addition, aerated lagoons, settling ponds, land at $1000 per acre, and sludge removal once every five years. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 18-II is a BOD reduction of 96.4 percent and a suspended solids reduction of 89.1 percent.

Alternative A 18-III - This alternative adds dual media filtration to the treatment modules in Alternative A 18-II. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 18-III is a BOD reduction of 98.2 percent and a suspended solids reduction of 94.5 percent.

DRAFT

TABLE 115

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

Subcategory A 18

Treatment Train Alternative		Effluent BOD (kg/cu m)	Effluent SS (kg/cu m)	Percent BOD Reduction	Percent SS Reduction
A 18-I	A	13.53	6.19	0	0
A 18-II	E1BCFHL	0.48	0.68	96.4	89.1
A 18-III	E1BCFHLBN	0.24	0.34	98.2	94.5
A 18-IV	E1BCFHLBNZ	0.12	0.17	99.0	97.3
A 18-V	B1E1BCFHKQRSY	0.48	0.68	96.4	89.1
A 18-VI	B1E1BCFHKQRSYBN	0.24	0.34	98.2	94.5
A 18-VII	B1E1BCFHKQRSYBNZ	0.12	0.17	99.0	97.3
A 18-VIII	B1E1BCFHKQRYU	0.48	0.68	96.4	89.1
A 18-IX	B1E1BCFHKQRYUBN	0.24	0.34	98.2	94.5
A 18-X	B1E1BCFHKQRYUFBNZ	0.12	0.17	99.0	97.3
A 18-XI	B1E1BCFHKQRT	0.48	0.68	96.4	89.1
A 18-XII	B1E1BCFHKQRTBN	0.24	0.34	98.2	94.5
A 18-XIII	B1E1BCFHKQRTBNZ	0.12	0.17	99.0	97.3

DRAFT

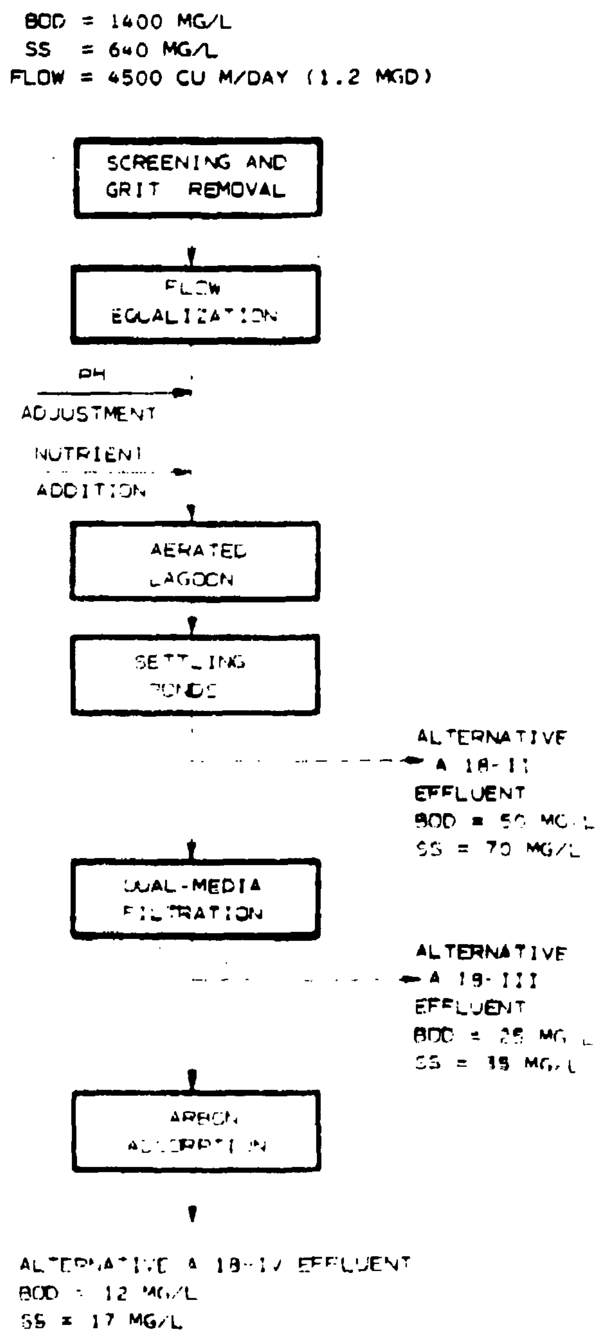


FIGURE 181

SUBCATEGORY A18
TREATMENT ALTERNATIVES II THROUGH IV

DRAFT

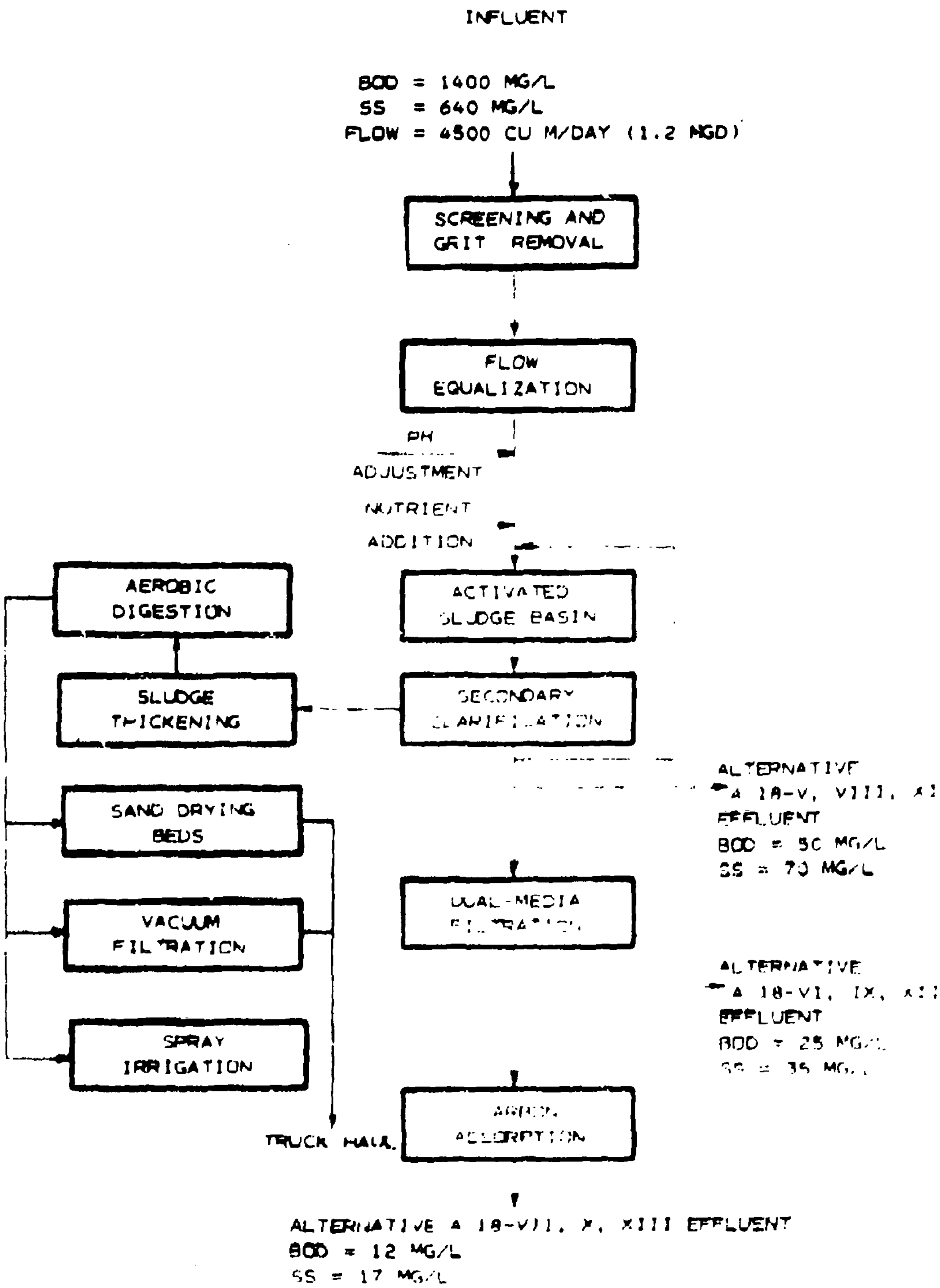


FIGURE 162

SUBCATEGORY A18
TREATMENT ALTERNATIVES V THROUGH XIII

Alternative A 18-IV - This alternative adds activated carbon to the treatment modules in Alternative A 18-III. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 18-IV is a BOD reduction of 99.0 percent and a suspended solids reduction of 97.3 percent.

Alternative A 18-V - This alternative consists of a screen and grit chamber, pumping station, diffused air flow equalization with twenty-four hour detention time, pH adjustment, nutrient addition, complete mix activated sludge system with fixed surface aerators, secondary clarifiers, control house, sludge thickening producing two percent solids, aerobic digestion producing 3.5 percent solids, vacuum filtration producing 15 percent solids, sludge storage, truck hauling, and land at $16,000 per acre. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 18-V is a BOD reduction of 96.4 percent and a suspended solids reduction of 89.1 percent.

Alternative A 18-VI - This alternative adds dual media filtration to the treatment modules in Alternative A 18-V. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 18-VI is a BOD reduction of 98.2 percent and a suspended solids reduction of 94.5 percent.

Alternative A 18-VII - This alternative adds activated carbon to the treatment modules to Alternative A 18-VI. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 18-VII is a BOD reduction of 99.0 percent and a suspended solids reduction of 97.3 percent.

Alternative A 18-VIII - This alternative replaces vacuum filtration in Alternative A 18-V with sludge storage and spray irrigation. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 18-VIII is a BOD reduction of 96.4 percent and a suspended solids reduction of 89.1 percent.

Alternative A 18-IX - This alternative adds dual media filtration to the treatment modules in Alternative A 18-VIII. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 18-IX is a BOD reduction of 98.2 percent and a suspended solids reduction of 94.5 percent.

Alternative A 18-X - This alternative adds activated carbon to the treatment modules in Alternative A 18-IX. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 18-X is a BOD reduction of 99.0 percent and a suspended solids reduction of 97.3 percent.

Alternative A 18-XI - This alternative replaces vacuum filtration in Alternative A 18-V with sand drying beds. Dried sludge is hauled by truck. The predicted effluent concentrations are 50 mg/l BOD and 70 mg/l suspended solids. The overall effect of Alternative A 18-XI is a BOD reduction of 96.4 percent and a suspended solids reduction of 96.4 percent.

Alternative A 18-XII - This alternative adds dual media filtration to the treatment modules in Alternative A 18-XI. The predicted effluent concentrations are 25 mg/l BOD and 35 mg/l suspended solids. The overall effect of Alternative A 18-XII is a BOD reduction of 98.2 percent and a suspended solids reduction of 94.5 percent.

Alternative A 18-XIII - This alternative adds activated carbon to the treatment modules in Alternative A 18-XII. The predicted effluent concentrations are 12 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 18-XIII is a BOD reduction of 99.0 percent and a suspended solids reduction of 97.3 percent.

SUBCATEGORY A 19 - MALT

Existing In-Plant Technology

As discussed in Section V, steeping and germinating create soluble organic wastes which may contain high levels of suspended solids if not properly screened. Plant 83A13 has installed a 30 mesh vibrating chain link screen prior to final discharge. This effectively removes all the sprouts in the waste stream in addition to creating a marketable by-product. The elimination of these solids enhances biological treatment.

Potential In-Plant Technology

Potential waste reduction centers around good in-plant supervision. For example, the number of steep changes and the amount of water required is, of course, a quality decision. During steeping, however, close operator supervision can minimize the amount of overflow in the steep tanks without affecting quality standards. Water reduction can also be exercised in germination by maintaining a closed spray-and-refrigeration cycle so that only makeup is required. While both of these measures are undoubtedly practiced by some maltsters it is felt that these are areas of possible pollution abatement for other members of the industry.

End-of-Line Technology

There is currently one one separate malt house treating its own waste. Figure 183 illustrates this treatment system as it now operates. Current removal rates are 97.7 percent BOD and 91.6 percent suspended solids. Originally the final clarifier effluent was being discharged to navigable waters with only a 77 percent reduction of BOD. In 1971 the aerated lagoons were added on to the original system. Approximate unit effluents as of August 1974 are as follows:

DRAFT

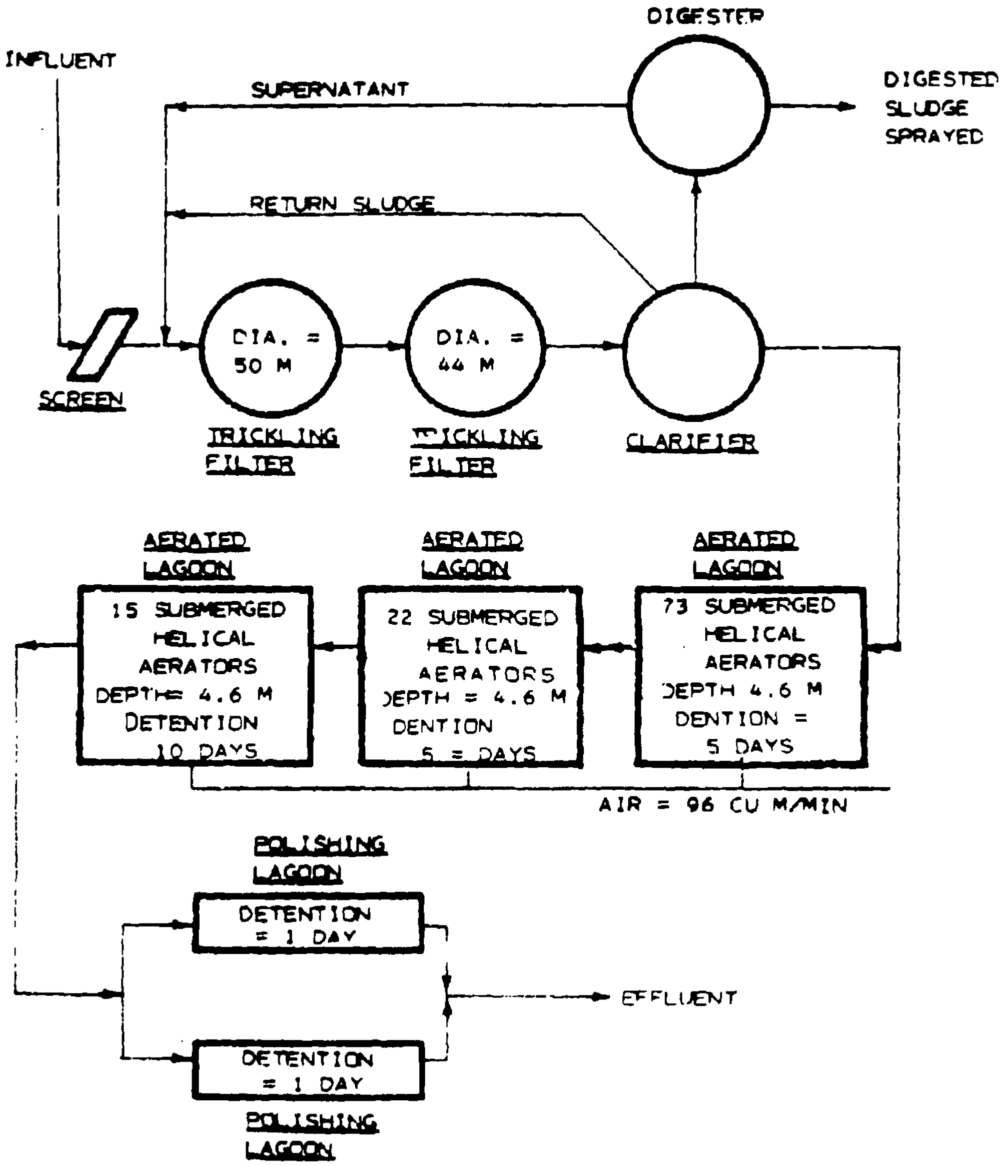


FIGURE 183

CONTROL AND TREATMENT PLANT 83A13

	BOD (mg/l)	SS (mg/l)
Influent	800	84.2
Primary Filter	450	67.4
Secondary Filter	210	251.4
Clarifier	200	51.0
Lagoons	18	7

No sludge disposal has been required during the last two years although spray irrigation facilities are available.

According to Isaac (62) the two principal biological processes used for the treatment of malting wastes outside the United States are bacteria beds (trickling filters) and activated sludge. The bacteria bed system is actually quite similar to that originally employed by Plant 83A13. The Pasveer ditch, a modification of the activated sludge process, is used in Europe and England. It consists of elliptical ditch of trapezoidal cross section with a liquid depth of 1 M. The mixture is oxygenated and kept moving by means of an aeration rotor. Final settling may be carried out either in the ditch or in a separate tank.

Selection of Control and Treatment Technology

In Section V a model malt plant based on typical effluent characteristics was developed for purposes of developing control and treatment alternatives. The wastewater characteristics of the model plant are:

Flow	2590 cu m/day (0.685 MGD)
BOD	615 mg/l
SS	104 mg/l
Total KN	17 mg/l
Total P	7 mg/l
pH	6.0 to 9.0

It was assumed that process and non-contact water are segregated, and that screening removes grain and sprouts prior to discharge.

Table 116 presents treated effluent loadings and removal efficiencies for each of the treatment alternatives chosen for Subcategory A 19. Figures 184 and 185 show simplified flow diagrams for each of the six treatment trains.

Alternative A 19 - I - This treatment alternative adds no treatment and control to the model plant.

Alternative A 19 - II - This alternative consists of a control house, pumping station, flow equalization, nutrient addition in the form of 43.24 kg/day (95.32 lb/day) anhydrous ammonia, aerated lagoons, and

TABLE 116

SUMMARY OF TREATMENT TRAIN ALTERNATIVES - SUBCATEGORY A 19
MALT

ALTERNATIVE	EFFLUENT BOD KG/KKG	EFFLUENT SS KG/KKG	PERCENT BOD REMOVAL	PERCENT SS REMOVAL
A19 - I	4.55	0.77	0	0
A19 - II	0.22	0.13	95.2	83.1
A19 - III	0.11	0.06	97.6	92.2
A19 - IV	0.22	0.13	95.2	83.1
A19 - V	0.11	0.06	97.6	92.2
A19 - VI	0.22	0.13	95.2	83.1
A19 - VII	0.11	0.06	96.6	92.2

DRAFT

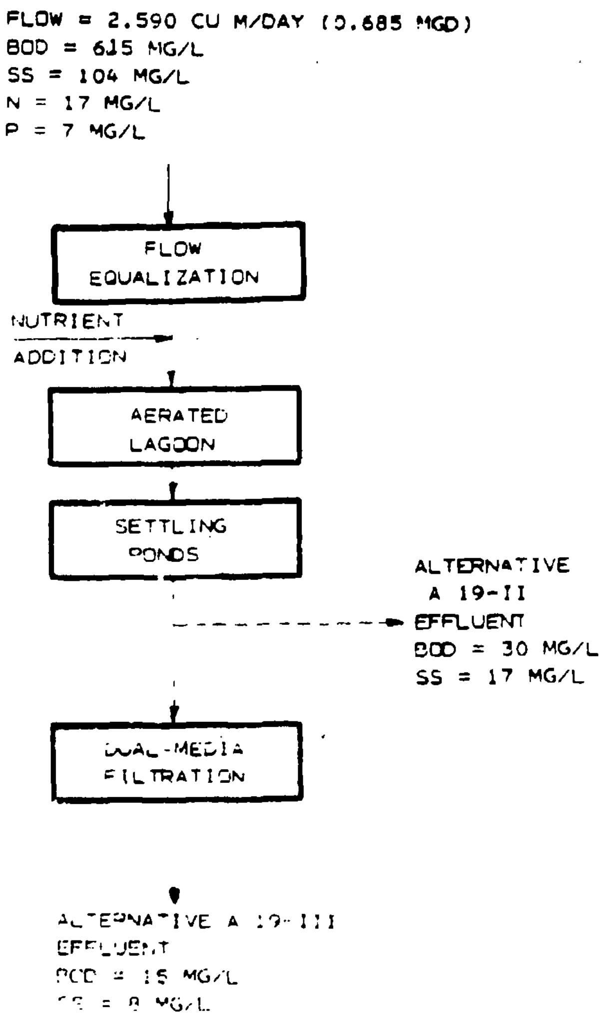


FIGURE 184

SUBCATEGORY A19
TREATMENT ALTERNATIVES II THRU III

DRAFT

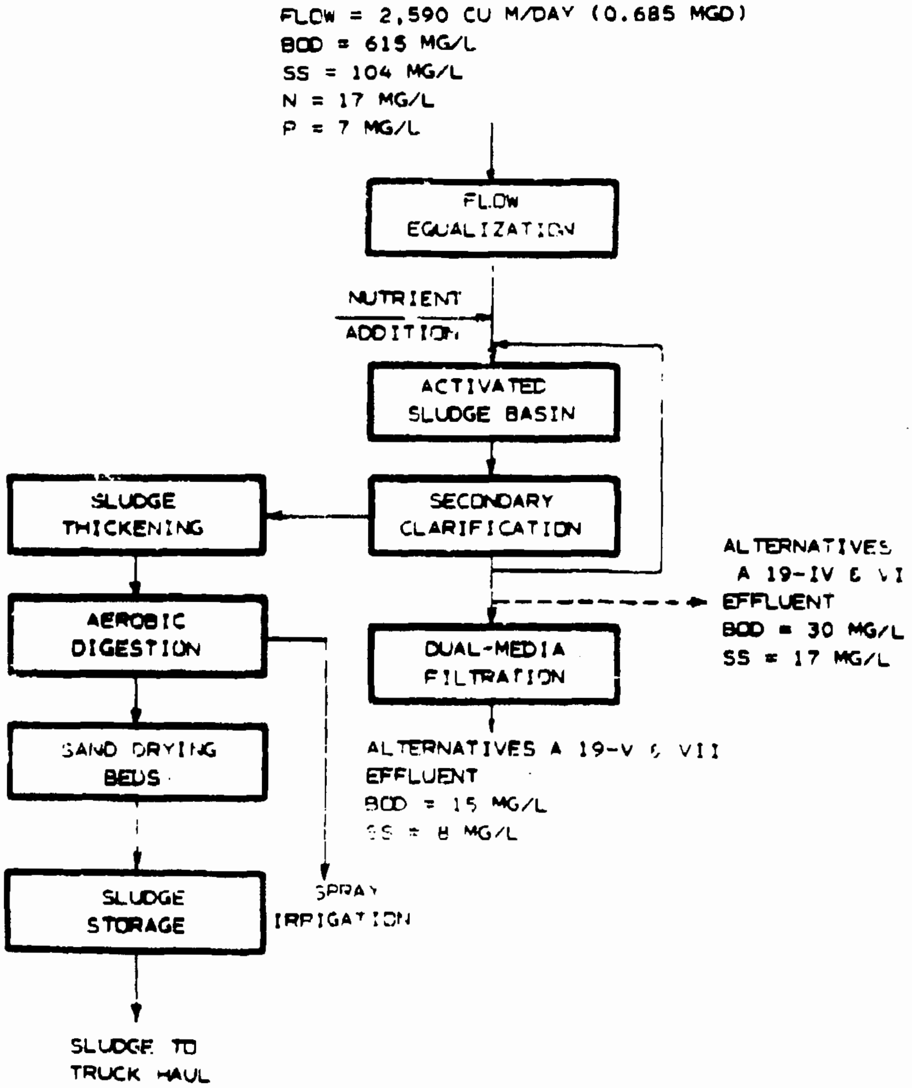


FIGURE 105

SUBCATEGORY A19
TREATMENT ALTERNATIVES IV THRU VII

settling ponds with dredging every five years. The predicted treated effluent concentrations are 30 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 19-II is a BOD reduction of 95.2 percent and a suspended solids reduction of 83.1 percent.

Alternative A 19 - III - This alternative consists of adding dual media filtration to the treatment chain in Alternative A 19-II. The predicted treated effluent concentrations are 15 mg/l BOD and 8 mg/l suspended solids. The overall effect of Alternative A 19-III is a reduction of 97.6 percent

Alternative A 19 - IV - This alternative consists of a control house, pumping station, flow equalization, nutrient addition in the form of 43.24 kg/day (95.32 lb/day) anhydrous ammonia, a complete mix activated sludge system, sludge thickening, aerobic digestion, and spray irrigation. The predicted treated effluent concentrations are 30 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 19-IV is a reduction of 95.2 percent of the BOD and 83.1 percent of the suspended solids.

Alternative A 19 - V - This alternative consists of adding dual media filtration to the treatment chain in Alternative A 19-IV. The predicted treated effluent concentrations are 15 mg/l BOD and 8 mg/l suspended solids. The overall effect of Alternative A 19-V is 96.6 percent BOD reduction and 92.2 suspended solids reduction.

Alternative A 19 - VI - This alternative replaces spray irrigation of sludge in Alternative A 19-IV with sandbed drying and truck hauling. The predicted treated effluent concentrations are 30 mg/l BOD and 17 mg/l suspended solids. The overall effect of Alternative A 19-VI is a reduction of 95.2 percent of the BOD and 83.1 percent of the suspended solids.

Alternative A 19 - VII - This alternative adds dual media filtration to the treatment chain in Alternative A 19-VI. The predicted treated effluent concentrations are 5 mg/l BOD and 8 mg/l suspended solids. The overall effect of Alternative A 19-VII is a reduction of 95.2 percent for BOD and a reduction of 92.2 percent for suspended solids.

SUBCATEGORY A 20 - WINERIES WITHOUT STILLS

In-Plant Technology

As described in Section V, stems, pressed pomace, and filter aid are assumed to be separated from wastewater to be sent to treatment facilities. If these are properly disposed, the lees from racking represent the greatest potential source of high strength waste. If tanks are fully drained and lees passed through filter presses or centrifuges, little waste results. If lees are sewered, the strength of the waste will change appreciably. Separate water meters should be installed in all major departments of the winery such as crushing, fermentation, pressing and bottling. By accurately identifying water usage, both reduction procedures and future planning will be benefited.

Water pressure regulators and pressure nozzles may also be used to reduce the quantity of water used for cleanup. Sweeping rather than, or prior to, hosing down floors may be applicable in some areas of the winery. Reused water from tank cleaning may be used as makeup wash water for other nearby tanks. Blowdown from water-cooled refrigeration units may also be reused. Wastewater which is not suitable for in-plant reuse may be suitable for such areas as lawn and landscaping, vineyard frost protection, vineyard irrigation, and vineyard heat protection.

End-of-Line Technology

As described in Section V the effluent from wineries in this subcategory is a medium to high strength organic waste deficient in nitrogen and phosphorus. It is amenable to treatment by a number of alternatives including aerated lagoons, biological discs, activated sludge, and land irrigation. During the course of this study six wineries with treatment systems were visited. Figures 186 through 191 show a block diagram of each of these systems.

Plant 84*10 utilizes four ponds, each of 5700 cu m (1.5 MG) volume with a total aeration capacity of 27 kw (36 hp). According to Ryder (111) average effluent concentrations were 22 mg/l BOD and 29 mg/l suspended solids in March 1973. The treated effluent is utilized to irrigate approximately 6 ha (15 ac) of landscaped areas adjacent to the winery. A similar system operated by the same company has achieved BOD removal rates of 97.2 percent. Plant 84*09 has recently completed construction of a two lagoon system as shown in Figure (187). The effluent from this system will also be used for winery irrigation. Tofflemire, et al (112) reports that the dual lagoon system as it was originally constructed at Plant 84*03 achieved a BOD removal of 96 percent. According to Rice (113) BOD removal remained between 94.7 and 95.6 percent from 1971 through 1974. Suspended solids levels in the aerated lagoon remained high due to bacterial and algal growths. In general, lagoon systems perform well with winery waste when sufficient land is available. Little supervision is required and large volumes of water act as a buffer for fluctuations in pH and waste concentrations.

Two activated sludge systems are being used to treat winery waste exclusively. Figures (188) and (189) show block diagrams of each system. Annual operating efficiencies are as follows:

	Plant 84A01	Plant 84A03
BOD Removal	97.3	97.6
Suspended Solids Removal	89.5	66.5

DRAFT

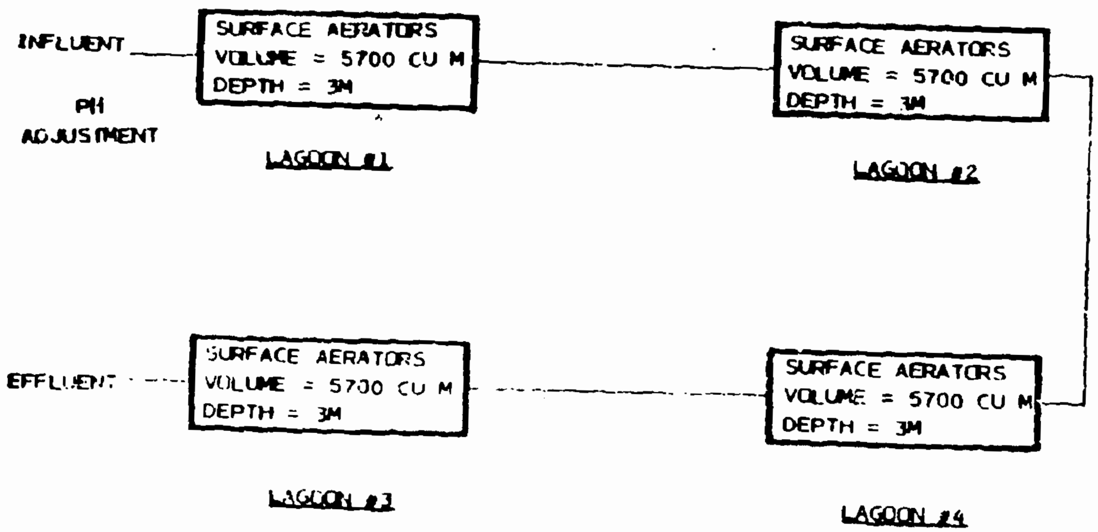


FIGURE 186

CONTROL AND TREATMENT
PLANT 84*10

DRAFT

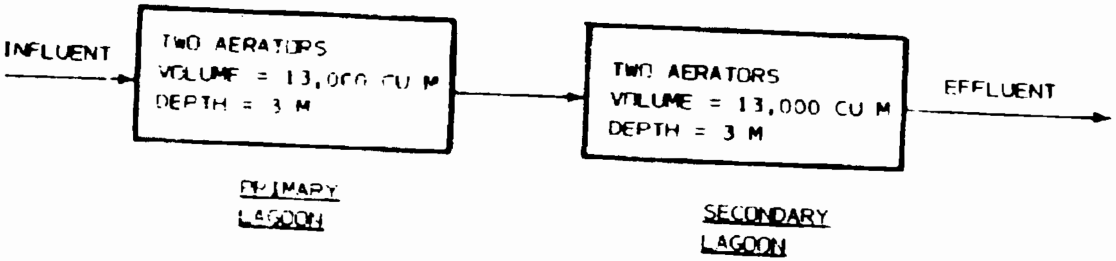


FIGURE 187

CONTROL AND TREATMENT PLANT 84*09

DRAFT

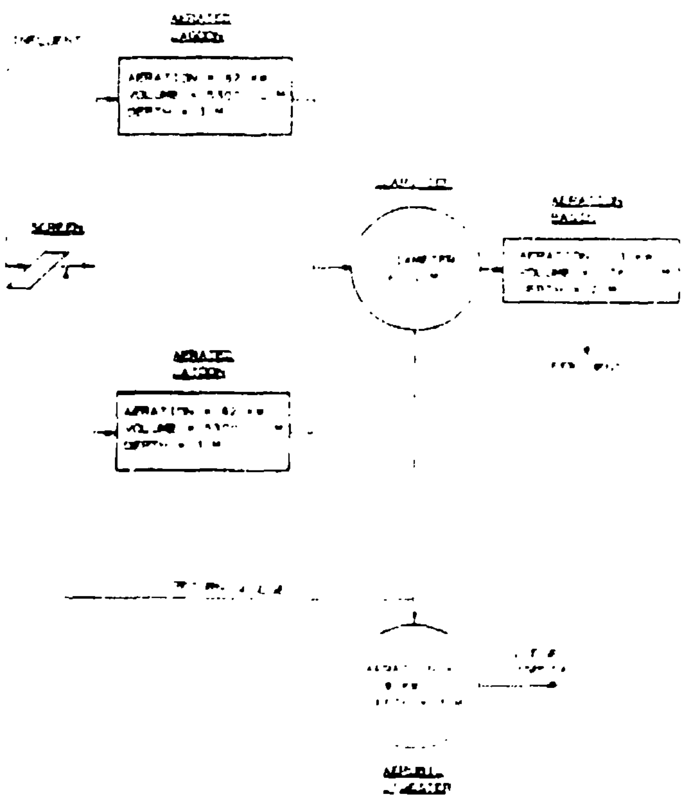


FIGURE 188

CONTROL AND [illegible] PLANT [illegible]

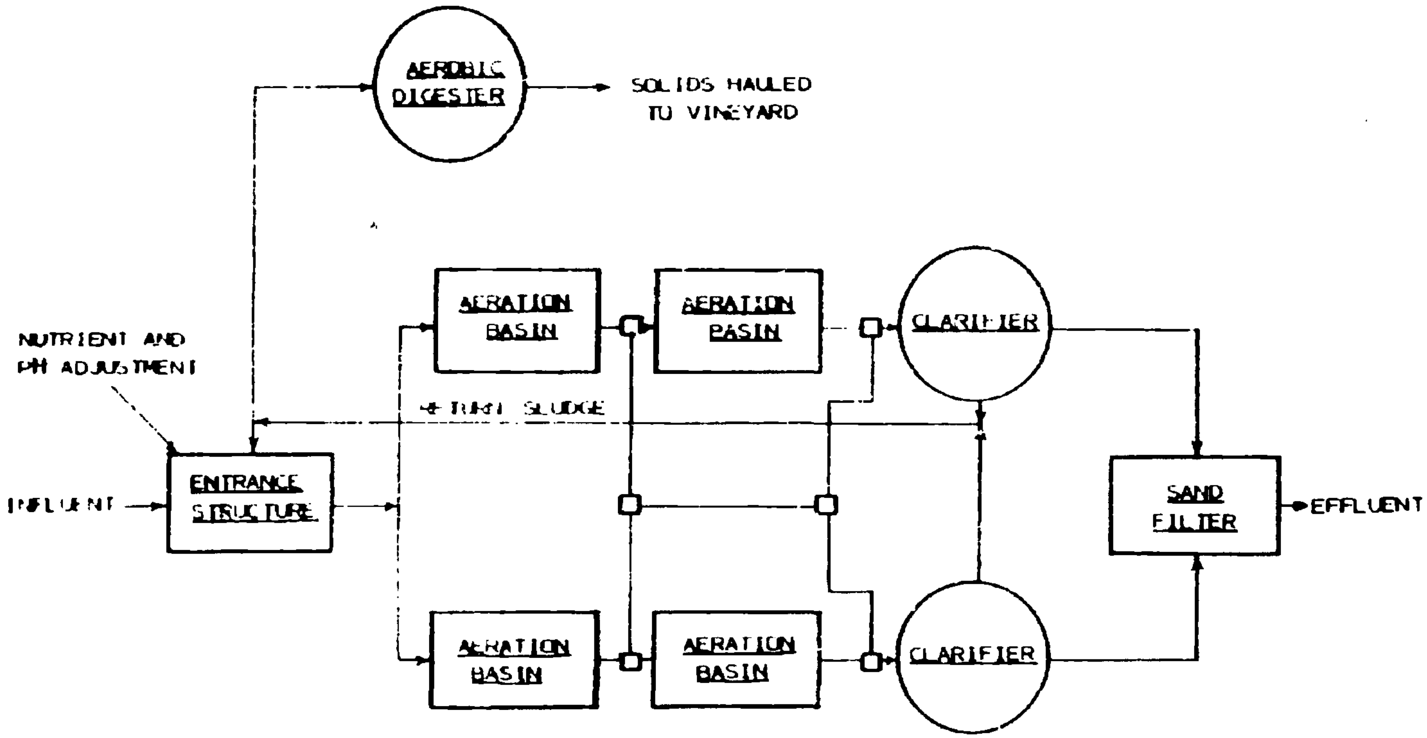


FIGURE 165

CONTROL AND TREATMENT

PLANT 8401

DRAFT

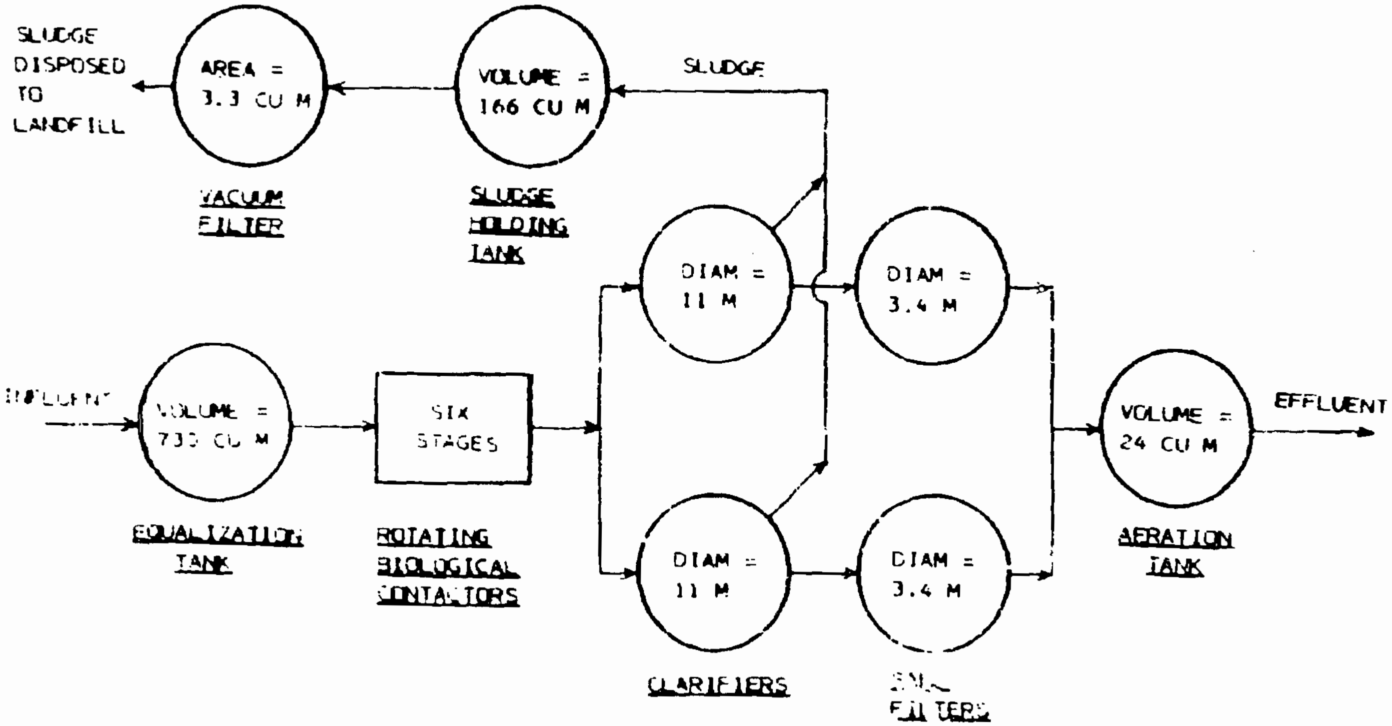


FIGURE 190

CONTROL AND TREATMENT
PLANT 84*02

DRAFT

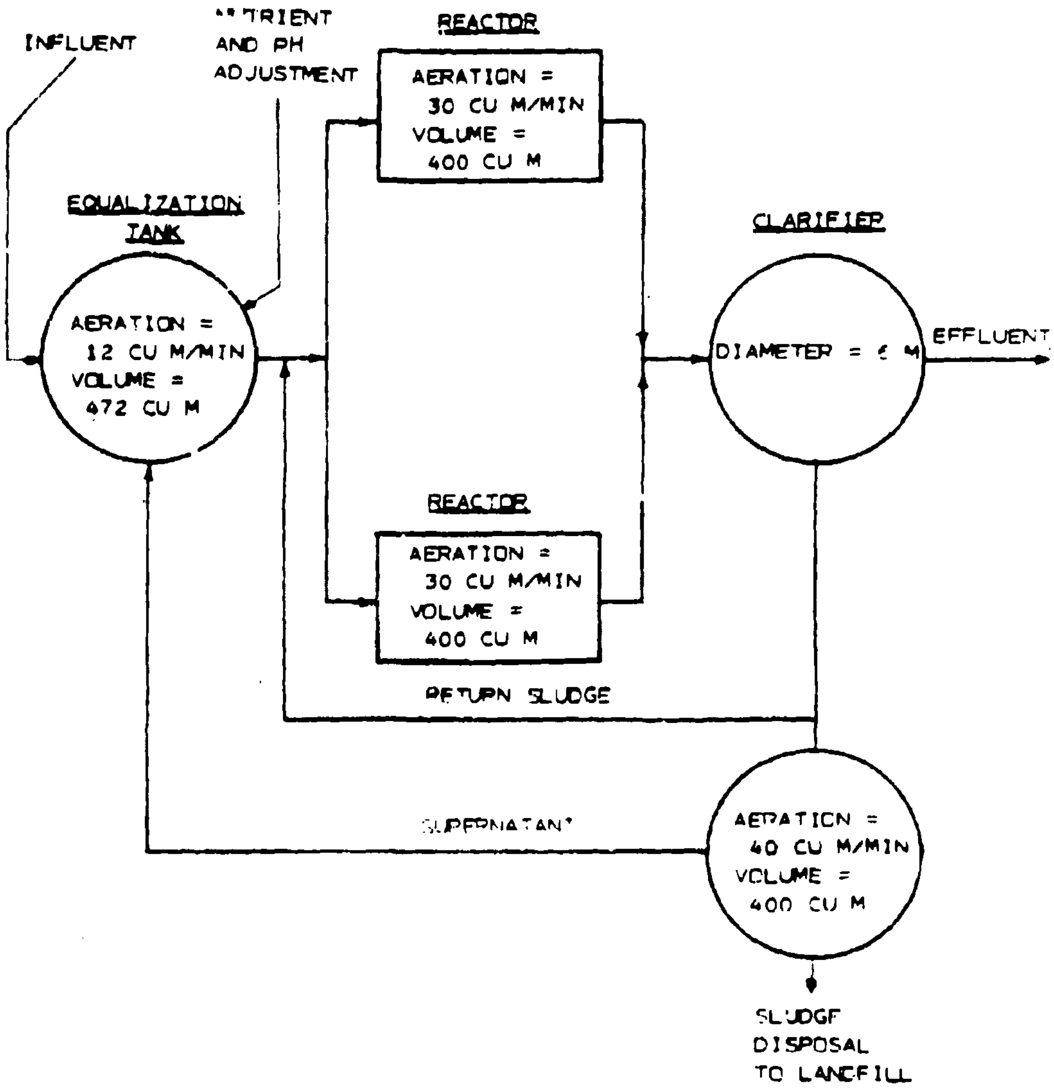


FIGURE 191

CONTROL AND TREATMENT PLANT 84*04

On a short term basis, considerably higher suspended solids removals have been achieved by Plant 84A03. Tertiary treatment by sand filtration at Plant 84A01 has not achieved the predicted 50 percent reduction, hence suspended solids removal is also somewhat lower than expected. Both plants provide aerobic digestion for sludge, although infrequent wasting of activated sludge has been required. Close operational control of pH is required, especially at Plant 84A01 where the aeration volume of 2360 cu m (624,000 gal) is relatively small.

A rotating biological disc has been used at Plant 84*02. A flow diagram of the complete system is shown in Figure 190. The original pilot plant study (114) indicated a BOD removal of 95 percent at a loading rate of 2.8 l (0.75 gal) per day. Data collected during this study indicated BOD and suspended solids removals at 93.0 and 56.1 percent, respectively. Once again, the low level of suspended solids removal is due to the poor operation of the sand filter; in many cases solids were increased by filtration.

Several wineries in this subcategory discharge treated waste to irrigation systems. Due to climate and soil permeability, this method of disposal is almost exlcusively practiced in California. A further discussion is included in Subcategory 21 for those wineries disposing stillage by intermittent irrigation.

Selection of Control and Treatment Technology

In Section V a model plant was developed for the manufacturing of wine in wineries not utilizing stills. It was assumed that the model plant provided screening of its wastewater prior to discharge. The raw wastewater characteristics after screening were assumed to be as follows:

	Crushing Season	Processing Season
Flow	0.073 MGD	0.060 MGD
BOD	2300 mg/l	1200 mg/l
SS	760 mg/l	420 mg/l
P	13 mg/l	7 mg/l
Total N	7 mg/l	4 mg/l

Due to the fact that larger flow and pollutant loadings are generated during the crushing season, the treatment system designs are based on the crushing season values presented above. Tables 117 (Crushing Season) and 118 (Processing Season) list the pollutant effluent loading and the estimated operating efficiency of each of the ten treatment alternatives selected for this subcategory. It should be noted that the pollutant concentrations in the treated effluent remain the same during the crushing and processing season. The treatment alternatives presented below are illustrated in Figures 192 and 193.

DRAFT

TABLE 117

SUMMARY OF TREATMENT TRAIN ALTERNATIVES - SUBCATEGORY A 20 WINERIES (CRUSHING SEASON)

Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent BOD removed	Percent SS removed
A 20-I	3.57	1.16	0	0
A 20-II	0.77	0.115	97.8	90.1
A 20-III	0.38	0.054	98.9	95.3
A 20-IV	0.23	0.031	99.4	97.3
A 20-V	0.77	0.115	97.8	90.1
A 20-VI	0.38	0.054	98.9	95.3
A 20-VII	0.23	0.031	99.4	97.3
A 20-VIII	0.77	0.115	97.8	90.1
A 20-IX	0.38	0.054	98.9	95.3
A 20-X	0.23	0.031	99.4	97.3

TABLE 118

SUMMARY OF TREATMENT TRAIN ALTERNATIVES - SUBCATEGORY A 20 WINERIES (NON-CRUSHING SEASON)

DRAFT

Alternative	Effluent BOD kg/cu m	Effluent SS kg/cu m	Percent BOD removed	Percent SS removed
A 20-I	6.63	2.33	0	0
A 20-II	0.277	0.415	95.8	82.2
A 20-III	0.138	0.194	97.9	91.7
A 20-IV	0.083	0.111	98.7	95.2
A 20-V	0.277	0.415	95.8	82.2
A 20-VI	0.138	0.194	97.9	91.7
A 20-VII	0.083	0.111	98.7	95.2
A 20-VIII	0.277	0.415	95.8	82.2
A 20-IX	0.138	0.194	97.9	91.7
A 20-X	0.083	0.111	98.7	95.2

INFLUENT
FLOW = 276 CU M/DAY (0.073 MGD)
BOD = 2,300 MG/L
SS = 760 MG/L
N = 7 MG/L
P = 13 MG/L

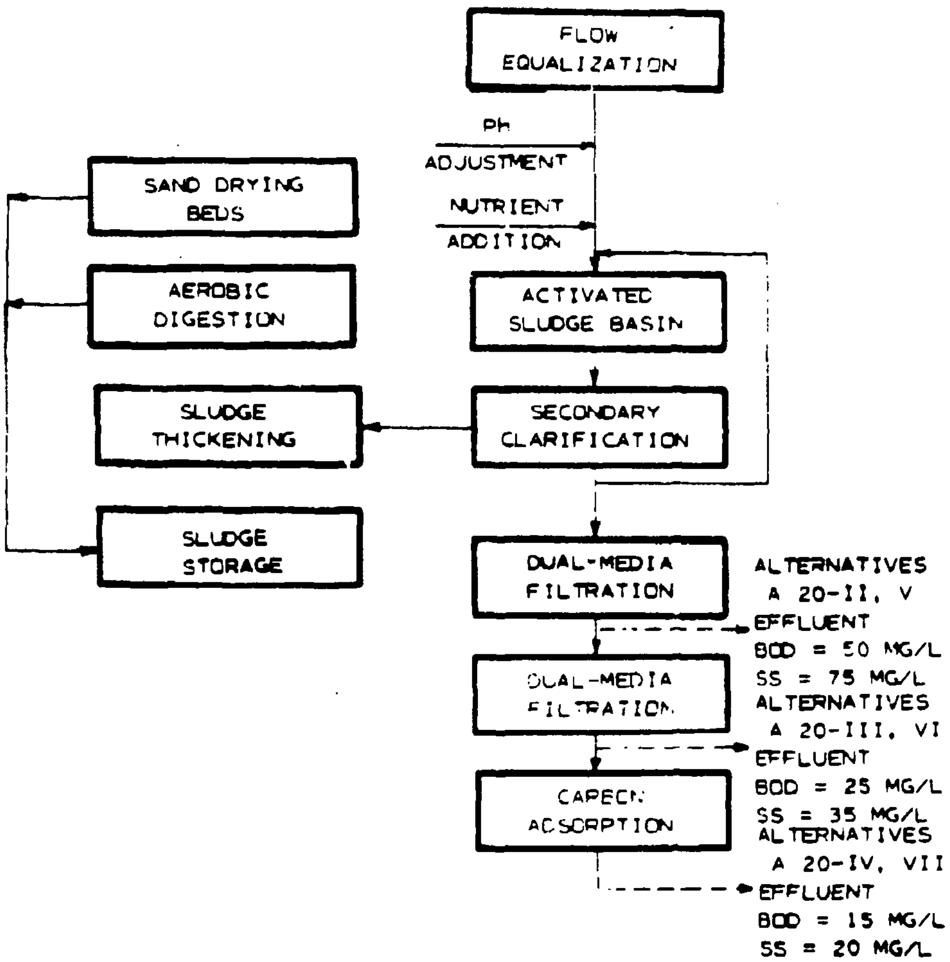


FIGURE 192

SUBCATEGORY A20
TREATMENT ALTERNATIVES II THRU VII

DRAFT

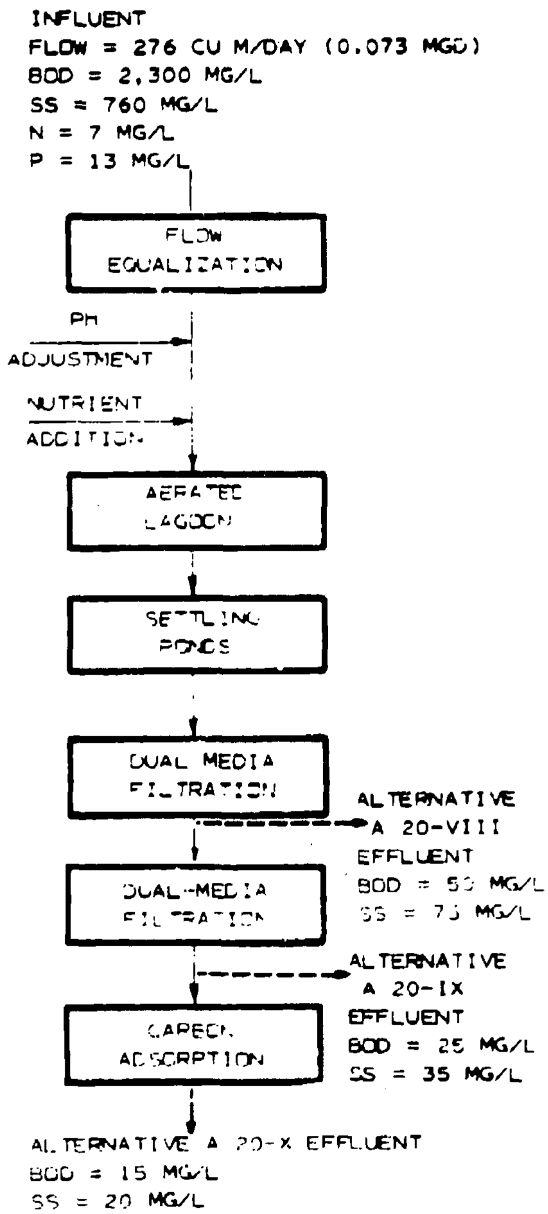


FIGURE 193

SUBCATEGORY A20
TREATMENT ALTERNATIVES VIII THRU X

Alternative A 20-I - This alternative provides no additional treatment to the screened wastewater.

Alternative A 20-II - This alternative consists of a control house, a pumping station, flow equalization, nutrient addition, acid and caustic neutralization, a complete-mix activated sludge system, sludge thickening, aerobic digestion, dual media filtration, a sludge holding tank and spray irrigation of digestor sludge. Flow equalization is provided to dampen the effect of shock loadings to the activated sludge system. Nitrogen and phosphorus addition is provided to increase the deficient raw wastewater BOD:N:P ratio of 100:0.3:0.57 to the required 100:5:1. Both acid and caustic neutralization are provided to accommodate the model plants pH range of 4.0 to 10.0. The combined efficiency of the activated sludge system and dual media filtration module is estimated at 97.8 percent during the crushing season and 95.8 percent during the processing season. Sludge thickening and aerobic digestion are provided to decrease the volume of sludge which is subsequently spray irrigated.

The overall benefit of this alternative is a BOD reduction of 97.8 percent and a suspended solids reduction of 90.1 percent during the crushing season and 95.8 and 82.2 percent respectively during the processing season.

Alternative A 20-III - This alternative is identical to Alternative A 20-II except an additional dual media filtration module is provided to further reduce the effluent BOD and suspended solids loadings.

The overall effect of this alternative is a BOD reduction of 98.9 percent a suspended solids reduction of 95.3 percent during the crushing season and 97.9 and 91.7 percent, respectively, during the processing season.

Alternative A 20-IV - This alternative is identical to Alternative A 20-III with the addition of activated carbon adsorption to further reduce the effluent BOD and suspended solids loadings.

The overall benefit of this alternative is a BOD reduction of 99.4 percent and a suspended solids reduction of 97.3 percent during crushing season and 98.7 and 95.2 percent, respectively, during the processing season.

Alternative A 20-V - This alternative replaces the spray irrigation of digestor sludge in Alternative A 20-II with sand drying beds. The overall benefit of this alternative is a BOD reduction of 97.8 percent and a suspended solids reduction of 90.1 percent during the crushing season and 95.8 and 82.2 percent, respectively, during the processing season.

DRAFT

Alternative A 20-VI - This alternative is identical to Alternative A20-V with the addition of dual media filtration. The overall benefit of this alternative is a BOD reduction of 98.9 percent and a suspended solids reduction of 95.3 percent during crushing season and 97.9 and 91.7 percent, respectively, during processing season.

Alternative A 20-VII - This alternative is identical to Alternative A 20-VI with the addition of activated carbon adsorption.

The overall benefit of this alternative is a BOD reduction of 99.4 percent and a suspended solids reduction of 97.3 percent during crushing season and 98.7 and 95.2 percent, respectively, during processing season.

Alternative A 20-VIII - This alternative consists of a pumping station, flow equalization, nutrient addition, acid and caustic neutralization, aerated lagoons, stabilization ponds, and dual media filtration. Flow equalization, nutrient addition and neutralization provide the same benefits as previously discussed in Alternative A 20-II. The aerated lagoon and dual media filter would be expected to provide the same treatment efficiency as the activated sludge system and dual media filtration module of Alternatives A 20-II and A 20-V.

The overall benefit of this alternative is a BOD reduction of 97.8 percent and a suspended solids reduction of 90.1 percent during crushing season and 95.8 and 82.2 percent, respectively, during processing season.

Alternative A 20-IX - This alternative is identical to Alternative A 20-VIII with the addition of a second dual media filtration module.

The overall benefit of this alternative is a BOD reduction of 98.9 percent and a suspended solids reduction of 95.3 percent during crushing season and 97.9 and 91.7 percent, respectively, during processing season.

Alternative A 20-X - This alternative is identical to Alternative A 20-IX with the addition of activated carbon adsorption

The overall benefit of this alternative is a BOD reduction of 99.4 percent and a suspended solids reduction of 97.3 percent during crushing season and 98.7 and 95.2 percent, respectively, during processing season.

SUBCATEGORY A 21 - WINERIES WITH STILLS

In-Plant Technology

During the processing season the same methods of in-plant reduction are applicable for this subcategory as for wineries without stills.

During crushing, however, stillage disposal requires additional methods of conservation.

Physical Methods - The volume of the stillage may be reduced 15 percent by using indirect heat rather than live steam in the still. In addition, the amount of water used in the preparation of distilling material will have a direct effect on the total volume of stillage. The Coast Laboratories (115) recommended maintaining distilling material at eight percent alcohol by volume in order to reduce distilling and handling costs. In a separate report (116) the following methods of separating solids from stillage were investigated:

1. Settling by gravity
2. Filtration
3. Screening
4. Centrifuging
5. Flocculation by chemicals

Centrifuging and screening were proven to be the most effective and all wineries were advised to use one of these two types of mechanical separators.

Chemical Methods - Solids removal by chemical means has been investigated by Vaughn and Marsh (117) and Schroeder (118). Liming causes the suspended solids and colloidal material to settle as a sludge. This treatment precipitates the tartrates and reduces the BOD by 50 percent, although dewatering the sludge may be difficult. Tofflemire (119) indicates, however that this problem can be overcome. Detartration, coagulation, and flocculation with polyelectrolyte addition were all considered to be less effective than centrifugation.

End-of-Line Technology

In consideration of the seasonal nature of stillage wastes, the location, climate, and soil of wineries discharging stillage, and the lack of any demonstrated cost effective alternative, it is considered that waste disposal by intermittant irrigation is a satisfactory method of treatment provided no ground water contamination occurs.

Intermittent Irrigation - The recommended methods for the disposal of winery stillage by intermittent irrigation is described in detail by the Coast Laboratories (114, 115, 120, 121, 122, 123). Basically the system is as follows: conventional stillage is pumped to a series of "checks" at loading rates of 935,000 l/day/ha (100,000 gpd/ac). The liquid, which should accumulate to no more than 10 cm (4 in.) in depth, is allowed topercolate and evaporate until a cake forms and breaks into small pieces. The plot is then disced and leveled for reuse approximately 7 to 10 days after the initial loading.

Studies by York (124, 125, 126) indicate that intermittent irrigation has no deleterious effect on the soil as measured by salt content, nitrate concentration, and soil clogging, imperviousness, and impacting. A study by the City of Fresno, California (127) indicates that some degradation of well water exists, but that this may be controlled by proper measures, i.e., control of nitrate leaching by elimination of ammonia, removing leathers, and nitrogen-harvesting of winter crops.

Anaerobic treatment of wine stillage appears to be feasible, although further treatment would be required. Stander (128) experimented with a clarigester with 7.2 days detention time. The system resulted in a COD removal of 96 percent. Tofflemire (119) noted, however, that ammonia in the digester would cause an additional oxygen demand in the receiving water. Chadwick and Schroeder (129) studied both aerobic and anaerobic treatment of settled stillage on a pilot plant scale. Effluent of 1,100 to 2,500 mg/l of COD, which appeared to be nonbiodegradable, existed after treatment. Schroeder (118) suggested that centrifugation followed by two aerated lagoons and a stabilization pond in series will produce effluents of 75 mg/l BOD, but noted that biological treatment will not substantially alter the salt content of the wastewater. Since the resultant wastewater will probably be used for irrigation, direct land disposal by intermittent irrigation is a more cost-effective method of disposal.

Selection of Control and Treatment Technology

In Section V a model plant was developed for wineries with stills. The raw waste volume due to crushing and distilling was assumed to be 1680 cu m (0.443 MGD). The operating efficiency of the treatment chain selected for this subcategory is 100 percent BOD and suspended solids removal.

Alternative A 21-I - This alternative provides no additional treatment to the raw waste.

Alternative A 21-II - This alternative consists of a holding tank pumping station, 2.3 km of pipeline, and land at 4,100/ha ($1,660/acre). The total flow is applied at a rate of 935 cu m/week/ha (100,000 gal/week/acre). Leveling and discing are assumed to cost $412/year/ha ($166/year/acre).

SUBCATEGORY A 22 - GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS

The discussion in this section applies to both Subcategory A 22 and Subcategory A 23 (except for evaporation).

In-Plant Technology

As described in Section V, many plants operate barometric condenser systems for mash cookers, mash coolers, and evaporators and, as reported by plants 85A01 and 85A29, this can amount to as much as 28 percent of the total BOD load. By replacing the barometric condensers with surface condensers this load can be eliminated from the system. This water may then be recycled for other in-plant uses.

DRAFT

Since the evaporator condensate contributes a majority of the total plant waste, any possible reductions in this area should not be overlooked. Added instrumentation for automatic operation of evaporators will tend to reduce the load. Replacing worn out evaporator sections wtih newer designs will also reduce the waste. The load to the evaporator can be reduced by using spent stillage as a sterilizing medium and by using indirect heating rather than live steam in the still.

Water usage can be considerably reduced by recycling non-contact waters. Many plants have, of course, already made such changes. Mash cooling water, still condenser water, and refrigeration condenser water are all suitable quality for other in-plant uses.

End-of-Line Technology

Grain distillery wastewater treatment encompasses a wide range of biological processes. These include aeration lagoon, trickling filter, and activated sludge systems. During the course of the study eleven of these systems were visited. Table 119 summarizes the type and efficiency of each of these systems. Figures 194 through 201 present flow diagrams for each of these systems.

Many plants operate variations of the aerated lagoon. Plants 82A02 and 82A22 both have one aerated lagoon and one stabilization pond. Although both systems had comprehensive effluent data, the influent was not regularly monitored. Both maintained approximately 30 days detention followed by chlorination (since sanitary sewage was present). Plants 85A04 and 85A05 employ as many as five lagoons in series to achieve as much as nine months detention. Plant 85A27 has installed submerged helical aerators. This treatment system was only receiving one-third the expected load during the period of 98.7 percent BOD removal. In general, BOD removals of 96 percent can be expected from these types of systems. Suspended solids removals are somewhat lower than expected due to the growth of algae in the stabilization ponds. Sand filtration has been demonstrated to improve suspended solids removals considerably in such cases.

Several activated sludge systems exist throughout the production spectrum in the industry. Plants 85A17 and 85A18 installed rock filters in 194[illegible]. These systems operated well into the mid-1960's when the filter media began to break down. At that time it was decided to upgrade the system by adding contact stabilization. Plant 85A07, Figure 197, operates a dual activated sludge system with sludge thickening. Considerable foaming was evident during visitation in the aeration basins and final clarifier. This was attributed to the fact that the plant did not practice caustic equalization after weekend cleanups. Figure 194 demonstrates the combined activated sludge--bio-disc system operated by plant 85A01. Tohmaas and Koehrsen (78) have compared the efficiencies of the two types of systems during different stages of operation. In general, the activated sludge process demonstrated advantages over the bio-disc based on economics, treatment performance, and ability to handle shock loads. Expected removals for activated sludge systems are 96 percent for BOD and 92 percent

DRAFT

TABLE 119

TREATMENT SYSTEM SUMMARY
SUBCATEGORY A22

PLANT	TREATMENT SYSTEM DESCRIPTION	PERCENT BOD	REMOVAL SS
85A01	Activated Sludge, Bio Disc.	97.5*	90.7*
85A02	Aerated Lagoon Stabilization Pond	87.0	75.7
85A04	Aerated Lagoon, Stabilization Ponds	93.3	84.4
85A05	Aerated Lagoon, Stabilization Ponds	93.3	73.8
85A07	Activated Sludge	91.9	82.8
85A15	Bio Disc.	----	----
85A17	Activated Sludge Contact Stabilization	35.6**	93.2
85A18	Activated Sludge, Contact Stabilization	96.6	94.3
85A22	Aerated Lagoon, Stabilization Pond	96.2	72.2
85A27	Aerated Lagoons	98.7	34.3
85A29	Aerated Lagoons, Trickling Filters, Stabilization Ponds	97.3	----

* Activated Sludge Portion
** Before Contact Stabilization Added

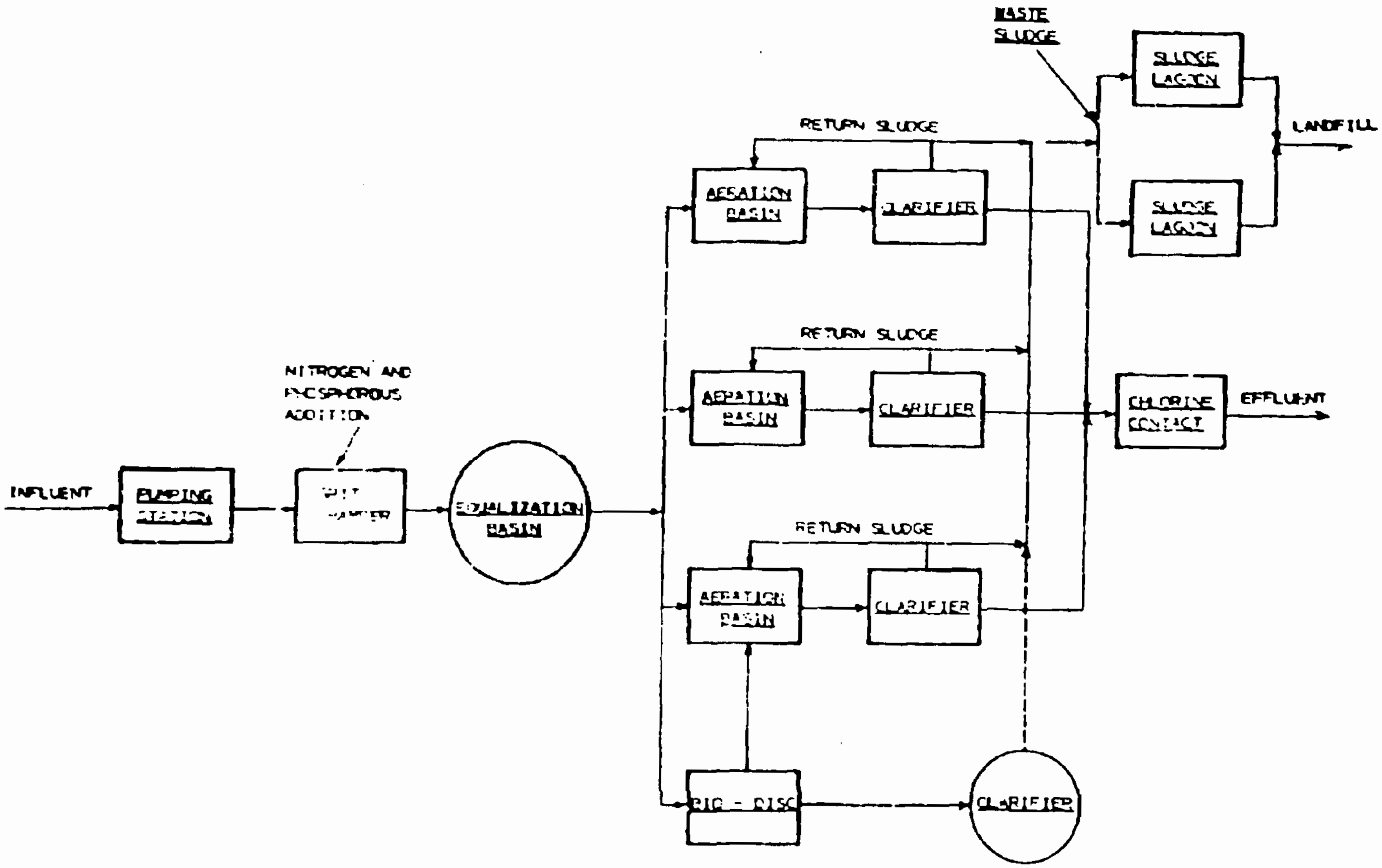


FIGURE 194

CONTROL AND TREATMENT

PLANT 85A01

DRAFT

DRAFT

G36

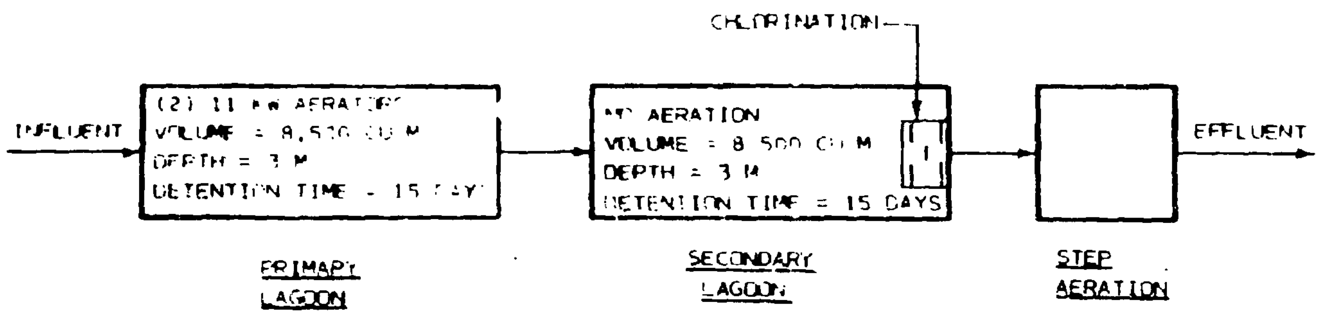


FIGURE 195

CONTROL AND TREATMENT

PLANT 85A02

DRAFT

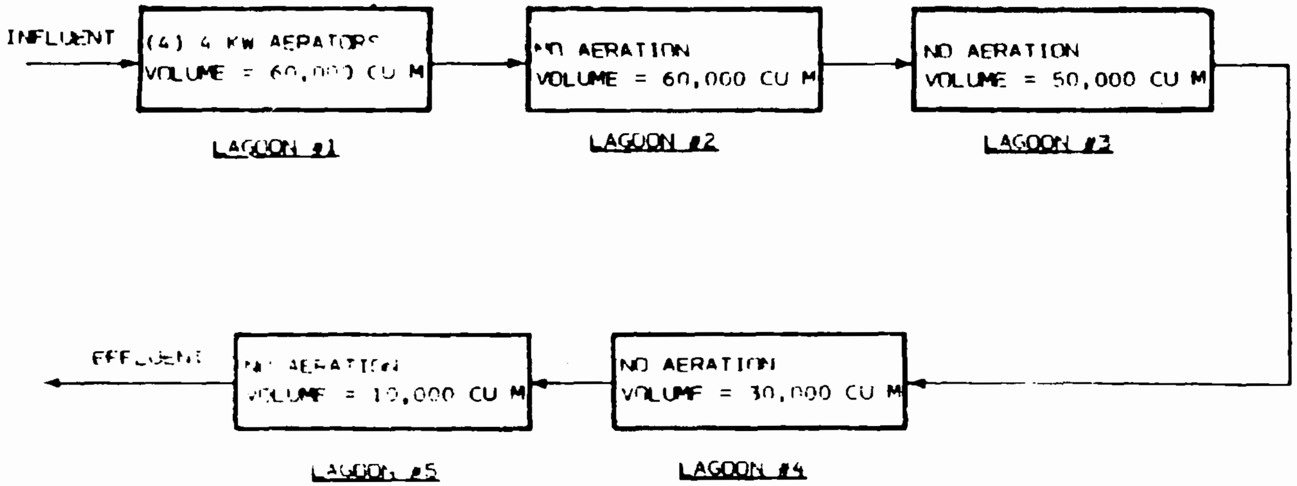


FIGURE 19b

CONTROL AND TREATMENT

PLANT 85A05

DRAFT

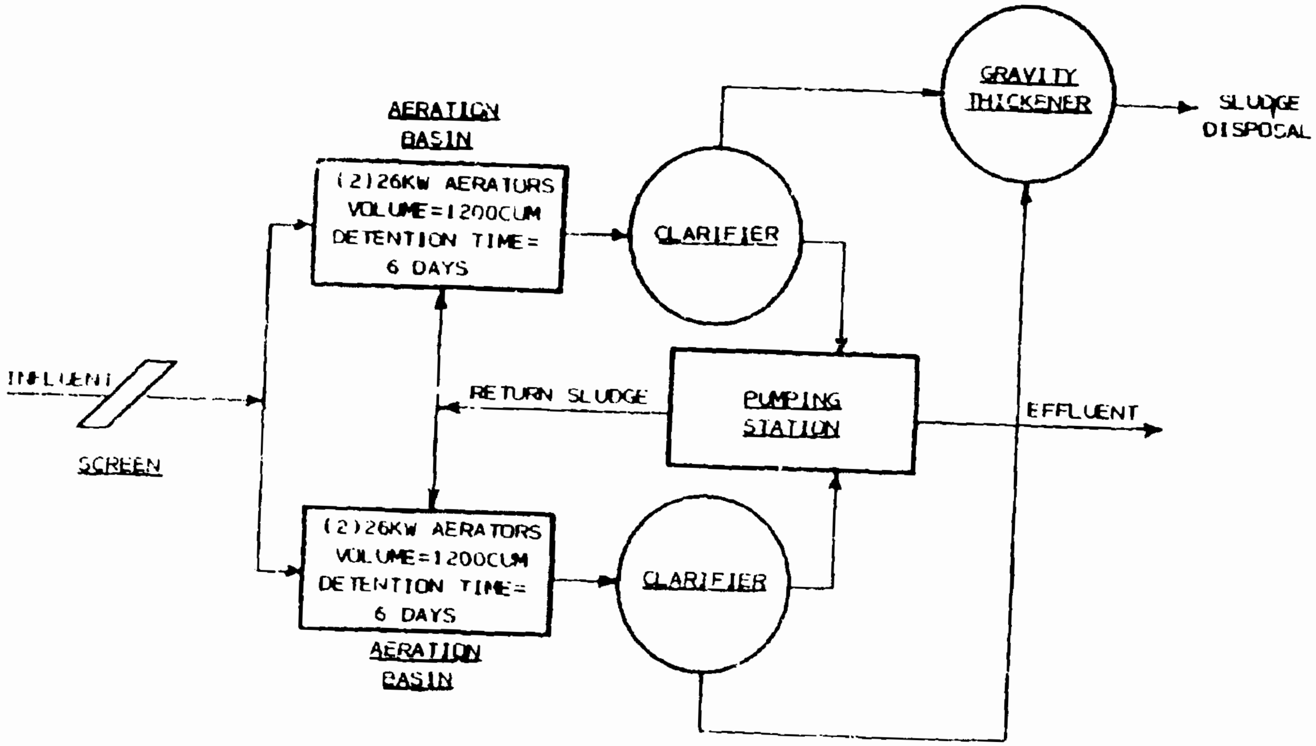


FIGURE 197

CONTROL AND TREATMENT
PLANT 85A07

DRAFT

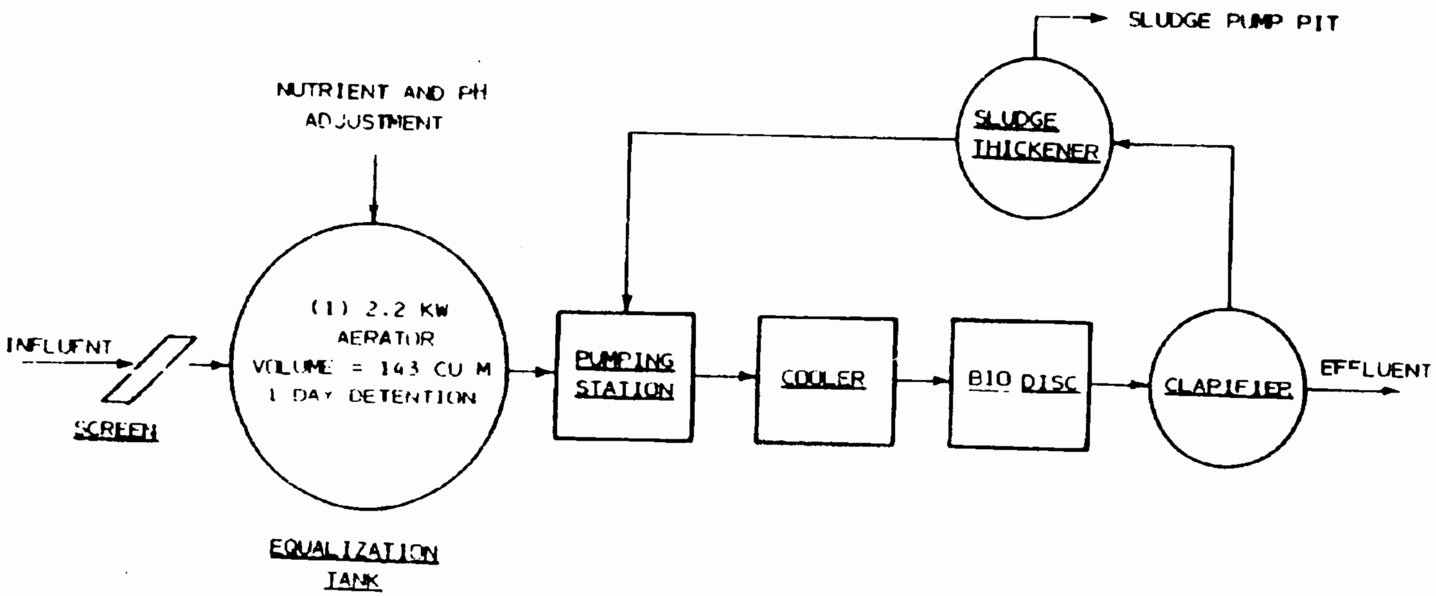


FIGURE 198

CONTROL AND TREATMENT
PLANT 85A15

DRAFT

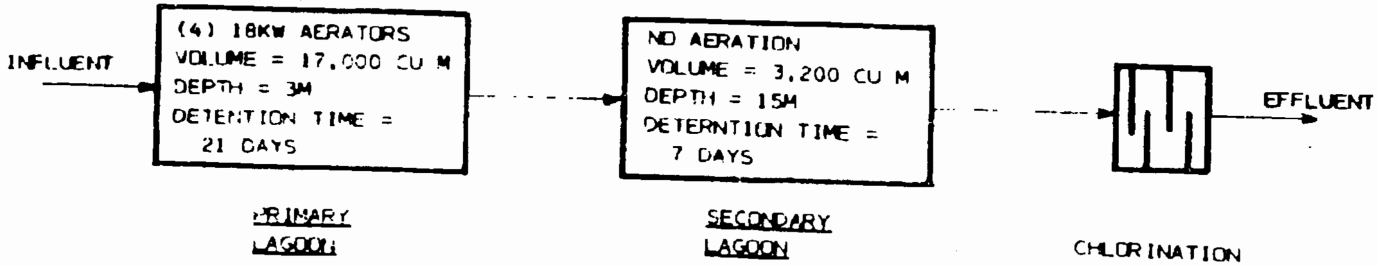


FIGURE 199

CONTROL AND TREATMENT
PLANT 85A22

DRAFT

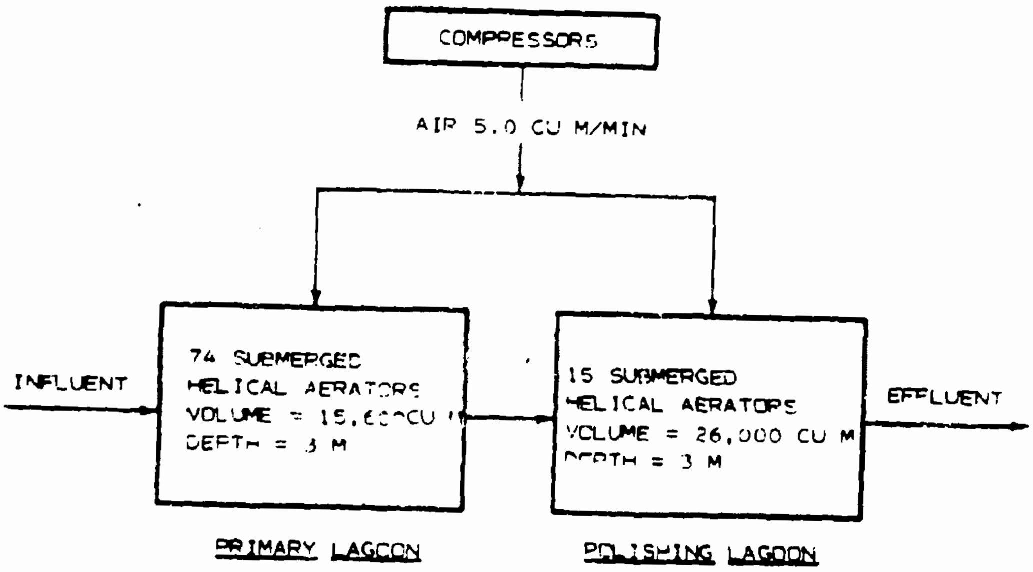


FIGURE 2.c

CONTROL AND TREATMENT

PLANT 85A27

for suspended solids. Nutrient addition will be required. With twenty-four hour flow equalization, pH variations are expected to be adequately buffered.. —

Selection of Control and Treatment Technology

Two model plants were developed in Section V for grain distillers operating stillage recovery systems. It is assumed that neither model plant provides treatment of its wastewater prior to discharge, but both provide screening of the effluent. The nine applicable alternatives discussed below are identical for model plants A22-A and A22-B which have the following wastewater characteristics:

Model Plant A22-A		Model Plant A22-B	
Production	380 kkg/day (15,000 bu/day)	Production	90 kkg/day (3,500 bu/day)
Flow	2500 cu m/day (0.650 MGD)	Flow	570 cu m/day (0.150 MGD)
BOD	930 mg/l	BOD	950 mg/l
SS	650 mg/l	SS	670 mg/l
Total KN	33 mg/l	Total KN	33 mg/l
Total P	3 mg/l	Total P	3 mg/l

Figures 202 and 203 present simplified flow diagrams for model plant A22-A treatment alternatives, and Figures 204 and 205 illustrate the identical treatment chains applicable to model plant A22-B. Tables 120 and 121 present calculated removal efficiencies for A22-A and A22-B treatment alternatives, respectively.

Alternative A 22-I - This alternative provides no additional treatment to either model plant. The removal efficiency is zero.

Alternative A 22-II - This alternative consists of a pumping station, diffused air flow equalization, nutrient addition, and aerated lagoons with settling ponds. The predicted effluent concentrations are 40 mg/l BOD and 50 mg/l suspended solids. The removal efficiency of alternative A 22-AII is 95.7 percent of the BOD, and 92.3 percent of the suspended solids.. Alternative A 22-BII removes 95.8 percent of the BOD and 92.5 percent of suspended solids.

Alternative A 22-III - This alternative adds dual media filtration to the treatment chain in Alternative A 22-II. The predicted effluent concentrations are 20 mg/l BOD and 20 mg/l suspended solids. The overall affect of Alternative A 22-AIII is a reduction of 97.8 percent of the BOD and 96.9 percent of the suspended solids. Alternative A 22-BIII removes 97.9 percent of the BOD and 96.3 percent of suspended solids.

Alternative A 22-IV - This alternative consists of a control house, pumping station, diffused air flow equalization, nutrient addition, a complete mix activated sludge system, sludge thickening, aerobic digestion, and sand drying beds. The predicted effluent concentrations are 40 mg/l

DRAFT

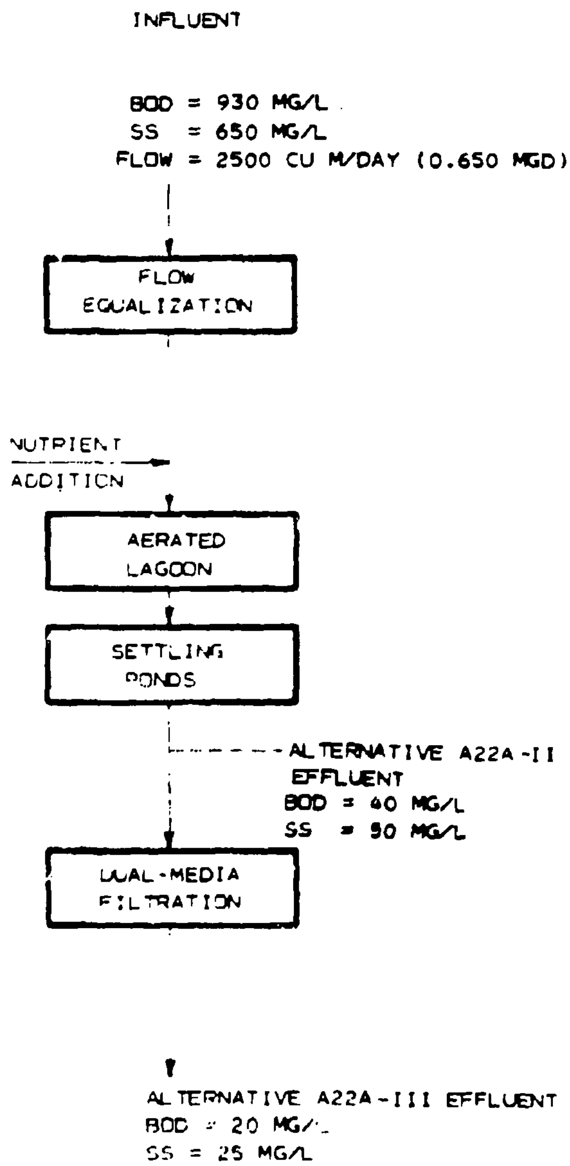


FIGURE 202

SUBCATEGORY A22A
TREATMENT ALTERNATIVES II THROUGH III

DRAFT

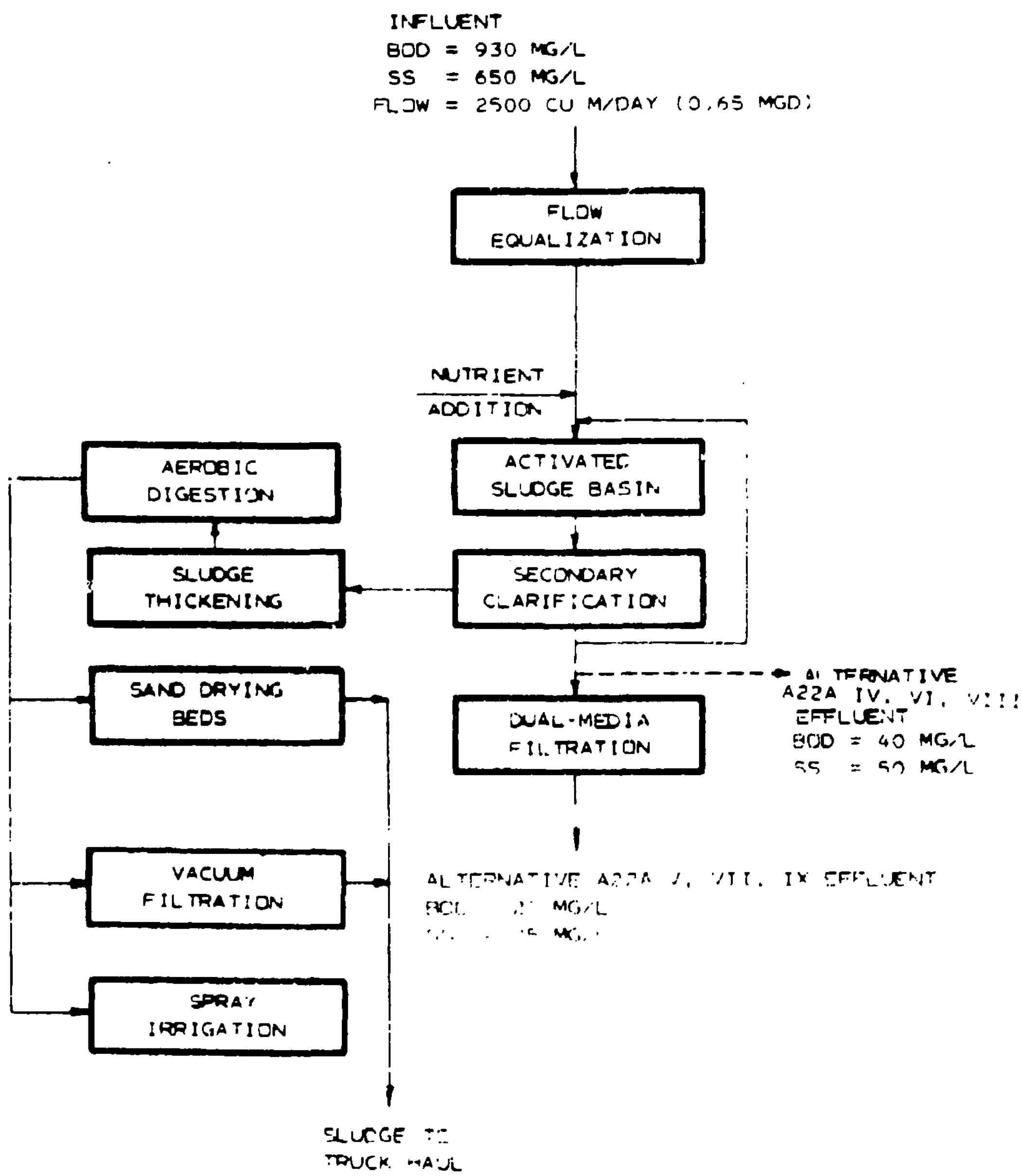


FIGURE 203

SUBCATEGORY A22A
TREATMENT ALTERNATIVES IV THROUGH IX

DRAFT

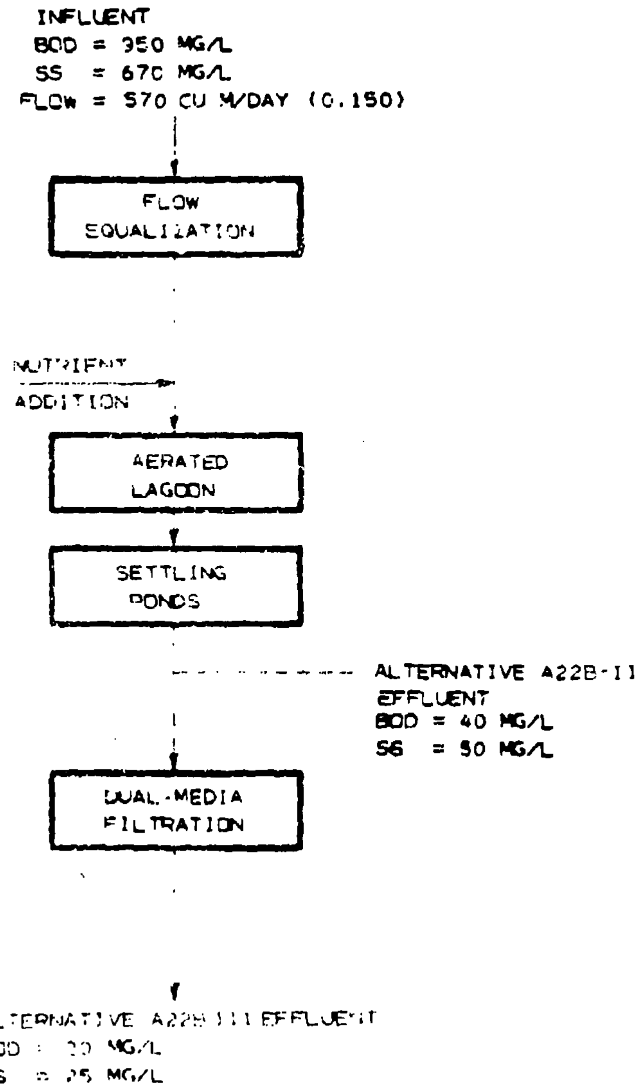


FIGURE 204

SUBCATEGORY A22B
TREATMENT ALTERNATIVES II THROUGH III

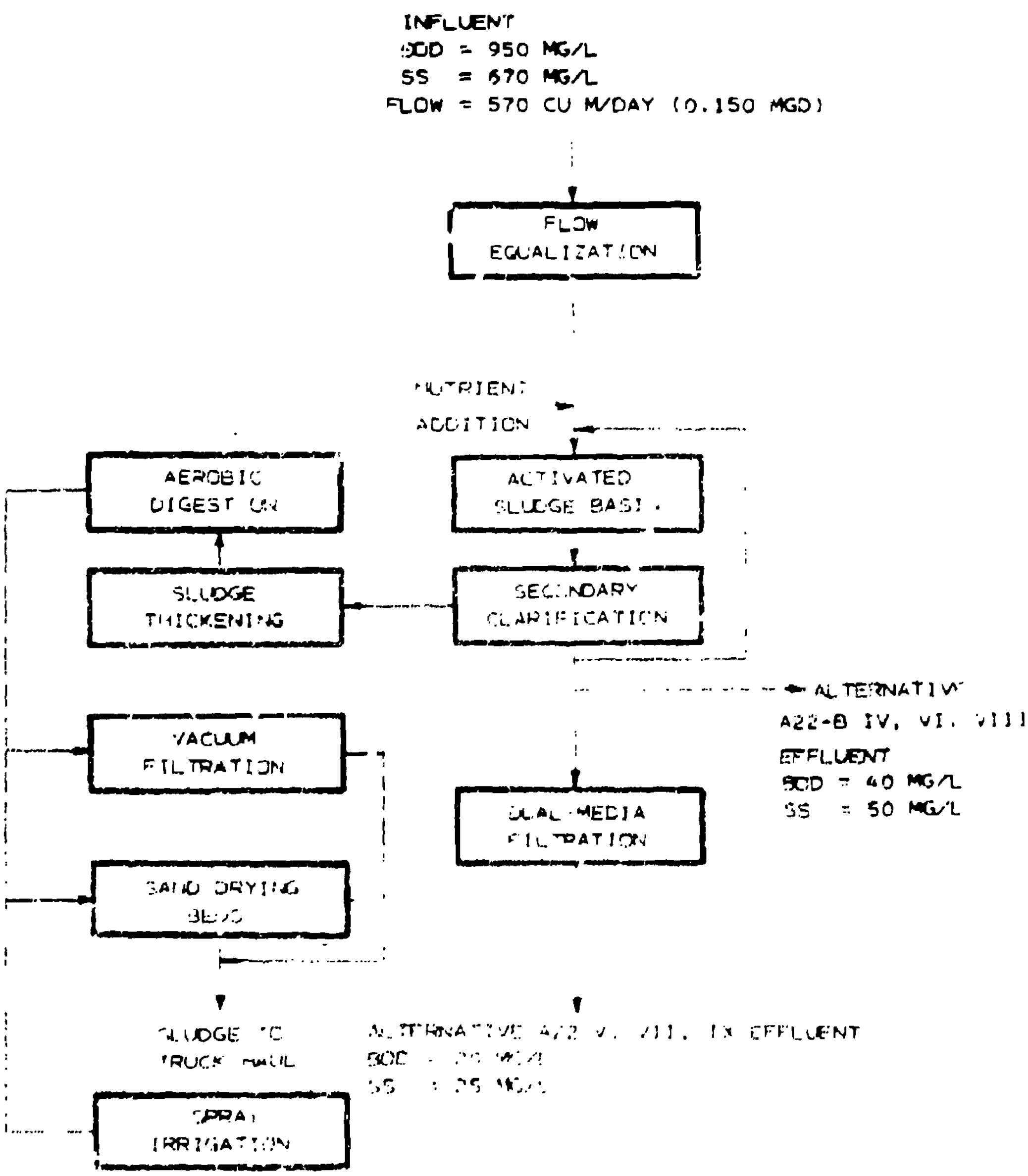


FIGURE 205

SUBCATEGORY A22B
TREATMENT ALTERNATIVES IV THROUGH IX

TABLE 120

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY A22A

Treatment Train Alternative	Effluent BOD (kg/kkg)	Effluent SS (kg/kkg)	Percent BOD Reduction	Percent SS Reduction
A 22A-I	6.02	4.21	0	0
A 22A-II	0.26	0.32	95.7	92.4
A 22A-III	0.13	0.16	97.8	96.2
A 22A-IV	0.26	0.32	95.7	92.4
A 22A-V	0.13	0.16	97.8	96.2
A 22A-VI	0.26	0.32	95.7	92.4
A 22A-VII	0.13	0.16	97.8	96.2
A 22A-VIII	0.26	0.32	95.7	92.4
A 22A-IX	0.13	0.16	97.8	96.2

TABLE 121

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY A22B

Treatment Train Alternative	Effluent BOD (kg/kkg)	Effluent SS (kg/kkg)	Percent BOD Reduction	Percent SS Removal
A 22B-I	5.99	4.23	0	0
A 22B-II	0.26	0.32	95.7	92.4
A 22B-III	0.13	0.16	97.9	96.2
A 22B-IV	0.26	0.32	95.7	92.4
A 22B-V	0.13	0.16	97.9	96.2
A 22B-VI	0.26	0.32	95.7	92.4
A 22B-VII	0.13	0.16	97.9	96.2
A 22B-VIII	0.26	0.32	95.7	92.4
A 22B-IX	0.13	0.16	97.9	96.2

BOD and 50 mg/l suspended solids. Alternative A 22-AIV is expected to remove 95.7 percent of BOD and 92.3 percent of suspended solids. The overall effect of Alternative A 22-BIV is a reduction of 95.8 percent of the BOD and 92.5 percent of the suspended solids.

Alternative A 22-V - This alternative provides in addition to Alternative A 22-IV a pumping station and dual media filtration.. The predicted effluent concentrations are 20 mg/l BOD and 25 mg/l suspended solids. Alternative A 22-AV removes 97.8 percent of the BOD and 96.9 percent of the suspended solids. Alternative A 22-BV removes 97.9 percent of the BOD and 96.3 percent of the suspended solids.

Alternative A 22-VI - This alternative replaces sand drying beds in Alternative A 22-IV with vacuum filtration and truck hauling or sludge. The predicted effluent concentrations are 40 mg/l BOD and 50 mg/l suspended solids. The overall effect of Alternative A 22-AVI is a reduction of 95.7 percent of BOD and 92.3 percent of suspended solids. The overall effect of Alternative A 22-BVI is a reduction of 95.8 percent of the BOD and 92.5 percent of the suspended solids.

Alternative A 22-VII - This alternative adds a pumping station and dual media filtration to Alternative A 22-VI. The predicted effluent concentrations are 20 mg/l BOD and 25 mg/l suspended solids. The overall effect of Alternative A 22-AVII is a reduction of 97.8 percent of BOD and 96.9 percent of suspended solids. Alternative A 22-BVII removes 97.9 percent of the BOD and 96.3 percent of the suspended solids.

Alternative A 22-VIII - This alternative replaces sand drying beds in Alternative A 22-IV with spray irrigation of the sludge. The predicted effluent concentrations are 40 mg/l BOD and 50 mg/l suspended solids. The overall effect of Alternative A 22-AVIII is a reduction of 95.7 percent of the BOD and 92.3 percent of the suspended solids. The overall effect of Alternative A 22-BVIII is a reduction of 95.8 percent of the BOD and 92.5 percent of the suspended solids.

Alternative A 22-IX - This alternative adds dual media filtration to Alternative A 22-VIII. The predicted effluent concentrations are 20 mg/l BOD and 25 mg/l suspended solids. Alternative A 22-AIX results in 97.[illegible] percent reduction of BOD and 96.9 percent reduction of suspended solids. Alternative A 22-BIX removes 97.9 percent of the BOD and 96.3 percent of the suspended solids.

SUBCATEGORY A 23 - GRAIN DISTILLERS

In-Plant Technology

No plants in this subcategory operate evaporator systems. Atmospheric cooling is more common than pressure cooking, therefore, cooker barometric condensers are not a source of pollutants. Since few plants in this subcategory operate multi-column distillation units, doubler discharge may generate the only waste from distillation. Waste reduction measures include recycling of water from mash coolers, still condensers, and refrigeration systems. Caustic cleanup may be collected, adjusted, reused, or metered to treatment systems. Slops holding and transfer must be supervised to avoid spillage.

End-of-Line Technology

Historically, due to the low level of raw waste for this subcategory, the primary method of treatment has been small aerated lagoons followed by stabilization ponds. Efficiencies of these systems are expected to be somewhat lower than those in Subcategory A 22 due to the fact that effluent concentrations are approaching the lower limit achievable from stabilization ponds, unless further treatment such as sand filtration is added. It is also felt that spray irrigation of the final effluent may be a viable alternative due to the rural locale of these distilleries.

Selection of Control and Treatment Technology

In Section V, a model plant was developed for grain distillers not operating stillage recovery systems. The wastewater characteristics of the model plant were determined to be as follows:

Flow	91 cu m/day (0.024 MGD)
BOD	210 mg/l
SS	160 mg/l
TKN	7 mg/l
P	1 mg/l

Table 122 lists the effluent pollutant loadings and the estimated treatment efficiency of each of the four treatment alternatives selected for this subcategory. All treatment alternatives are illustrated in Figure 206.

Alternative A 23-I - This alternative provides no additional treatment of the raw waste effluent.

Alternative A 23-II - This alternative consists of screening, a pumping station, nutrient addition, and an aerated lagoon system. Screening is assumed to have removed the large particles of debris which are subsequently disposed as solid waste. Nutrient addition is provided to increase the BOD:N:P deficit of the wastewater from 100:3.33:0.48 to the required 100:5:1. The aerated lagoon and settling pond would provide an estimated BOD and suspended solids removal of 85.7 and 75.0 percent, respectively.

The overall benefit of this alternative is a BOD reduction of 85.7 percent and a suspended solids reduction of 75.0 percent.

Alternative A 23-III - This alternative is identical to Alternative A 23-II with the addition of dual-media filtration which would provide an additional BOD and suspended solids removal of 7.2 and 12.5 percent,

DRAFT

TABLE 122

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY A23

Treatment Train Alternative	Effluent BOD (kg/kkg)	Effluent SS (kg/kkg)	Percent BOD Reduction	Percent SS Reduction
A 23-I	0.38	0.29	0	0
A 23-II	0.054	0.072	85.7	75.0
A 22-III	0.027	0.036	92.9	87.5
A 23-IV	0	0	100	100

DRAFT

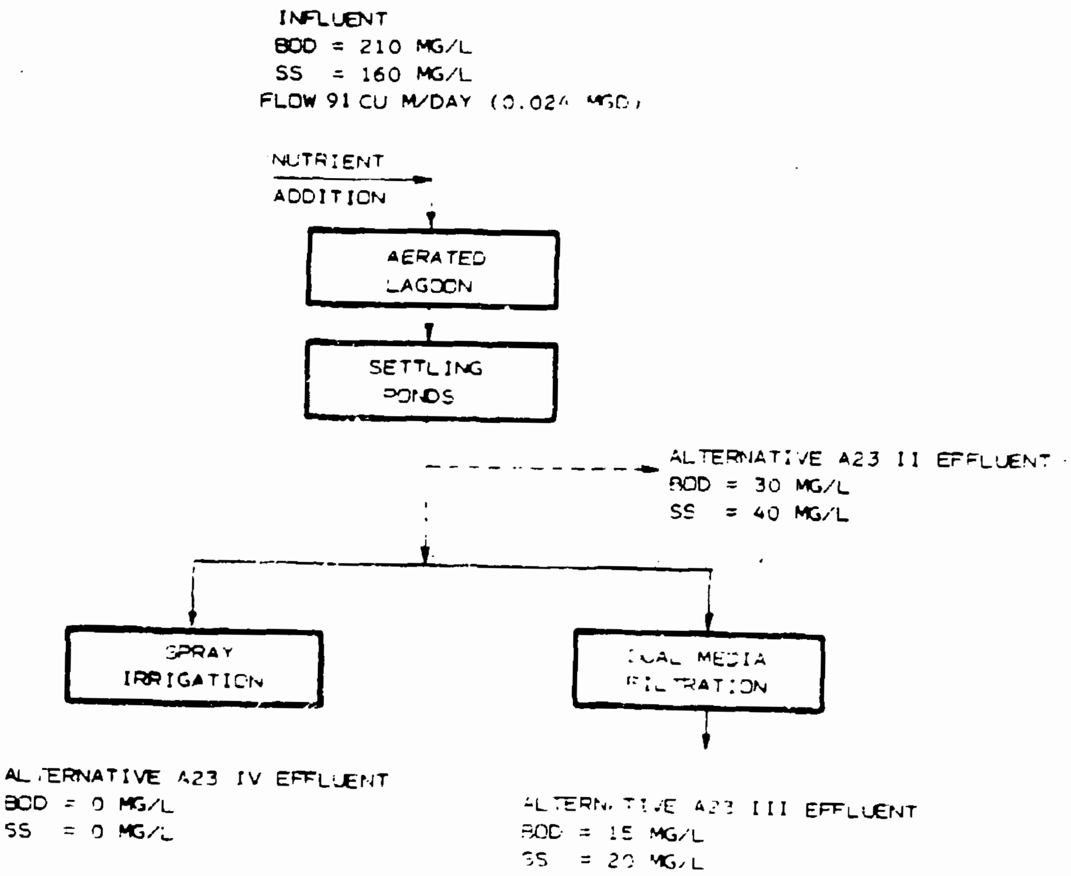


FIGURE 206

SUBCATEGORY A23
TREATMENT ALTERNATIVES II THROUGH IV

respectively, over that of Alternative A 23-II. The overall benefit of this alternative is a BOD reduction of 92.9 percent and a suspended solids reduction of 87.5 percent.

Alternative A 23-IV - This alternative consists of the same treatment modules as Alternative A 23-II with the addition of spray irrigation of the treated effluent at a land cost of $4,100/hectare ($1,160/acre). The overall benefit of this alternative is a BOD and suspended solids reduction of 100 percent to navigable waters.

SUBCATEGORY A 24 - MOLASSES DISTILLERS

Existing In-Plant Technology

As described in Section V, spent stillage is the primary waste in molasses distilling. Three methods of stillage waste reduction exist: 1) the character of the stillage may be changed by centrifuging after fermentation to remove yeast residues. According to Jackson (130) a reduction of up to nine percent total solids can result from centrifugation. The spent yeast may either be deposited on land, sold separately if a market exists, or be added to concentrated spent molasses for use as an animal feed supplemtn; 2) the volume of the stillage may be reduced by the use of indirect heat rather than live steam in the still. As evidenced by the wine and grain distilling industry, this change will reduce the flow from the bottom of the still by 15 to 30 percent, 3) the stillage may be evaporated such that the condensate is the only wastewater discharge. In this case the majority of the organics are concentrated into spent molasses by-product which must be marketed. At this point both the technical and economic aspects of evaporation must be explored.

Two U.S. molasses distilleries, Plants 85C43 and 85C44, currently have evaporators installed. Both of these plants alternate between citrus and cane molasses. The evaporator condensate is cited (80, 81) as containing between 250 and 300 mg/l BOD by both plants, although only sporadic sampling had been conducted to substantiate this range. Plant 85C44 has been successfully evaporating cane molasses stillage with a stainless steel, six effect evaporator system rated at 18,000 kg (40,000 lb) per hour. A concentrate of 50 percent solids is formed from 8 to 10 percent solids in the stillage. Scaling and fouling have been problems. Evaporators are presently operated for six to seven hours, then shut down for two hours while 11,400 l ([illegible] gal) of 50 percent caustic is circulated through the system. Since most of the scale develops in the first effect, this problem may be alleviated by the installation of an additional effect to provide maintenance time. If no additional effect is installed then storage tanks must be provided for the stillage. It should be pointed out that evaporation has been practiced elsewhere in the United States, as well as in Holland and South Africa. Also, transfer technology from the yeast industry is feasible since the raw product and resultant wastes are similar. Plant 99Y20, a yeast manufacturer, has installed a three stage, multi-effect evaporation system producing a condensate with approximately 600 mg/l BOD. This system is operated 20 hours per day with four hours cleanup.

DRAFT

Incineration, which has been used in some cases for disposal of the concentrated syrup, offers the possibility of potash recovery for fertilizer. Two United States manufacturers, however, have found a market for the concentrate as an animal feed supplement. One plant ships its concentrate from Florida to Mississippi. Another plant finds it economical to barge the by-product from New York to Louisiana.

Other methods for overall plant effluent reduction are the reuse of boiler/cooling waters for fermenter rinse, barrel wash, general cleanup, or for make-up in the raw molasses mixture. In addition, any caustic cleanup may be reclaimed and adjusted for reuse instead of being sewered. These methods are, of course, being currently practiced by some distillers.

Potential In-Plant Technology

Ahlgren (131) has tested ultra-filtration of rum distillery slops in conjunction with evaporation in order to separate the insoluble materials into a separate stream which would not require evaporation. This would be accomplished by a membrane separation technique which would remove the yeasts and other particulates so that they could be recombined with the evaporator concentrate for sale as animal food material.

Plant 85C34 has experimented with the use of stillage as make-up for the raw molasses mixture. Since this practice may affect the taste of the final product, it cannot be recommended for all molasses distillers; however, this practice as it is used in the grain distilling industry can reduct eh amount of stillage up to 25 percent.

End-of-Line Technology

A wide range of methods have been explored for the treatment of molasses distillery effluents. Extensive studies (132) have shown that sedimentation and coagulation are not satisfactory treatment alternatives since most of the pollutants are in solution. Sen, et al, (133) reported that trickling filters treating undiluted molasses distillery waste were not practical due to the high organic concentration and low filtering rates required. The activated sludge process has been shown to operate efficiently only when treating a one percent solution of rum slops combined with domestic sewage (134). When ten percent rum slops were mixed with domestic sewage, Burnett (135) found that the neutralized, diluted waste treated by activated sludge (25 percent average COD removal) could enhance further treatment.

Of all the treatment processes available for raw stillage, only anaerobic digestion appears to be feasible. Bhaskaran (136) found that it was possible to carry out anaerobic digestion of the raw waste at 37°C and a BOD loading of 3.0 kg/day/cu m (0.183 lb/day/cu ft) with a detention time of 10 days. BOD removals greater than 90 percent were obtained while a ratio of 25:1 methane gas to waste volume was maintained. This treatment was followed by activated sludge to produce an effluent with 63 mgl BOD. Seven plants in India and ten plants in Japan (137) are presently utilizing methane fermentation combined with activated sludge to achieve 40 to 120 mgl BOD in the final effluent. Bhaskaran also operated a pilot plant showing that a quadruple effect forced circulation evaporator with forward feed achieving a 60 percent concentrate is quite suitable for the subsequent incineration and recovery of potassium salts for fertilizers.

Shea, et al (138) investigated the anaerobic contact process at the pilot scale, and developed design criteria for full scale application. Capital, operation, and maintenance costs were also estimated.

As previously described, the raw stillage may be evaporated rather than treated. Plant 85C44 has recently built an extended aeration treatment system designed only to handle the evaporator condensate. Other plant wastes will be sent to landfill. Design parameters were 320 cu m/day (0.085 MGD) at 200 mg/l BOD. Figure 207 illustrates a flow diagram for the system. Plant 85C43 has also just finished construction of an activated sludge unit designed to handle both evaporator condensate and other plant wastes. Existing plant loads are expected to average 104 cu m/day (27,000 GPD) at 1600 mg/l BOD. Evaporator load is expected to be 276 cu m/day (73,000 GPD) at 600 mg/l BOD. No effluent data is presently available. Figure 208 presents a flow diagram for the treatment system.

The two methods of treatment which were considered for the purpose of this study were: 1) evaporation of raw stillage followed by activated sludge treatment of condensate, or 2) use of anaerobic contact process for partial treatment of raw stillage, followed by activated sludge. The former was determined to be more cost effective when the additional treatment required for the anaerobic process was considered. For this reason evaporation with alternative treatment systems will be presented.

Selection of Control and Treatment Technology

The model plant developed in Section V for the rum distilling industry has the following wastewater characteristics:

BOD	35,600 mg/l
SS	6,720 mg/l
Flow	818 cu m/day (0.216 MGD)

Process wastewater is assumed to be segregated from all non-contact water. High strength wastes (molasses slops) are assumed to be 89 percent of the total non-contact flow and to contain 99 percent of the BOD and 97 percent of the suspended solids. When treated separately, high strength wastes and all other wastes have the following wastewater characteristics:

High Strength Wastes		All Other Wastes	
BOD	39,100 mg/l	BOD	2,849 mg/l
SS	7,230 mg/l	SS	1,964 mg/l
Flow	738 cu m/day (0.195 MGD)	Flow	79.5 cu m/day (0.021 MGD)

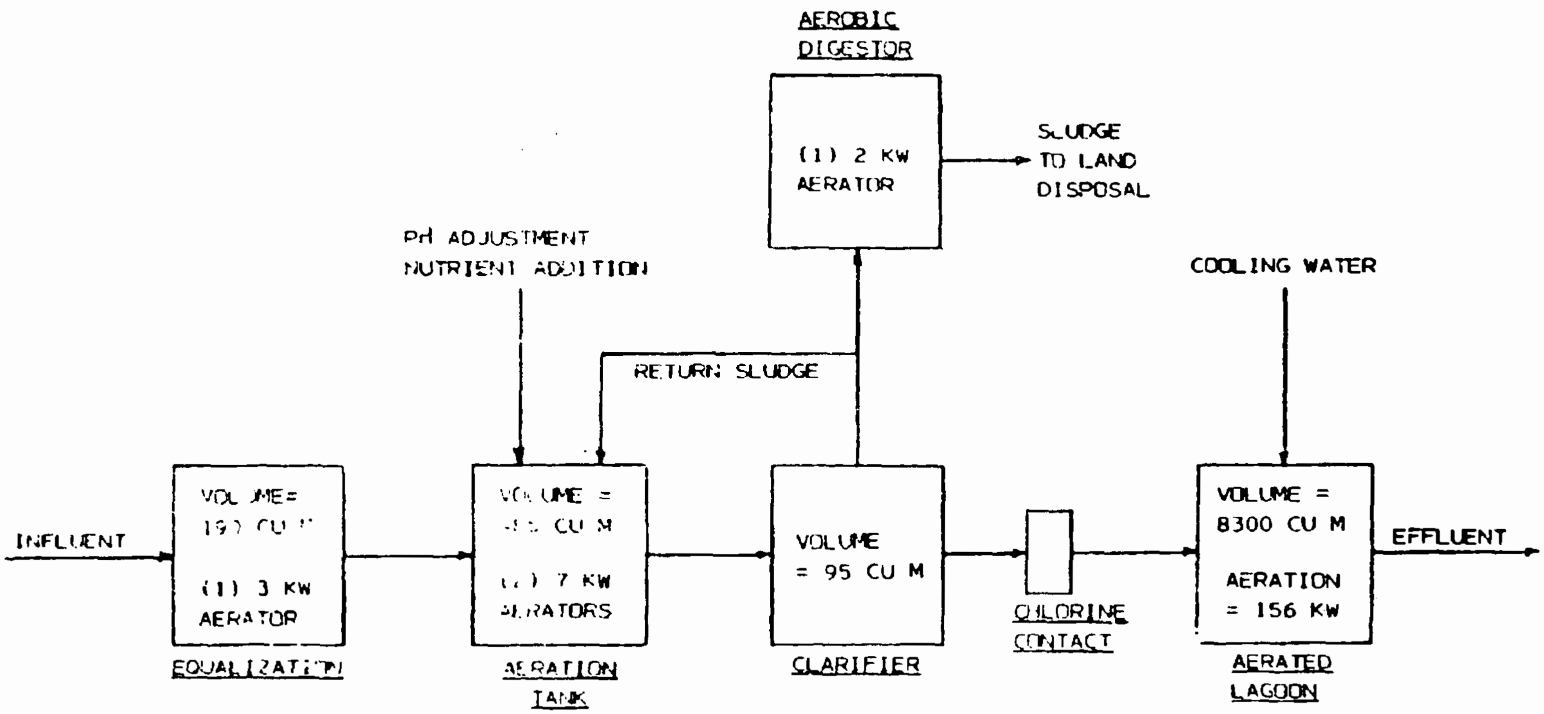


FIGURE 207

CONTROL AND TREATMENT
PLANT 85C43

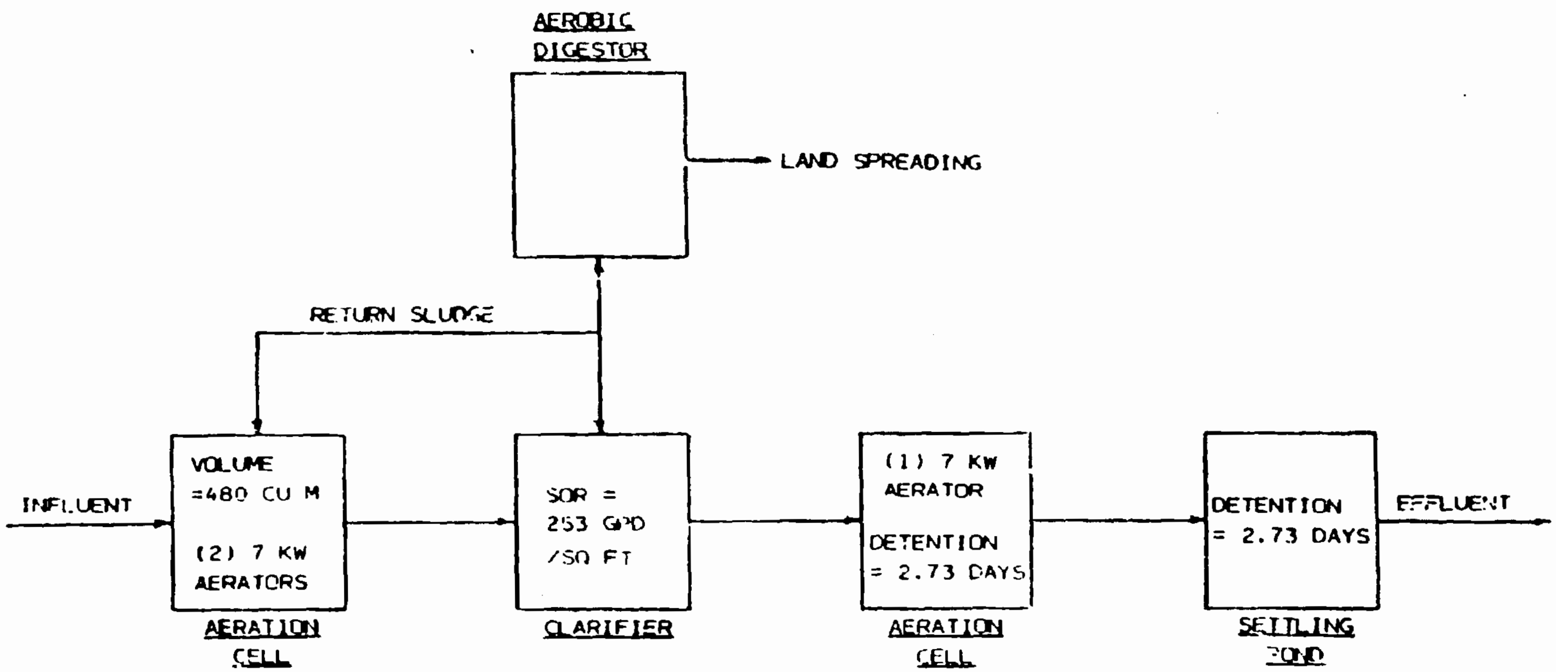


FIGURE 208

CONTROL AND TREATMENT
PLANT 85C44

DRAFT

Table 123 shows the removal efficiencies of each of the treatment alternatives. Figures 209 and 210 present simplified flow diagrams illustrating each of the chosen treatment chains.

Alternative A 24-I - This alternative adds no treatment to the model plant. The efficiency of BOD and suspended solids removal is zero.

Alternative A 24-II - This alternative consists of concentrating high strength molasses slops (stillage) by multi-effect evaporation, and then treating evaporator condensate and all other wastes with a treatment chain consisting of a control house, a pumping station, flow equalization, nutrient addition, a complete mix activated sludge system, sludge thickening, aerobic digestion, vacuum filtration, sludge storage, and truck hauling. Evaporation is predicted to remove 97 percent of the BOD and 99 percent of the suspended solids from high strength wastes. Two day storage of distillery slops and seven day storage of molasses by-product is provided, and all necessary pumping equipment is included.

The predicted effluent concentration is 50 mg/l BOD and 30 mg/l suspended solids. The overall affect of Alternative A 24-II is a 99.9 percent reduction of BOD and a 99.6 percent reduction of suspended solids.

Alternative A 24-III - This alternative consists of adding dual media filtration to the treatment chain in Alternative A 24-II. The predicted effluent concentrations are 25 mg/l of BOD and 15 mg/l of suspended solids. The overall effect of Alternative A 24-III is a 99.9 percent reduction of BOD, and a 99.8 percent reduction of suspended solids.

Alternative A 24-IV - This alternative consists of replacing vacuum filtration in Alternative A 24-II with spray irrigation. The predicted effluent concentrations are 50 mg/l BOD and 30 mg/l suspended solids. The overall effect of Alternative A 24-IV is a 99.9 percent reduction of suspended solids.

Alternative A 24-V - This alternative adds dual media filtration to the treatment chain in Alternative A 24-IV. The predicted effluent concentrations are 25 mg/l BOD and 15 mg/l suspended solids. The overall effect of Alternative V is a 99.9 percent reduction of BOD, and a 99.8 percent reduction of suspended solids.

Alternative A 24-VI - This alternative consists of replacing vacuum filtration in Alternative A 24-II with sand bed drying of sludge. The predicted effluent concentrations are 50 mg/l BOD and 30 mg/l suspended solids. The overall effect of Alternative A 24-VI is a 99.9 percent reduction of BOD, and a 99.6 percent reduction of suspended solids.

Alternative A 24-VII - This alternative adds dual media filtration to Alternative A 24-VI. The predicted effluent concentrations are 25 mg/l

DRAFT

TABLE 123

SUBCATEGORY A 24

SUMMARY OF TREATMENT ALTERNATIVES

Treatment Train Alternative	Effluent BOD (kg/1000 proof gallons)	Effluent SS (kg/1000 proof gallons)	Percent BOD Reduction	Percent SS Reduction
A 24-I	969	183	0	0
A 24-II	1.16	0.69	99.9	99.6
A 24-III	0.58	0.35	99.9	99.8
A 24-IV	1.16	0.69	99.9	99.6
A 24-V	0.58	0.35	99.9	99.8
A 24-VI	1.16	0.69	99.9	99.6
A 24-VII	0.58	0.35	99.9	99.8
A 24-VIII	1.16	0.69	99.9	99.6
A 24-IX	0.58	0.35	99.9	99.8

DRAFT

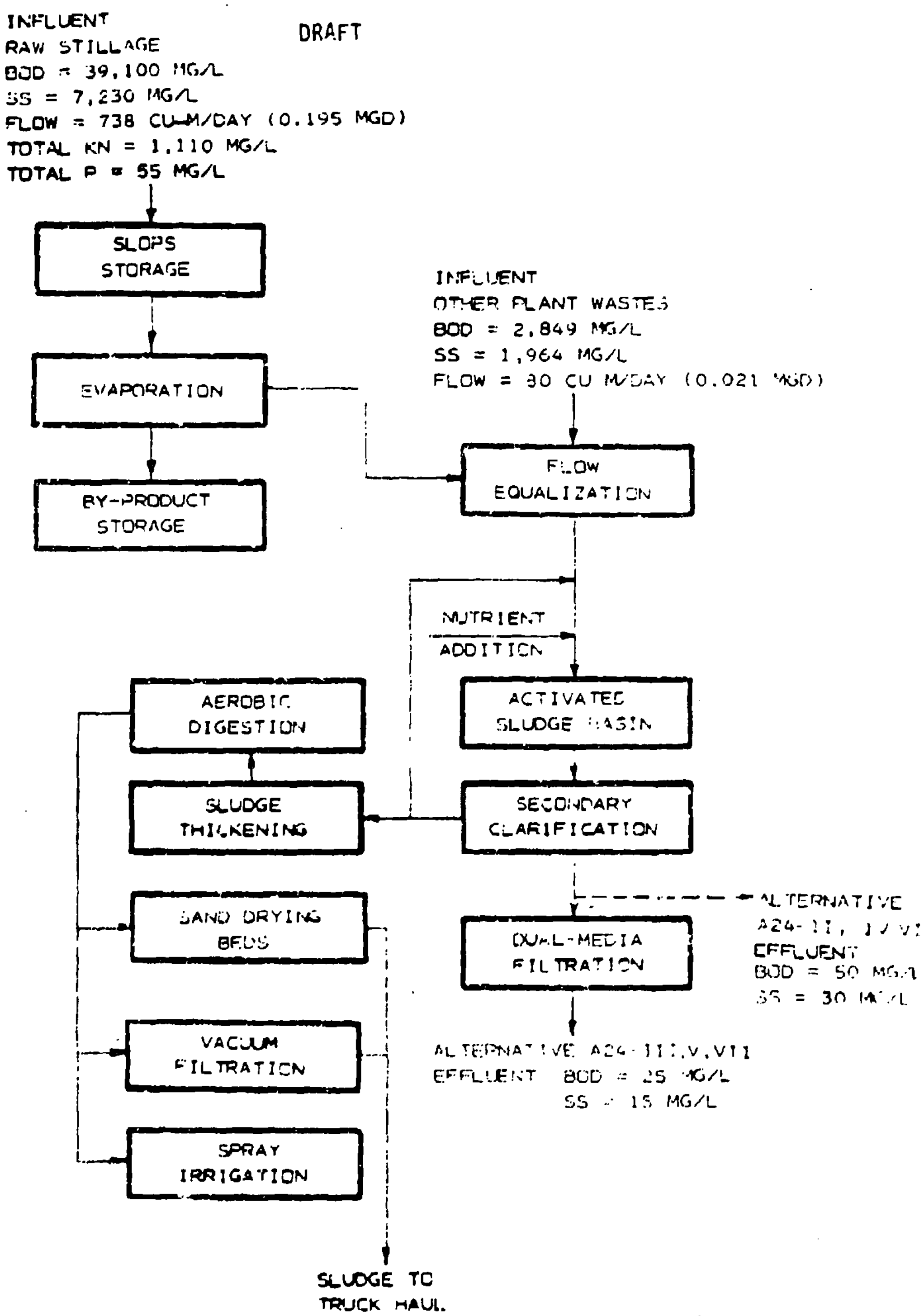


FIGURE 209

SUBCATEGORY A24
TREATMENT ALTERNATIVES II THRU IV

DRAFT

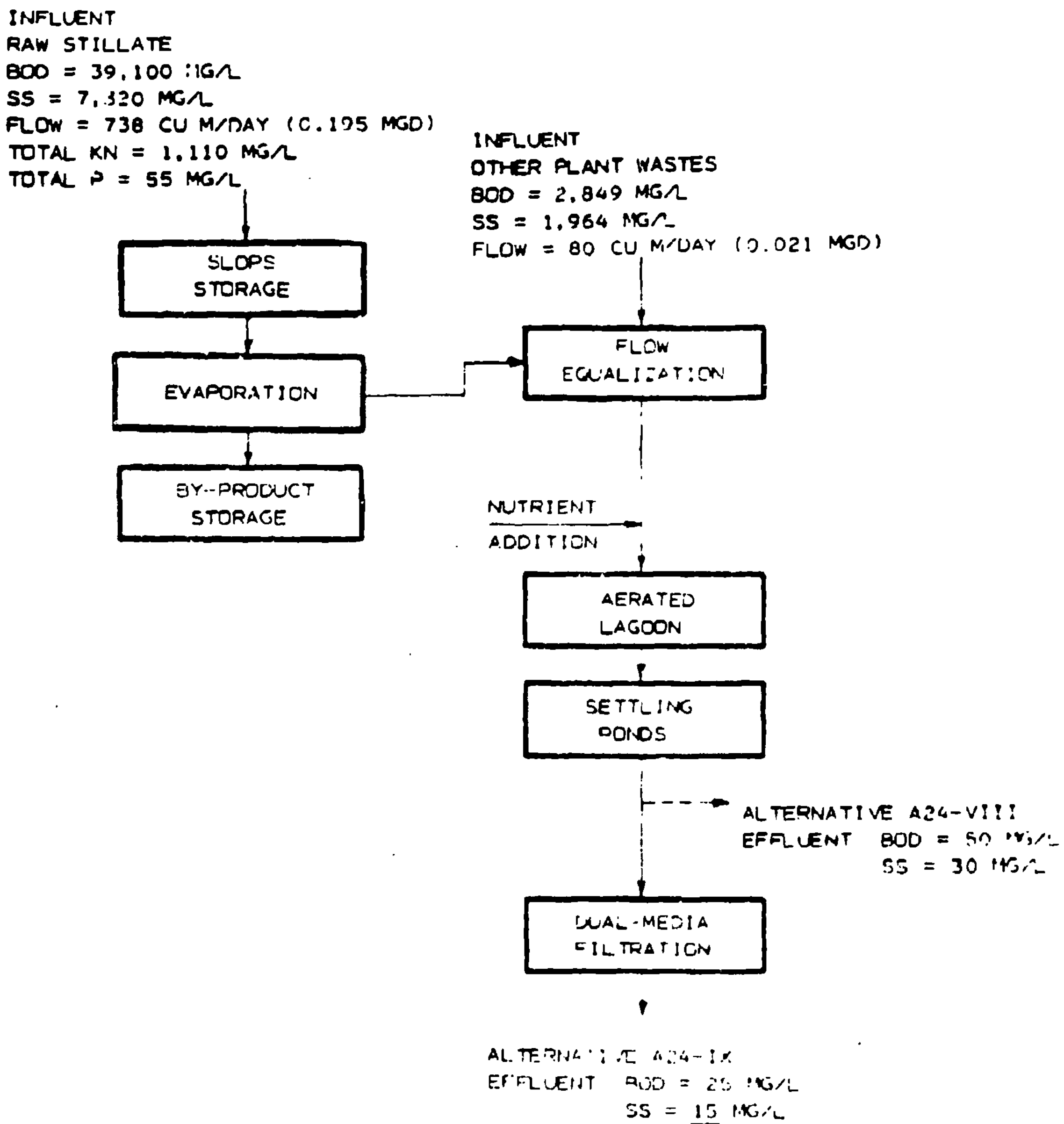


FIGURE 210

SUBCATEGORY A24
TREATMENT ALTERNATIVES VIII THRU IX

BOD and 15 mg/l suspended solids. The overall effect of Alternative A 24-VII is a 99.9 percent reduction of BOD, and a 99.8 percent reduction of suspended solids.

Alternative A 24-VIII - This alternative consists of replacing the complete mix activated sludge system and sludge handling modules in Alternative A 24-II with aerated lagoons and settling ponds. The settling ponds are dredged every five years. The predicted effluent concentrations are 50 mg/l BOD and 30 mg/l suspended solids. The overall effect of Alternative A 24-VIII is a 99.9 percent reduction of BOD, and a 99.6 percent reduction of suspended solids.

Alternative A 24-IX - This alternative adds dual media filtration to Alternative A 24-VIII. The predicted effluent concentrations are 25 mg/l BOD and 15 mg/l suspended solids. The overall effect of Alternative A 24-IX is a 99.9 percent reduction of BOD, and a 99.8 percent reduction of suspended solids.

SUBCATEGORY A 25 - BOTTLING AND BLENDING OF BEVERAGE ALCOHOL

In-Plant Technology

Non-contact cooling water may be separated and discharged to storm sewers as in Plant 85011 or to navigable waters as in Plant 85013 if allowable. While this does not reduce pollutant loadings, it does improve treatment economics. Residue from redistillation may be collected in a holding tank for subsequent disposal. Bad product may be collected and held rather than crushed and sewered. Demineralizer water regeneration discharges may be collected and neutralized for subsequent disposal. All other process wastes are assumed to be minor in strength.

End-of-Line Technology

There are no known plants in this subcategory which discharge pollutants to navigable waters.

Selection of Control and Treatment Technology

In Section V two model plants were developed for this subcategory. It was assumed that the following wastes are collected in holding tanks: redistillation residue, bad product, and demineralizer regeneration. All other process wastes were separated from non-contact water. Raw waste characteristics for the two model plants were:

	A	B
Flow	4 cu m/day (0.001 MGD)	40 cu m/day (0.010 MGD)

[redacted]

DRAFT

The alternatives listed below all achieve 100 percent removal of raw waste loading. Therefore, no discharge of pollutants to navigable waters is recommended.

Alternative A 25-I - This alternative provides no additional treatment to the raw wastewater.

Alternative A 25-II - This alternative provides daily truck hauling of all plant process wastes to municipal treatment facilities or approved land disposal sites. A holding tank is provided.

Alternative A 25-III - This alternative provides truck hauling on a monthly basis for rectifier bottlers. At this time redistillation residue, bad production, and demineralizer regeneration are hauled. No truck hauling is provided for small bottlers, however, since it was assumed in Section V that their effluent contained no redistillation residue or bad product. All other process wastes for both model plants are spray irrigated. A holding tank, pump, and pipeline are provided.

SUBCATEGORY A 26 - SOFT DRINK CANNERS

In-Plant Technology

As identified in Section V, the major sources of waste for this subcategory are filler spillage, mixing tank washing, and fill tank and line washing. At present the reduction of waste from filler spillage has not been fully addressed by soft drink manufacturers. Procedures for collecting lost product have been established, however, by the malt beverage industry. Applying this technology to the soft drink industry would entail the collection and holding of lost product for separate disposal. Mixing tank wastes could also be collected in order to reduce the load on waste treatment systems. A portion of the water used to flush full lines and fill tanks (the first two or three minutes or until the flow is clear) could be similarly collected. These combined collected wastes may then be disposed by landfilling, land spreading, or spray irrigating. In long term planning some form of sugar recovery from these collected wastes may be profitable.

End-of-Line Technology

As identified in Section V, the waste from soft drink canners contains organic materials which are amenable to treatment by biological processes. During the course of this study, data was collected from three plants with wastewater treatment systems. Since these plants were all bottlers the case histories will be presented in Subcategory 27. There is no reason to suspect that similar systems, tailored to the effluent characterisitcs of soft drink canners, would not function properly.

Selection of Control and Treatment Technology

In Section V a model plant was developed for soft drink canners. The raw wastewater characteristics were assumed to be as follows:

Flow	229 cu m/day (0.0605 MGD)
BOD	1380 mg/l
SS	167 mg/l
N	23 mg/l
P	12.5 mg/l

Table 124 lists the pollutant effluent loading and the estimated operating efficiency of each of the seven treatment alternatives selected for this subcategory. The schematics of the treatment alternatives are illustrated in Figures 211 and 212.

Alternative A 26-I - This alternative provides no additional treatment to the raw waste effluent.

Alternative A 26-II - This alternative consists of a control house, flow equalization, nutrient addition, a complete-mix activated sludge system, sludge thickening and spray irrigation of the thickened sludge. Flow equalization is provided for two reasons: (1) the pH of the intermittent flow from the plant can vary from 3.0 to 7.0 and, therefore, equalization will provide neutralization without chemical addition, and (2) to dampen shock loadings to the activated sludge system. Anhydrous ammonia addition is provided to increase the wastewater BOD:N ratio from 100:1.67 to the required 100:5. The activated sludge system would provide an estimated 94.9 percent treatment efficiency. The sludge from sludge thickening is spray irrigated at a land cost of $1,660/acre.

The overall benefit of this alternative is a BOD reduction of 94.9 percent and a suspended solids reduction of 76.0 percent.

Alternative A 26-III - This alternative consists of the same treatment modules as Alternative A 26-II with the addition of dual-media filtration which would provide an additional estimated BOD and suspended solids reduction of 2.6 and 12.1 percent, respectively. The overall benefit of this alternative is a BOD reduction of 97.5 percent and a suspended solids reduction of 88.1 percent.

Alternative A 26-IV - This alternative consists of the same treatment modules as Alternative A 26-II except spray irrigation of thickened sludge is replaced by sludge hauling. The overall benefit of this alternative is a BOD reduction of 94.9 percent and a suspended solids reduction of 76.0 percent.

Alternative A 26-V - This alternative is identical to Alternative A 26-IV with the addition of dual-media filtration. The overall benefit of this

DRAFT

TABLE 124

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY A 26
SOFT DRINK CANNERS

Treatment Train Alternative	Effluent BOD kg/cu m	Effluent SS kg/cu m	Percent BOD Removed	Percent SS Removed
A 26-I	1.02	0.123	0	0
A 26-II	0.052	0.030	94.9	76
A 26-III	0.026	0.015	97.5	88.1
A 26-IV	0.052	0.030	94.9	76
A 26-V	0.026	0.015	97.5	88.1
A 26-VI	0.052	0.030	94.9	76
A 26-VII	0.026	0.015	97.5	88.1

DRAFT

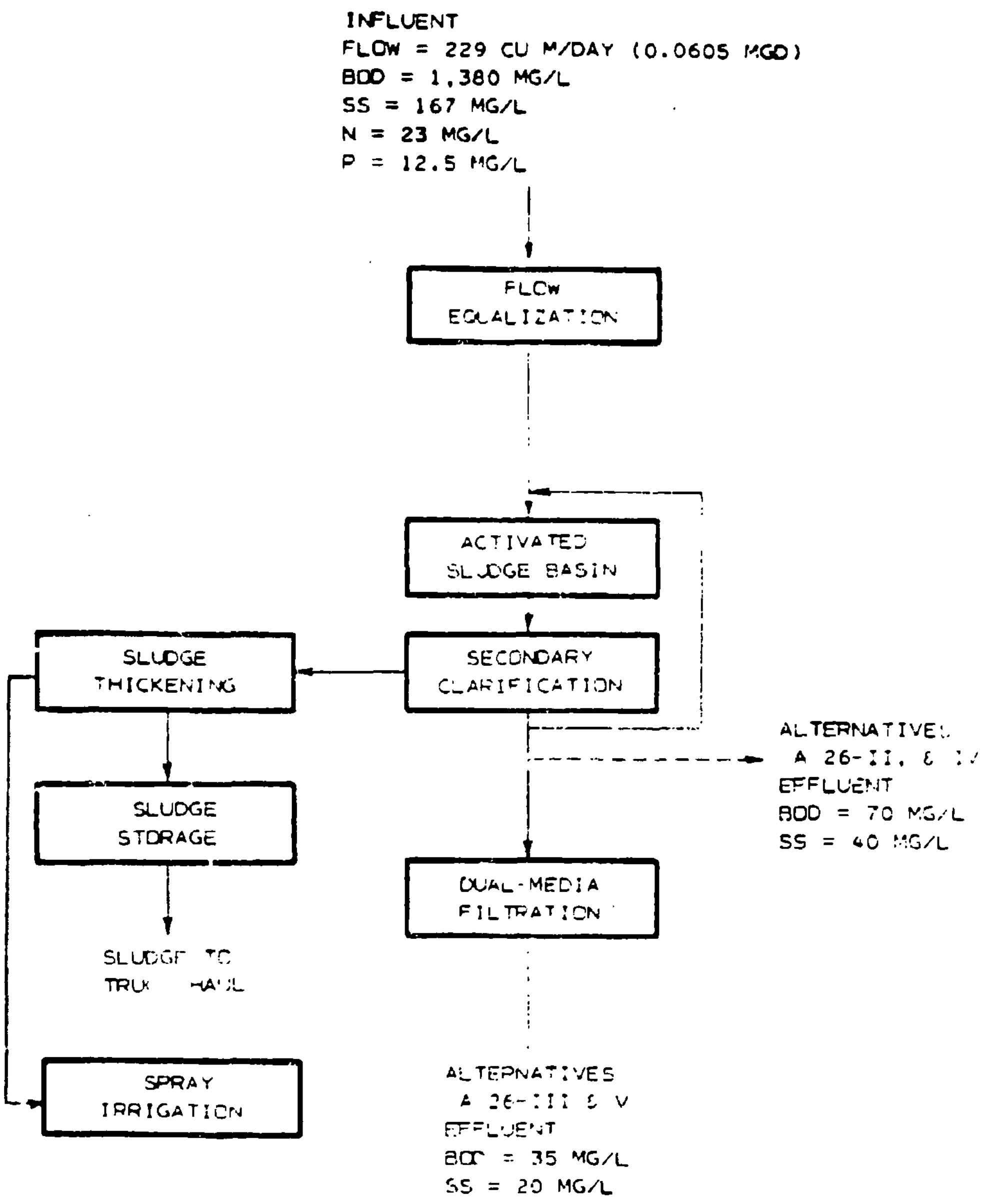


FIGURE 211

SUBCATEGORY A26
TREATMENT ALTERNATIVES II THRU V

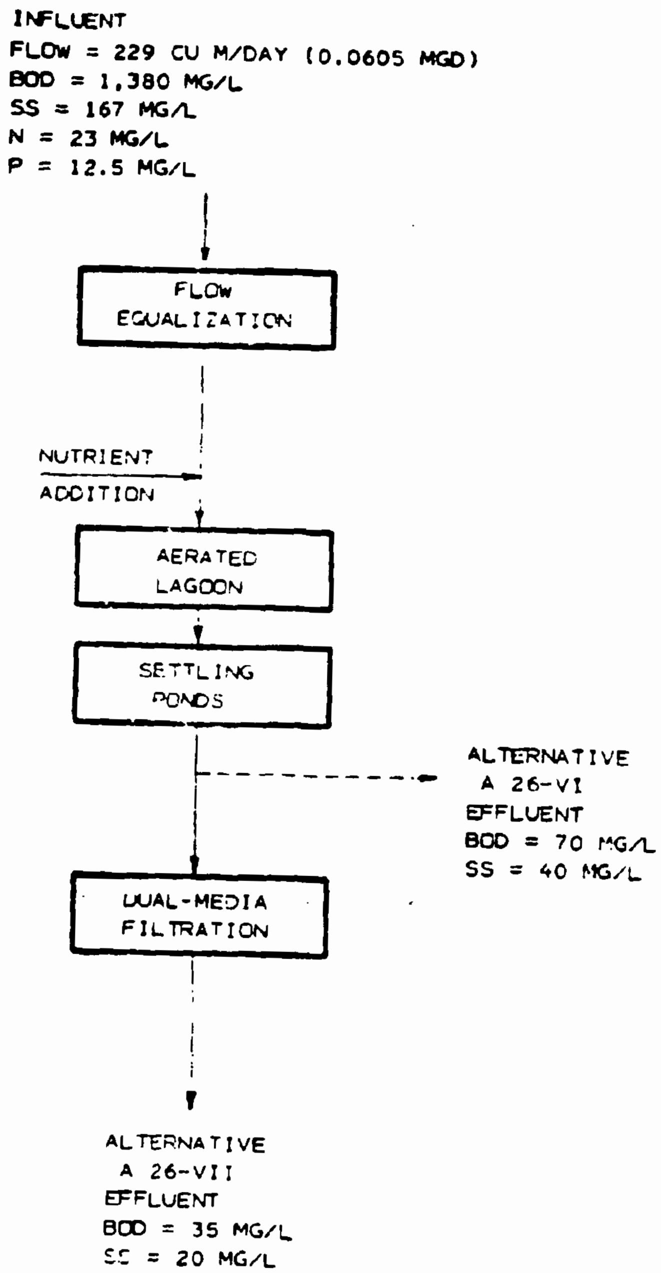


FIGURE 212

SUBCATEGORY A26
TREATMENT ALTERNATIVES VI AND VII

alternative is a BOD reduction of 97.5 percent and a suspended solids reduction of 88.1 percent.

Alternative A 26-VI - This alternative consists of a pumping station, flow equalization, nutrient addition, and an aerated lagoon. Flow equalization and anhydrous ammonia addition are provided for the same reasons given in Alternative A 26-II. It is assumed that the aerated lagoon provides the same treatment efficiency as the activated sludge system of the previous alternatives.

The overall benefit of this alternative is a BOD reduction of 94.9 percent and a suspended solids reduction of 76.0 percent.

Alternative A 26-VII - This alternative is identical to Alternative A 26-VI with the addition of dual media filtration. The overall effect of this alternative is a BOD reduction of 97.5 percent and a suspended solids reduction of 88.1 percent.

SUBCATEGORY A 27 - SOFT DRINK BOTTLING OR COMBINED BOTTLING/CANNING PLANTS

In-Plant Technology

Plants in this subcategory can incorporate waste reduction measures discussed for soft drink canners, i.e., the collection and holding of filler spillage (canners only), mixing tank washing, and fill tank and line washing. In addition, wastes from the bottle washer must be addressed. The character of final rinse water was documented in Section V. This may be recirculated to the prerinse section. Water pressure at the spray heads of bottle washers may exceed manufacturers specifications. Pressure reducing stations may be required to maintain specifications. Pressure reducing stations may be required to maintain recommended levels. Solenoid valves may be installed on city water inlets to cut off the rinse water completely when the washer is not operating. Caustic can be metered into treatment system instead of being dumped from soakers. Unused product left in returnable bottles may be collected and disposed of separately along with other product wastes. A similar method of disposal may be required for unused product left in returnable cannisters.

End-of-Line Technology

Aerated lagoons or variations of activated sludge are both employed in the treatment of soft drink wastes. Figures 213, 214, and 215 illustrate three such systems. Plant 86A16 is a small bottler producing only 18 cu m (4,900 gal) per day. The aerated lagoon and polishing lagoon system utilized by this plant is achieving 92 percent BOD and 73 percent suspended solids removal. Increased efficiencies could be expected, however, because at times the aerator is not operated.

The treatment system at plant 86A32 was undersigned and consequently is now severely overloaded hydraulically. A considerable amount of study of in-plant wastewater reduction has taken place. Nevertheless, it appears that the present system

DRAFT

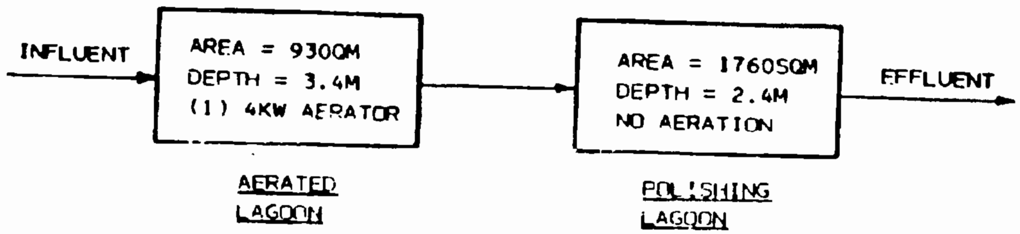


FIGURE 213

CONTROL AND TREATMENT

PLANT 86A16

DRAFT

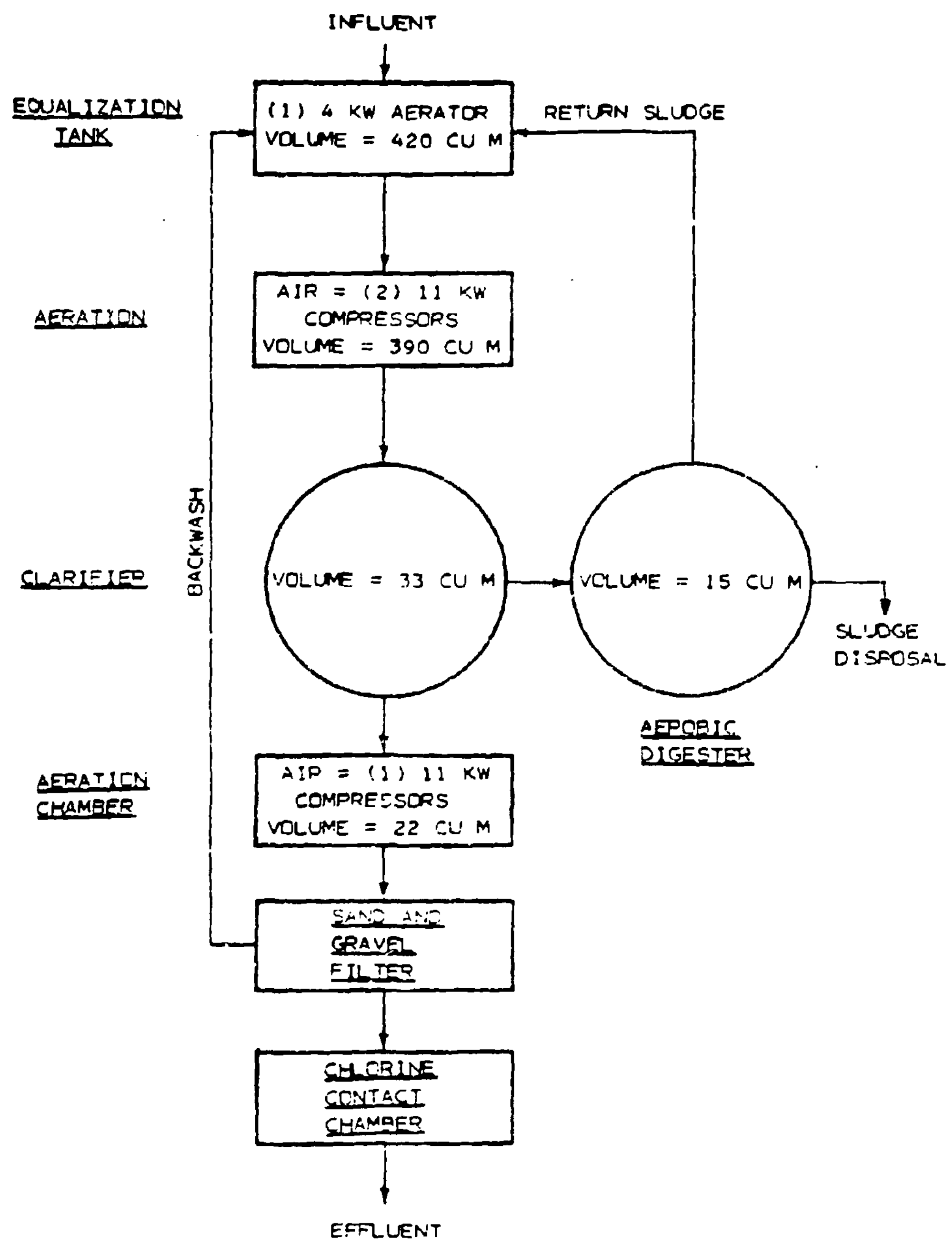


FIGURE 214
CONTROL AND TREATMENT
PLANT 86A32

DRAFT

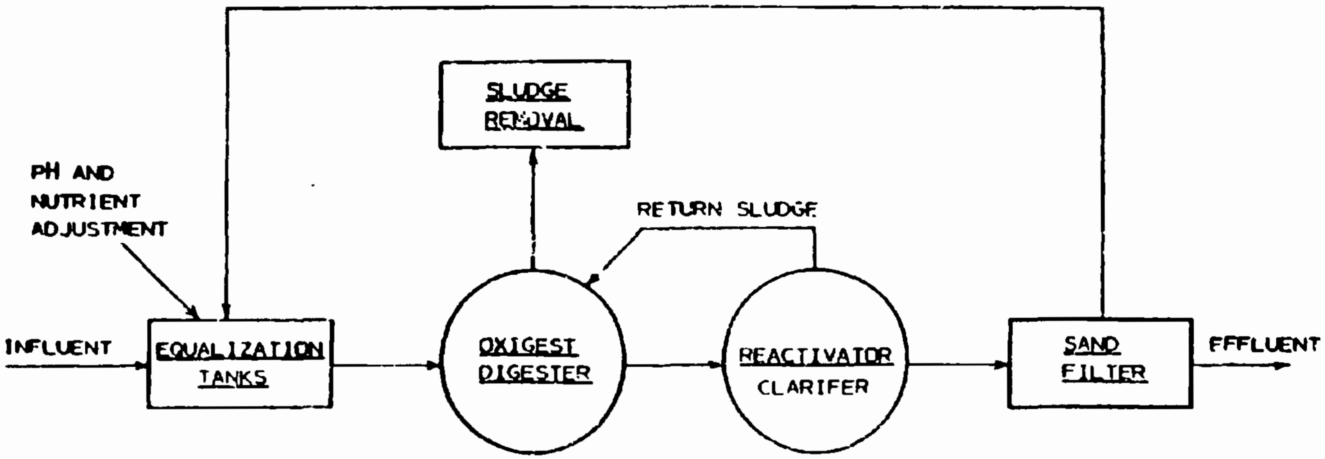


FIGURE 215
CONTROL AND TREATMENT
PLANT 86A29

will have to be expanded. Current BOD removal is approximately 69 percent. Effluent suspended solids levels were higher than those in the raw waste due to overloaded sand filters which passed solids to the clear well.

Plant 86A29 is not yet operational, hence no effluent data is available. Predicted values are 15 mg/l for both BOD and suspended solids. Sludge will be trucked to a larger treatment facility.

Selection of Control and Treatment Technology

In Section V a model plant was developed for soft drink canners. The raw wastewater characteristics were assumed to be as follows:

Flow	477 cu m/day (0.125 MGD)
BOD	660 mg/l
SS	108 mg/l
N	11 mg/l
P	6 mg/l

Table 125 lists the pollutant effluent loading and the estimated operating efficiency of each of the seven treatment alternatives selected for this subcategory. The schematics of the treatment alternatives are illustrated in Figures 216 and 217.

Alternative A 27-I - This alternative provides no additional treatment to the raw waste effluent.

Alternative A 27-II - This alternative consists of a control house, flow equalization, nutrient addition, a complete-mix activated sludge system, sludge thickening and spray irrigation of the thickened sludge. Flow equalization is provided for two reasons: (1) the pH of the intermittent flow from the plant can vary from 3.0 to 7.0 and, therefore, equalization will provide neutralization without chemical addition, and (2) to dampen shock loadings to the activated sludge system. Anhydrous ammonia addition is provided to increase the wastewater's BOD:N ratio from 100:1.67 to the required 100:5. Acid neutralization is provided to accomodate the frequently high alkalinity of the wastewater. The activated sludge system would provide an estimated 89.4 percent treatment efficiency. The sludge from sludge thickening is spray irrigated at a land cot of $1,660/acre.

The overall benefit of this alternative is a BOD reduction of 89.4 percent and a suspended solids reduction of 63.0 percent.

Alternative A 27-III - This alternative consists of the same treatment modules as Alternative A 26-II with the addition of dual-media filtration which would provide an additional estimated BOD and suspended solids reduction of 2.6 and 12.1 percent, respectively. The overall benefit of this alternative is a BOD reduction of 94.7 percent and a suspended solids reduction of 81.5 percent.

Alternative A 27-IV - This alternative consists of the same treatment modules of Alternative A 26-II except spray irrigation of thickened sludge

DRAFT

TABLE 125

SUMMARY OF TREATMENT TRAIN ALTERNATIVES - SUBCATEGORY A27
ALL OTHER SOFT DRINK PLANTS

ALTERNATIVE	EFFLUENT BOD KG/CU M	EFFLUENT SS KG/CU M	PERCENT BOD REMOVAL	PERCENT SS REMOVAL
A27 - I	2.30	0.38	0	0
A27 - II	0.24	0.14	89.4	63.0
A27 - III	0.123	0.07	94.7	81.5
A27 - IV	0.24	0.14	89.4	63.0
A27 - V	0.123	0.07	94.7	81.5
A27 - VI	0.24	0.14	89.4	63.0
A27 - VII	0.123	0.07	94.7	81.5

DRAFT

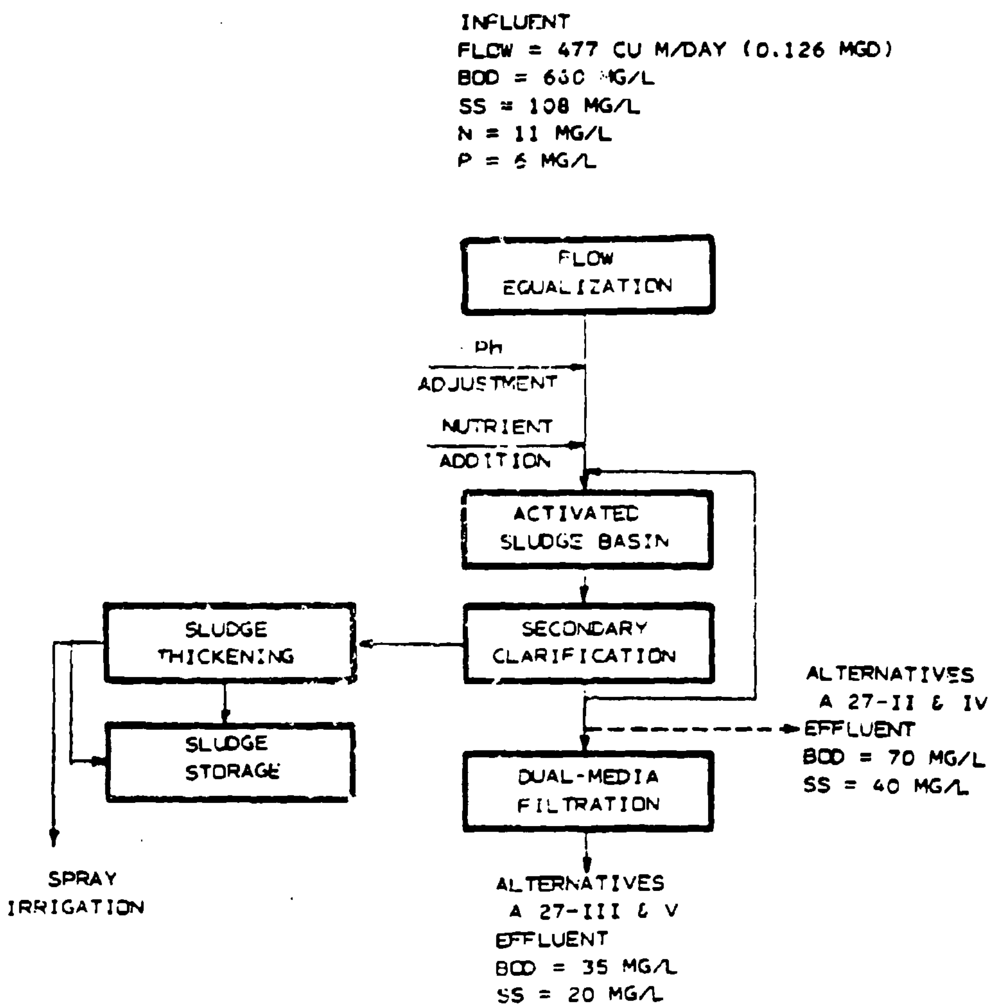


FIGURE 216

SUBCATEGORY A27
TREATMENT ALTERNATIVES II THRU V

DRAFT

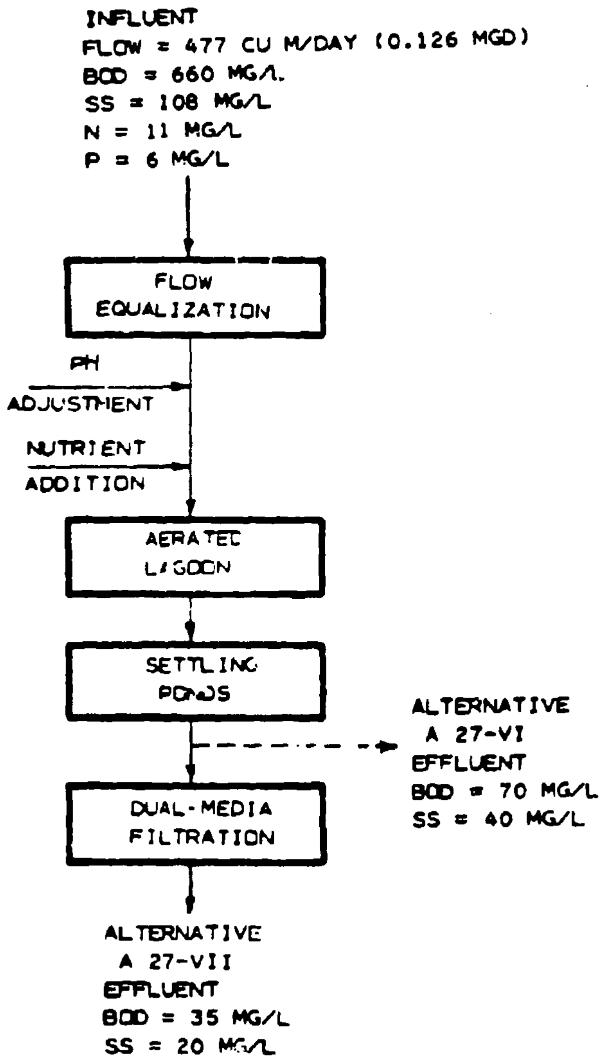


FIGURE 217

SUBCATEGORY A27
TREATMENT ALTERNATIVES VI AND VII

is replaced by sludge hauling. The overall benefit of this alternative is a BOD reduction of 89.4 percent and a suspended solids reduction of 63.0 percent.

Alternative A 27-V - This alternative is identical to Alternative A 26-IV with the addition of dual-media filtration. The overall benefit of this alternative is a BOD reduction of 94.7 percent and a suspended solids reduction of 81.5 percent.

Alternative A 27-VI - This alternative consists of a pumping station, flow equalization, nutrient addition, and an aerated lagoon. Flow equalization and anhydrous ammonia addition are provided for the same reasons given in Alternative A 26-II. It is assumed that the aerated lagoon provides the same treatment efficiency as the activated sludge system of the previous alternative.

The overall benefit of this alternative is a BOD reduction of 89.4 percent and a suspended solids reduction of 63.0 percent.

Alternative A 27-VII - This alternative is identical to Alternative A 26-VI with the addition of dual-media filtration. The overall effect of this alternative is a BOD reduction of 94.7 percent and a suspended solids reduction of 81.5 percent.

SUBCATEGORY A 28 - BEVERAGE BASE SYRUPS AND/OR CONCENTRATES

Existing In-Plant Technology

Wastewater generated from the manufacturing of beverage bases consists solely of cleanup water as described in Section V. Most plants regulate the amount of water used in all cleanup operations. Some plants discharge non-contact water into the wastestream and others to storm sewers.

Potential In-Plant Technology

Assuming that 50 percent of the cleanup water is wash water and 50 percent is rinse water, recycling all or a major portion of rinse water could conceivably reduce the quantity of wasteflow and water use by 50 percent. Additionally, recycling of caustic wash water and separation of all non-contact water from the wastestream would substantially reduce the volume of the process wastewater stream.

Reduction of pollutant loadings in the waste stream could be accomplished by recycling of caustic wash water and by avoiding any spills during receiving ingredients and filling tank cars, drums, and containers.

End-of-Line Technology

Presently all known beverage manufacturers discharge wastewater to municipal systems with no apparent adverse effects on the treatment systems. The waste stream could be slightly deficient in nitrogen based on the BOD:N:P ratio of 100:3.1:1.1 at Plant 87509. However, the data is not sufficient to warrant a valid conclusion that nutrient addition prior to biological treatment is necessary or desirable. Based on these facts, along with consideration of the origins of the wastewater and its characteristics, the wastewater is judged to be amenable to biological treatment with or without nutrient addition.

Selection of Control and Treatment Technology

A model plant for Subcategory A 28 with the following wastewater characteristics was presented in Section V.

Flow	379 cu m/day (0.10 MGD)
BOD	2400 mg/l
SS	50 mg/l
pH	8.0

Table 126 lists the treatment alternatives and their expected efficiencies. The treatment alternatives are illustrated in Figures 218 and 219.

Alternative A 28-I - This alternative consists of a pumping station, a flow equalization basin and an aerated lagoon. The flow equalization tank is recommended to provide a steady flow to the lagoon, preventing shock loadings and thereby increasing the efficiency of the aerated lagoon. Due the biodegradability of the wastewater, the aerated lagoon would provide a BOD reduction of 95.8 percent and a suspended solids reduction of 40 percent.

The overall benefit of this alternative is a BOD reduction of 95.8 percent and a suspended solids reduction of 40 percent.

Alternative A 28-II - This alternative consists of a pumping station, a flow equalization tank, a complete mix activated sludge basin, a sludge thickener, an aerobic digestor, a sludge holding tank and land application of sludge following digestion. The flow equalization tank is provided to dampen shock loadings to the activated sludge basin which would be expected due to the variations in cleanup activity during the day in a beverage base manufacturing plant. The activated sludge basin would reduce the BOD and suspended solids loadings of the wastewater to 100 mg/l and 30 mg/l, respectively. A two day sludge holding tank is provided to reduce the cost of hauling sludge of land application. The amount of land required to accommodate the yearly sludge production is 85 ha (210 acres).

The overall benefit of this alternative is a BOD reduction of 95.8 percent and a suspended solids reduction of 40 percent.

Alternative A 28-III - This alternative consists of the same treatment modules as Alternative A 28-II except land spreading of sludge is replaced by vacuum filtration provides a significant sludge reduction as

DRAFT

TABLE 126

SUMMARY OF TREATMENT ALTERNATIVES

BEVERAGE BASE SYRUPS AND/OR CONCENTRATES

Subcategory A28

Treatment Alternative	Effluent BOD kg/cu m	Effluent SS kg/cu m	Percent Reduction BOD	Percent Reduction SS
A 28 - I	0.01	0.003	95.8	40
A 28 - II	0.01	0.003	95.8	40
A 28 - III	0.01	0.003	95.8	40
A 28 - IV	0.01	0.003	95.8	40
A 28 - V	0.005	0.001	97.9	80
A 28 - VI	0.005	0.001	97.9	80
A 28 - VII	0.005	0.001	97.9	80
A 28 - VIII	0.005	0.001	97.9	80
A 28 - IX	0.0025	0.0005	98.9	90
A 28 - X	0.0025	0.0005	98.9	90
A 28 - XI	0.0025	0.0005	98.9	90
A 28 - XII	0.0025	0.0005	98.9	90
A 28 - XIII	0	0	100	100

DRAFT

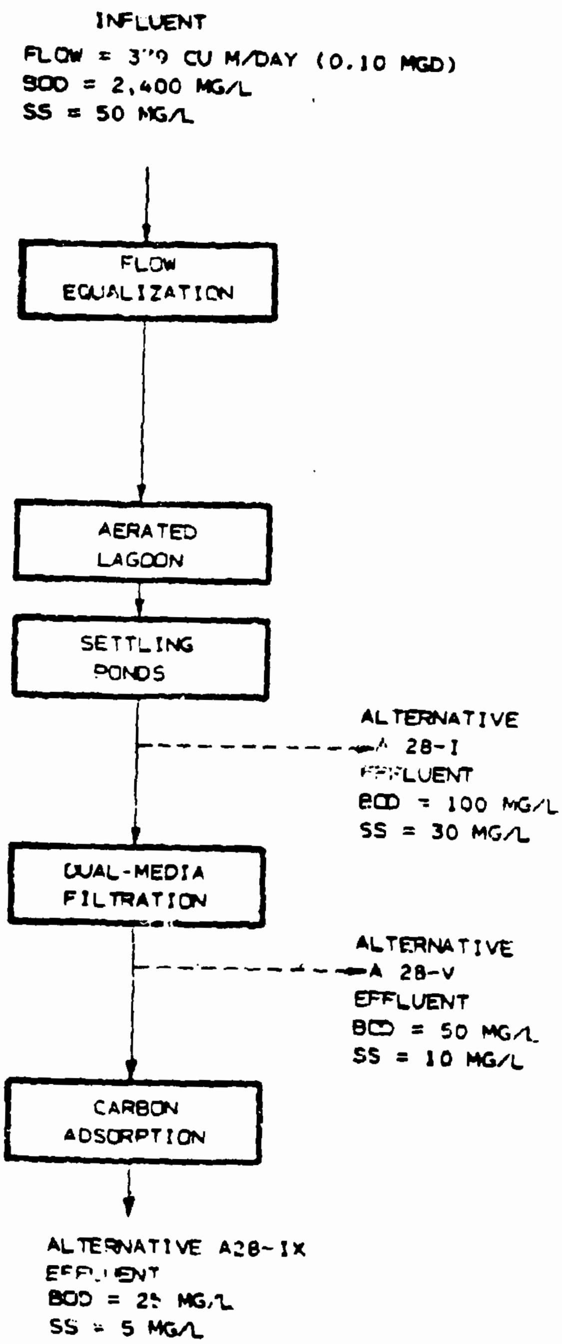


FIGURE 218

SUBCATEGORY A28
TREATMENT ALTERNATIVES I, V, AND IX

DRAFT

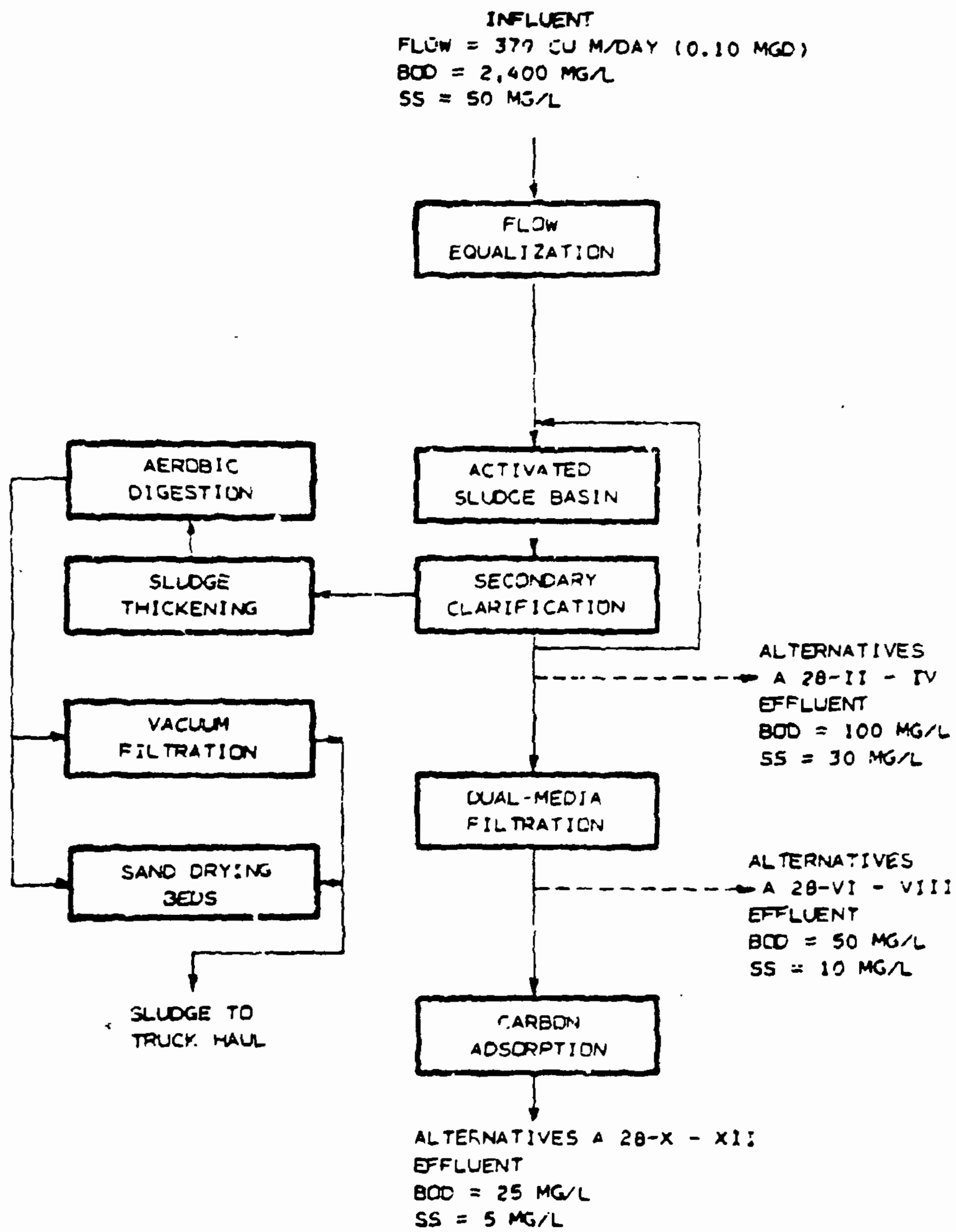


FIGURE 219

SUBCATEGORY A28
TREATMENT ALTERNATIVES II-IV, VI-VIII, AND X-XII

compared to Alternative A 28-II, thereby reducing hauling costs. A seven-day sludge holding tank is provided to limit the frequency of truck hauls, further reducing cost.

The overall benefit of this alternative is a BOD reduction of 95.8 percent and a suspended solids reduction of 40 percent.

Alternative A 28-IV - This alternative is identical to Alternative A 28-II except the vacuum filter is replaced by sand drying beds. This results in twice the sludge production of Alternative A 28-III.

The overall benefit of this alternative is a BOD reduction of 95.8 percent and a suspended solids reduction of 40 percent.

Alternative A 28-V - This alternative consists of the same treatment modules as Alternative A 28-I with the addition of dual-media filtration. which provides an additional 40 percent overall BOD reduction of 2.1 percent and a suspended solids reduction of over any of the previous alternatives.

The overall benefit of this alternative is a BOD reduction of 97.9 percent and a suspended solids reduction of 80 percent.

Alternative A 28-VI - This alternative is identical to Alternative A 28-II with the addition of dual-media filtration.

The overall effect of this alternative is a BOD reduction of 97.9 percent and a suspended solids reduction of 80 percent.

Alternative A 28-VII - This alternative consists of the same modules as Alternative A 28-III with the addition of dual media filtration. The overall benefit of this alternative is a BOD reduction of 97.9 percent and a suspended solids reduction of 80 percent.

Alternative A 28-VIII - This alternative consists of the same treatment modules as Alternative A 28-IV with the addition of dual media filtration. The overall benefit of this alternative is a BOD reduction of 97.9 percent and a suspended solids reduction of 80 percent.

Alternative A 28-IX - This alternative is identical to that of Alternative A 28-V with the addition of activated carbon which would further reduce the overall BOD and suspended solids loading of the wastewater by 1.0 percent and 10 percent, respectively. The overall benefit of this alternative is a BOD reduction of 98.9 percent and a suspended solids reduction of 90 percent.

Alternative A 28-X - This alternative is identical to Alternative A 28-VI with the addition of activated carbon. The overall benefit of this alternative is a BOD reduction of 98.9 percent and a suspended solids reduction of 90 percent.

Alternative A 28-XI - This alternative consists of the same modules as Alternative A 28-VII with the addition of activated carbon. The overall effect of this alternative is a BOD reduction of 98.9 percent and a suspended solids reduction of 90 percent.

Alternative A 28-XII - This alternative consists of the same treatment modules as Alternative A 28-VIII with the addition of activated carbon. The overall benefit of this alternative is a BOD reduction of 98.9 percent and a suspended solids reduction of 90 percent.

Alternative A 28-XIII - This alternative consists of a pumping station, a holding tank and spray irrigation which would required 8.1 ha (20 acres) of land. The overall benefit of this alternative is a 100 percent reduction of pollutants.

SUBCATEGORY A 30 - INSTANT TEA

Existing In-Plant Technology - Existing methods of reducing wastewater quantity and pollutant loadings include separation of non-contact cooling water from process water, recirculation of non-contact water, and elimination of clarifier tea sludge from the process wastestream. Plant 99T04, which separates non-contact cooling water from process water and does not discharge clarifier tea sludge into its wastestream, exhibited a wastewater quantity approximately 67 percent less than the rest of the industry and BOD and suspended solids loadings approximately 78 and 83 percent less, respectively, than the rest of the industry. Plant 99T01 decreased waste flow by construction of a cooling tower and subsequent recycling of cooling water as cooling tower makeup.

Potential In-Plant Technology - Separation of all non-contact cooling water and boiler blowdown could be implemented to reduce wastewater quantity. Recycling of non-contact water could also reduce overall water use in the plants. Pollutant reductions in the process wastestream could be realized by disposal of clarifier tea sludge separately from the wastestream. This could be accomplished by centrifugation of the sludge with the solids portion subsequently utilized as cattlefeed or disposed as solid waste.

Additionally, the reuse of fresh rinse water as makeup for the caustic and acid rinses could conceivably reduce wastewater from equipment cleanup by as much as 60 percent. This is based on the assumption that each of the five cleanup cycles comprises 20 percent of the total equipment cleanup flow. Therefore if three cycles were reused, 60 percent less wastewater would be generated. Caustic and acid rinses could conceivably be recycled, to further reduce waste volume. The use of low output, high pressure nozzles for external equipment cleanup and floor washing could also reduce wastewater volume.

End-of-Line Technology - Instant tea process wastewater has been shown to be biodegradable and well suited for biological treatment. Presently, two instant tea manufacturing plants operate secondary treatment systems to reduce pollutant loadings prior to municipal discharge. The treatment system flow diagram for plant 39T01 is illustrated in Figure 220. The treatment system consists of the following major components.

1. A 53 cu m (0.014 MG) primary clarifier for removal of settleable solids.
2. A 680 cu m (0.180 MG) activated sludge tank which is aerated by the addition of diffused air.
3. A 409 cu m (0.108 MG) aerobic digestor aerated by use of diffused air.
4. A 20-foot diameter secondary clarifier with a volume of 121 cu m (0.032 MG).
5. Adjustment of wastestream pH by the addition of limewater prior to aeration.

The detention time of the activated sludge system is 24 hours minimum, 48 hours maximum. Sludge generation from the aerobic digestor totals approximately 400 Kg/day (900 lb/day) of dry solids at 2 to 4 percent solids concentration. The overall efficiency of the treatment system is a BOD reduction of 87 percent and a suspended solids reduction of 52 percent.

The wastewater treatment system at plant 99T04 has the following major components:

1. Screening of wastewater with solids going to landfill.
2. A 40 cu m (0.01 MG) equalization tank.
3. A 285 cu m (0.075 MG) activated sludge basin with a detention time ranging from 36 to 48 hours and with aeration provided by two mechanical aerators.
4. Two rectangular clarifiers in parallel.
5. An aerobic digestor, mechanically aerated, with sludge disposal to a cesspool.
6. Gaseous ammonia addition for neutralization of raw wastewater prior to activated sludge basin.

The system has been in operation for less than 12 months and some difficulty in optimizing efficiency is being experienced. The overall efficiency of the treatment system at this plant is a BOD reduction of 88 percent and a suspended solids reduction of 52 percent. Higher efficiencies would be expected after operation optimization.

Selection of Control and Treatment Technology

A model plant was developed for instant tea processing in Section V. The raw wastewater characteristics were assumed to be as follows:

Flow:	454 cu m/day (0.12 MGD)
BOD :	1000 mg/l
SS :	750 mg/l
pH :	5.0 to 6.8

DRAFT

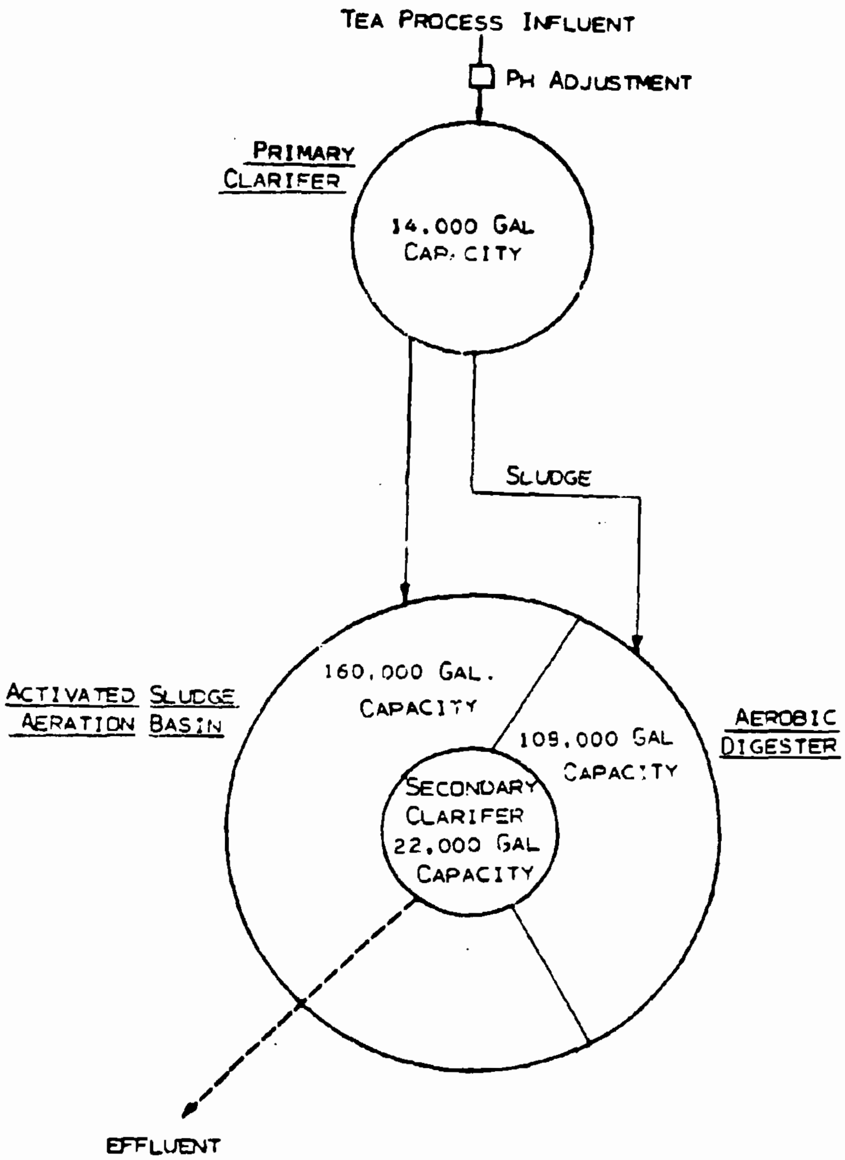


FIGURE 220

SECONDARY TREATMENT OF INSTANT TEA PROCESS WASTEWATER
PLANT 99T01

Table 127 lists the pollutant effluent loading and the estimated operating efficiency of each of the treatment trains selected for this subcategory. Figures 221 and 222 illustrate the treatment alternatives.

Alternative A 30-I - This alternative provides no additional treatment to the raw waste effluent.

Alternative A 30-II - This alternative consists of a pumping station, flow equalization, primary clarification, a complete mix activated sludge system, a sludge thickener, an aerobic digestor, and a vacuum filter. Flow equalization is provided to dampen the effects of shock loading to the system which would be expected due to variations in cleanup activities during the day. The primary clarifier is assumed to remove 20 percent of the BOD and 33 percent of the suspended solids. The activated sludge system is designed for a BOD loading of 800 lbs per day, a detention time of 34 hours, and a BOD reduction of 96 percent. The reduction of BOD is assumed based on the high biodegradability of the waste and the data from existing systems. The quantity of sludge from the vacuum filter is estimated at 1500 l/day (400 gal/day) for a yearly total of 219 x 10^5 cu m (773 cu yd) of sludge to be hauled.

The overall benefit of this alternative is a BOD reduction of 96 percent and a suspended solids reduction of 85.3 percent.

Alternative A 30-III - This alternative consists of the same modules as Alternative A 30-II except vacuum filtration is replaced by sand drying beds resulting in twice the amount of sludge to be hauled per year than that of Alternative A 30-II.

Alternative A 30-IV - This alternative consists of a pumping station, flow equalization, and an aerated lagoon. The lagoon volume is 10,900 cu m (2.88 MG). The overall efficiency of this alternative is a BOD reduction of 96 percent and a suspended solids reduction of 85.3 percent.

Alternative A 30-V - This alternative consists of the same modules as Alternative A 30-II with the addition of dual-media filtration. The overall benefit of this alternative is a BOD reduction of 98 percent and a suspended solids reduction of 97.3 percent.

Alternative A 30-VI - This alternative is identical to that of Alternative A 30-III with the addition of dual-media filtration. The overall benefit of this alternative is a BOD reduction of 98 percent and a suspended solids reduction of 97.3 percent.

Alternative A 30-VII - This alternative consists of the same modules as Alternative A 30-IV except for the addition of dual media filtration. The overall benefit of this system is a BOD reduction of 98 percent and a suspended solids reduction of 97.3 percent.

Alternative A 30-VIII - This alternative consists of a pumping station and flow equalization followed by spray irrigation. The land requirement for this alternative is 9.7 ha (24 acres) and it is assumed that

DRAFT

TABLE 127

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
Subcategory A 30
(INSTANT TEA)

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent Removal BOD	Percent Removal SS
A30-I	50	37.5	0	0
A30-II	2.00	5.50	96	85.3
A30-III	2.00	5.50	96	85.3
A30-IV	2.0	5.50	96	85.3
A30-V	1.0	1.0	98	97.3
A30-VI	1.0	1.0	98	97.3
A30-VII	1.0	1.0	98	97.3
A30-VIII	0	0	100	100

DRAFT

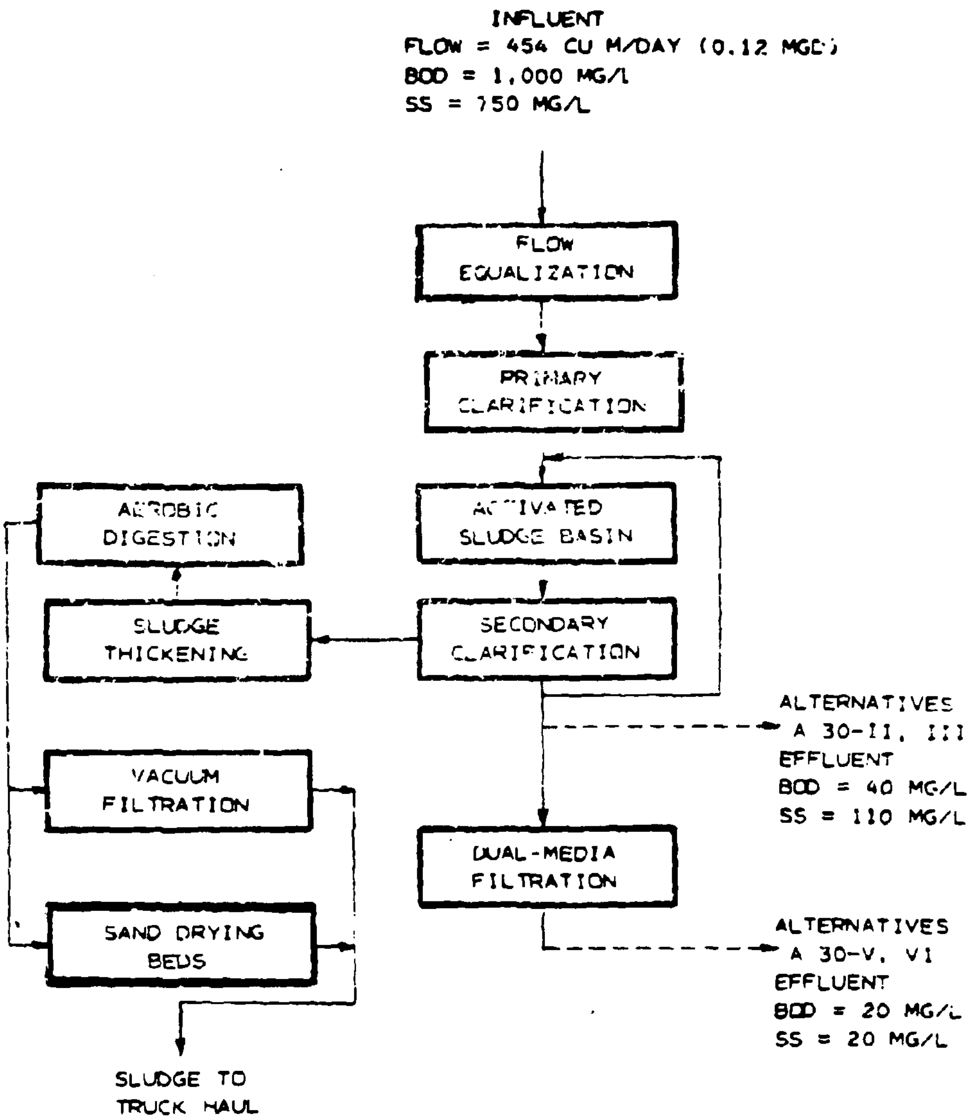


FIGURE 221

SUBCATEGORY A30
TREATMENT ALTERNATIVES II, III, V, AND VI

DRAFT

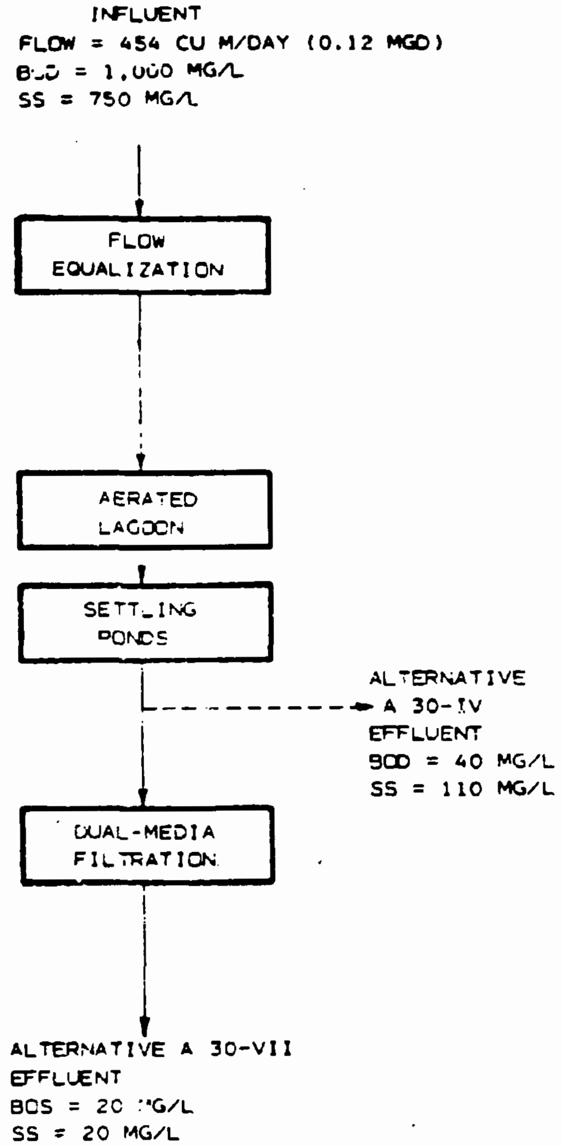


FIGURE 222

SUBCATEGORY A30
TREATMENT ALTERNATIVES IV AND VII

the spray field will be a maximum of one-half mile from the plant. The overall benefit of this alternative is a BOD and SS reduction of 100 percent in terms of discharge to navigable waters.

SUBCATEGORY C 8 - COFFEE ROASTING UTILIZING ROASTER WET SCRUBBERS

In-Plant Technology

At the present time, no measures are employed to reduce the strength of the wastewater from coffee roaster wet scrubbers. The volume of flow from the wet scrubbers is determined by the degree of odor control desired and the type of scrubber used. The flow can be minimized by selecting a type of wet scrubber which effects the desired degree of odor removal with the least amount of water consumption.

One plant contacted during this study and a pilot plant study indicate that a recirculating type of roaster wet scrubber can be utilized. The use of a recirculating type of scrubber could reduce the volume of wastewater generated per kkg (ton) of product by more than 90 percent. The solids which accumulate in the recirculation tank could be disposed of in a landfill. In this way, wastewater discharge from roaster wet scrubbers could be nominal.

End-of-Line Technology

Coffee roasting plants which utilize roaster wet scrubbers normally discharge their wastewater to municipal systems. Since roaster wet scrubber wastewater is not particularly strong (BOD of 100 to 500 mg/l and suspended solids of about 200 mg/l), municipal treatment systems have been able to treat the wastes with no difficulty. As a result, no information has been developed on possible methods for treating the wastewater from roaster wet scrubbers.

Selection of Control and Treatment Technology

In Section V of this document, a model plant was developed for coffee roasting utilizing once-through roaster wet scrubbers. The raw wastewater characteristics without screening were as follows:

BOD 350 mg/l

SS 200 mg/l

Flow 0.063 mld (0.017 mgd)

Since the strength of coffee roaster wet scrubber wastewater is approximately that of normal domestic sewage, no pretreatment before discharge to municipal systems should be necessary. It is assumed that conventional biological treatment methods are applicable to these wastes because of their similarity to municipal sewage.

Table 128 lists the pollutant effluent loading and the estimated operating efficiency of each of the five treatment trains selected for this subcategory.

DRAFT

TABLE 128

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

Treatment Train Alternative			Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent BOD Reduction	Percent SS Reduction
C 8	- I	A	0.76	0.43	0	0
C 8	- II	BEGKOSV	0.043	0.043	95	90
C 8	- III	BEGKOSVN	0.021	0.013	97	97
C 8	- IV	BL	0.076	0.086	90	80
C 8	- V	BLN	0.038	0.025	95	94

Alternative C 8 - I - This alternative provides no additional treatment to the screened wastewater.

Alternative C 8 - II - This alternative consists of a pumping station, caustic neutralization, a primary clarifier, an activated sludge aeration basin, secondary clarifier, sludge thickening vacuum filtration, and sludge pumping and storage.

Alternative C 8 - III - This alternative consists of all of the treatment modules of Alternative C 8 - II with the addition of dual media pressure filtration and the associated pumping station. A schematic diagram of Alternative C 8 - III is shown in Figure 223.

Alternative C 8 - IV - This alternative consists of a pumping station, aerated lagoons, and associated settling ponds.

Alternative C 8 - V - This alternative consists of the treatment modules of Alternative C 8 - IV with the addition of a dual media pressure filtration and the associated pumping station. A schematic diagram of Alternative C 8 - V is shown in Figure 224.

SUBCATEGORY C 9 - DECAFFEINATION OF COFFEE

In-Plant Technology

Currently efforts to reduce the waste load from plants producing decaffeinated coffee center on instruction of the personnel in water conservation. Since the equipment and floors are wet cleaned, the volume of wastewater generated can be minimized by use of efficient cleanup procedures. Some plants, especially those which are subject to municipal surcharge programs, also stress the handling of screened solids for disposal as solid waste.

Reductions in wastewater volume could be achieved through elimination of the dewatering screen or redesigning it to reduce the quantity of water required to prevent clogging of the screen. In addition, water meters could be installed at the cleanup stations to make cleanup personnel accountable for their water usage.

Reductions in wastewater strength could be accomplished by segregation of the wastewater sources within the decaffeination process; e.g., the high strength/low volume waste stream from centrifuge blowdown could be handled as a sludge and hauled away for land disposal (burial). In addition, by installing a storage tank, the equipment cleaning solutions could be used several times before becoming so dirty that they must be disposed to the waste stream; currently these cleaning solutions are used only once.

DRAFT

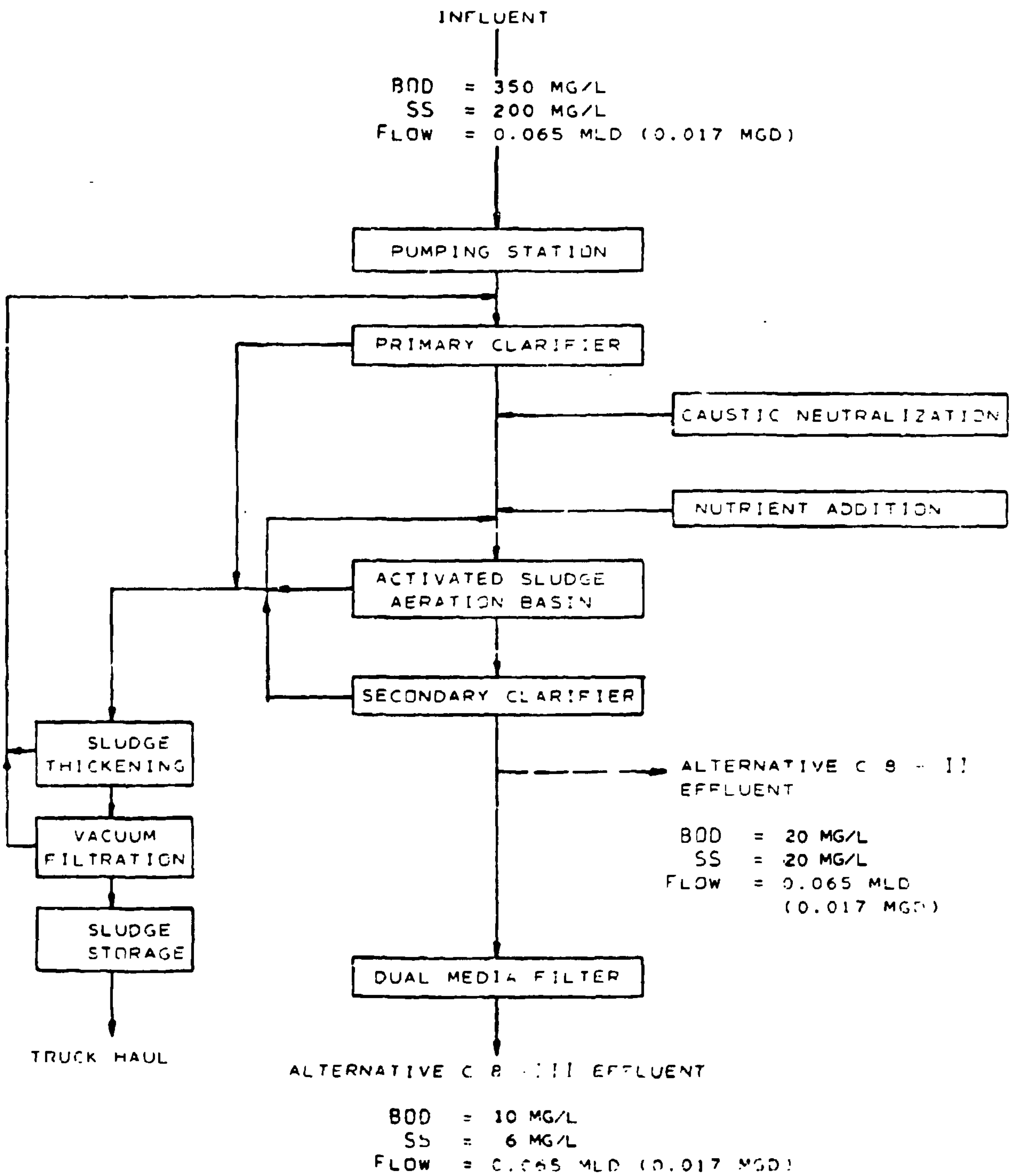


FIGURE 223

CONTROL AND TREATMENT ALTERNATIVES C 8 - II AND III

DRAFT

End-of-Line Technology

All of the decaffeinated coffee producers in this country discharge their wastes to municipal treatment systems; therefore, no complete treatment systems are currently used to treat this type of wastewater. Three plants are known to utilize primary clarification followed by a multi-stage evaporative concentrator to pre-treat their soluble and/or decaffeination coffee process wastewaters prior to discharge to municipal sewers.

Some producers of decaffeinated coffee, in this country and abroad, have conducted studies on the characteristics and treatability of coffee processing wastes. The National Coffee Association has reported (103) that the wastewater is biologically treatable. Municipalities currently receiving coffee decaffeination wastewater report no particular problems in treating the waste. Unlike soluble coffee process wastewater, the color characteristics of this wastewater are such that they apparently do not create a problem during treatment.

Selection of Control and Treatment Alternatives

In Section V, a model plant was developed for decaffeinated coffee production. It was assumed that the model plant provided screening of its wastewater prior to discharge. The raw wastewater characteristics were assumed as follows:

1. Flow rate - average - 0.24 mld (70,000 gpd)
2. BOD - 864 mg/l
3. SS - 1590 mg/l
4. pH - 4.3 to 7.2
5. 3.8 kg BOD per kkg of green coffee processed
6. 7.0 kg SS kkg of green coffee processed
7. N - 0 mg/l (deficient)
8. P - 0 mg/l (deficient)

Table 129 lists the pollutant effluent loading and the estimated operating efficiency of each of the three treatment trains selected for this subcategory. A schematic diagram of all of the following alternatives is shown in Figure 225.

Alternative C 9 - I - This alternative provides no additional treatment to the screened wastewater.

DRAFT

TABLE 129

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent BOD Reduction	Percent SS Reduction
9 - I - A	3.8	7.0	0	0
C 9 - II - BCEGVY	2.5	1.8	35	75
C 9 - III - BCEGHIKQVNY	0.09	0.09	97	99

DRAFT

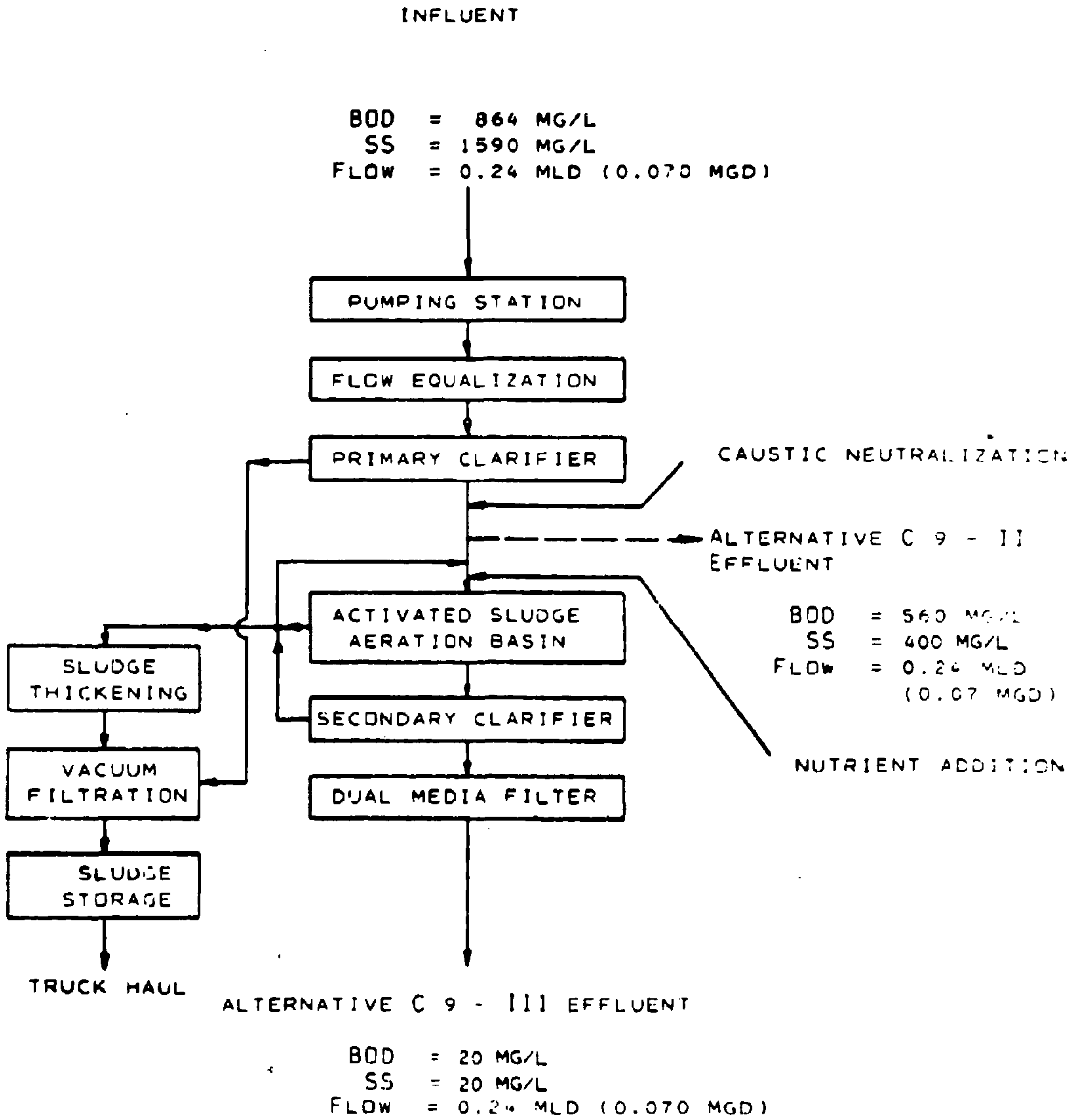


FIGURE 225

CONTROL AND TREATMENT ALTERNATIVE C 9-II, III AND IV

Alternative C 9 - II - This alternative consists of a pumping station, flow equalization basin, primary clarifier, caustic neutralization, vacuum filter, and sludge storage tank.

Alternative C 9 - III - This alternative consists of the treatment modules of Alternative C 9 - II plus nitrogen addition, phosphorus addition, activated sludge aeration basin, secondary clarifier, sludge thickening, a dual media filter, and associated pumping station.

SUBCATEGORY C 10 - SOLUBLE COFFEE

In-Plant Technology

Currently the efforts of soluble coffee manufacturers to reduce the waste load from their plants center around reduction of water consumption. Cleanup personnel in some plants are educated in water conservation practices. Contact and non-contact waste streams have been separated in many plants to permit the reuse or direct discharge to navigable waters of non-contact wastewaters.

Several other procedures could be utilized to control wastewater from soluble coffee plants. Use of rotary drying in lieu of grounds pressing as a means of reducing the moisture content of spent grounds substantially reduces the plant waste load. However, rotary drying uses more energy than grounds pressing. One plant contacted indicated that it was planning on installing water meters at each cleaning station. The cleanup foreman would then be responsible for insuring that water consumption was within the prescribed limits. One plant contacted indicated that they planned to install a storage tank to permit recovery and reuse of caustic cleaning solutions.

End-of-line Technology

All soluble coffee plants discharge to municipal sewers. In most cases the municipal treatment systems are ones serving large cities, with the result that the wastewater from the coffee plant is only a small percentage of the average daily flow through the treatment facility. Where this situation exists, the municipal treatment systems reportedly are capable of adequately treating the soluble coffee plant wastewater. However, soluble coffee plants which are located in small municipalities have found that the municipal treatment systems are incapable of treating their entire wasteload. Chalmers (140) has studied this problem, and in at least three instances soluble coffee plants (two are in the United States) have installed pre-treatment systems which utilize clarifiers and multi-stage evaporative concentrators to remove a majority of the waste load (especially suspended solids and color) from the waste stream. The resulting condensate is then discharged to the municipal treatment system for further treatment, and the concentrated sludge is disposed by burial on land or ocean dumping. The capital cost and the operation and maintenance cost for evaporative condensers as a treatment method are high. A significant percentage of the operating cost is for energy, both electrical consumption and fuel oil.

One plant of these three plants plans to replace its evaporative condenser pre-treatment system with a physical-chemical pre-treatment system utilizing air flotation or centrifugation, chemical addition, and carbon absorption for suspended solids and color removal. Pilot tests of this system are just beginning and final selection of the treatment modules to be utilized has not been made. As a result this method of treatment could not be included within the scope of this report at the present time.

In addition, it has been reported that at least one complete treatment facility for soluble coffee wastewater is operating outside this country. Information concerning this treatment system is not published and unavailable at the present time.

Selection of Control and Treatment Technology

In Section V a model plant was developed for soluble coffee processing. It was assumed that the model plant provided screening of its wastewater prior to discharge. The raw wastewater characteristics after screening were assumed as follows:

1. Flow - 0.62 mld (0.18 mgd)
2. BOD - 2400 mg/l
3. SS - 1560 mg/l
4. pH - 4 to 5
5. N - 0 mg/l (deficient)
6. P - 0 mg/l (deficient)
7. Color - 2775 Cobalt - platinum units

Table 130 lists the pollutant effluent loading and the estimated operating efficiency of each of the four treatment trains selected for this subcategory.

Alternative C 10 - I - This alternative provides no additional treatment to the screened wastewater.

Alternative C 10-II - This alternative consists of a pumping station, flow equalization basin, primary clarifier, multi-stage evaporative concentrator, caustic neutralization and sludge storage tank. The removal efficiencies shown in Table 130 for Alternative C 10-II are based on data collected during this study from a plant employing this treatment train. A schematic diagram of Alternative C 10-II is shown in Figure 226. The primary purpose of this treatment train is the removal of color.

TABLE 130

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

DRAFT

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent COD Reduction	Percent SS Reduction
C 10 - I - A	18.8	12.3	0	0
C 10 - II - BCEDIGVY	1.9	0.25	90	99
C 10 - III - BCEGHIKQSVNY	0.47	0.35	96	94
C 10 - IV - BCEDIGHIKQSVY	0.19	0.04	99	99+

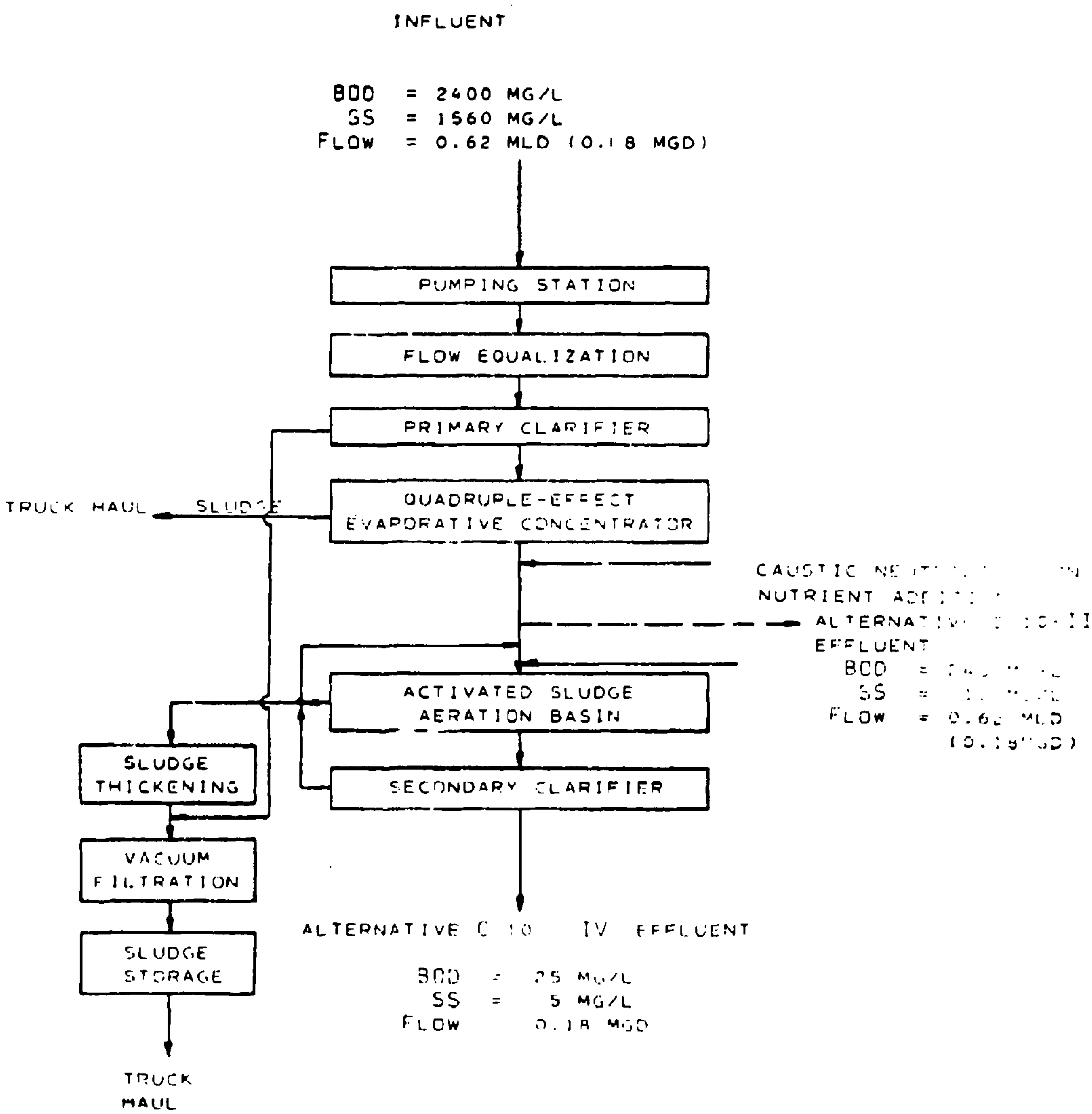


FIGURE 226

CONTROL AND TREATMENT ALTERNATIVES C 10-II AND IV

Alternative C 10-III - This alternative consists of a pumping station, flow equalization basin, primary clarifier, caustic neutralization, nitrogen addition, phosphorus addition, activated sludge aeration basin, secondary clarifier, sludge pumping, sludge thickening, vacuum filter, sludge storage, and dual media filter. A schematic diagram of Alternative C 10-III is shown in Figure 227. This alternative is presented for use at plants which do not have a significant color problem associated with their wastewater.

Alternative C 10-IV - This alternative consists of the treatment modules of Alternative C 10-II plus nitrogen addition, phosphorus addition, activated sludge aeration basin, secondary clarifier, sludge pumping, sludge thickener, vacuum filter, and sludge storage. A schematic diagram of Alternative C 10-IV is shown in Figure 226.

SUBCATEGORY F 1 - TEA BLENDING

As described in Sections III and V of this document, the blending of tea is a dry process generating no wastewater. Therefore, no wastewater control and treatment technology is necessary.

SUBCATEGORY G 1 - BAKERY AND CONFECTIONERY PRODUCTS

In-Plant Technology

In-plant technology and procedures aimed at reducing waste load are primarily divided into two subcategories: production procedures, and cleanup operations. Since essentially all wastewater originates from cleaning equipment, both existing and potential methods of reducing either the strength or volume of the waste stream are aimed at less frequent wet cleaning of equipment.

Existing In-Plant Technology - With pan washing as the greatest single source of high strength waste, considerable efforts have been made to reduce or eliminate this operation. Cake bakeries attempt to wash their pans as infrequently as possible; however, the majority still wash the pans after each use. Some types of cakes, particularly the snack cakes, are amenable to production methods which eliminate pan washing entirely; however, full size cakes are almost universally baked in pans that do require wet cleaning. Three approaches to decreasing the pan washing waste load have been noted:

1. Dry cleaning the cake pans to the greatest extent possible

2. Baking cakes in one-way containers; e.g., aluminum foil pans or paper cupcake liners which also serve as partial containers for the finished product

3. The complete elimination of cake pans

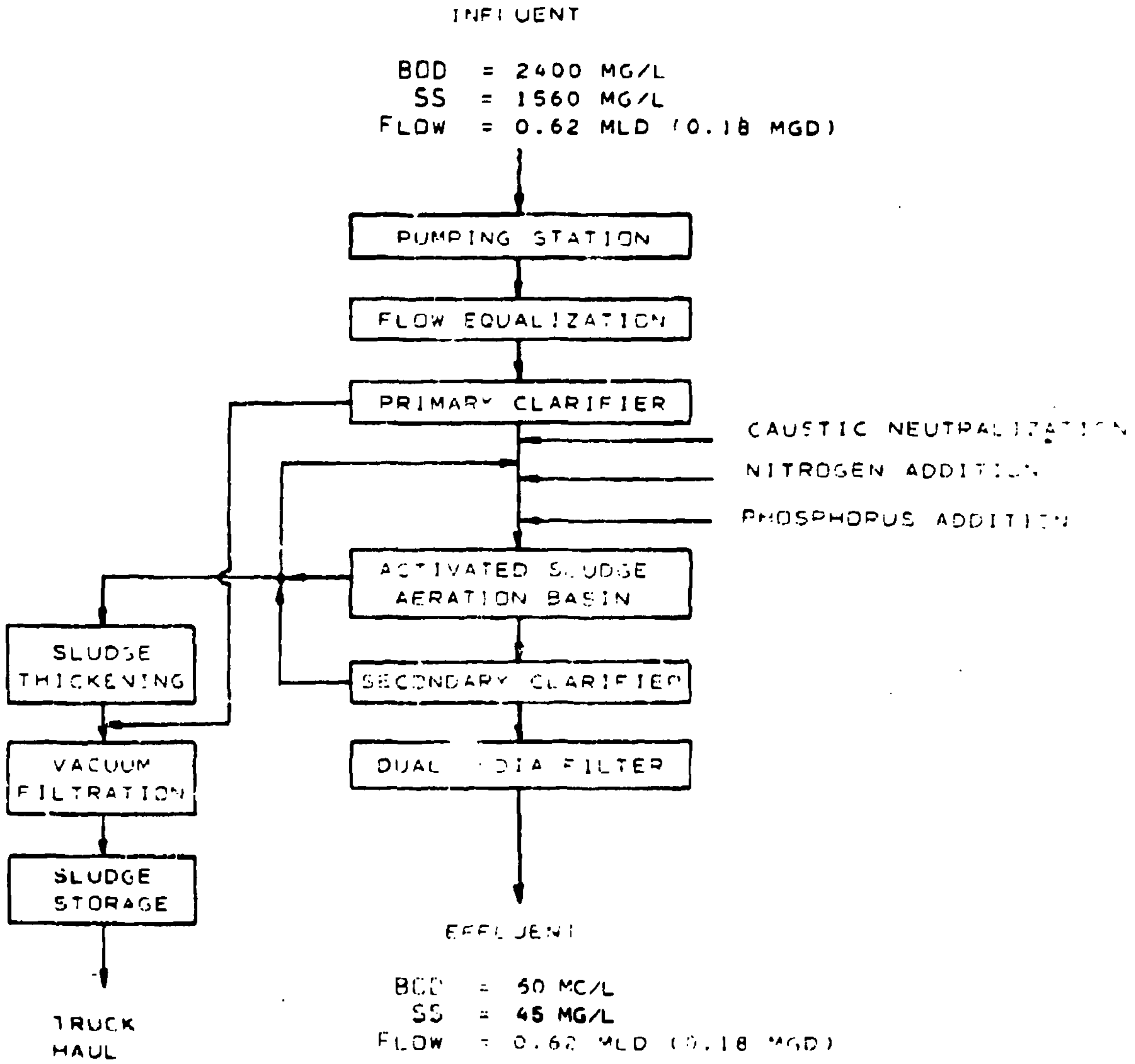


FIGURE 227

CONTROL AND TREATMENT ALTERNATIVE C 10 - III

Modifications and approaches to cleaning equipment in the plant itself have and will continue to decrease waste loads. In general, management of bakeries stresses the dry cleaning of as much equipment as possible before it is cleaned with water, particularly bakeries which have their own wastewater treatment facilities. In such plants, mixers, vats, hand utensils, and conveyors are cleaned as thoroughly as possible by hand using rubber scrapers, rags, and air hoses. Then they are either moved to the wash room or for larger equipment, they are washed using their clean-in-place system. The success of this approach in reducing the waste load appears to hinge on the motivation of the individual workers within the bakery. The extra effort required in thoroughly scraping a vat or mixer may appear to be busy work to many employees, and they must be continually reminded of the importance of thorough dry cleaning before the use of water in cleaning any equipment.

Potential In-Plant Technology - Potential methods of reducing a cake bakery's waste load hinge on decreasing the amount of wet cleaning required. The reduction or elimination of pan washing using one of the approaches listed above will have the greatest impact on reducing the strength of a bakery's waste stream. Increased stress on dry cleaning, particularly of equipment taken to the wash room for final wet cleaning, will minimize the amounts of pollutants entering the waste stream.

Another potential approach is a decrease in the number of varieties of cakes and pies produced in a single bakery. Some bakeries make hundreds of varieties of cakes. After the mixing and depositing of the batter and filling for each variety of cake, the equipment is usually cleaned before the next variety of cake is mixed. These variety-induced cleanings occur as frequently as every two hours. By reducing the number of product variations, a bakery can reduce its waste load.

End-of-Line Technology

Only one bakery in this subcategory is known to have a wastewater treatment system that approaches the degree of treatment required prior to discharge to navigable waters. The facility is atypical to this subcategory in that the bakery is located where treatment plant effluent can be disposed of via infiltration lagoons. Another unusual feature is the fact that the system employs physical-chemical methods rather than biological treatment. The treatment system is shown as a block diagram in Figure 228.

While the facility achieves up to 9[illegible] percent removal of BOD, from about 28,000 mg/l to 1,400 mg/l, the operation of the system is still somewhat in the shakedown phase. Considerable experimentation is continuing and reliable operation is apparently operator sensitive as witnessed by the fact that the designer of the system has been retained as its chief operator. Additionally, with the outlawing of infiltration as a disposal

DRAFT

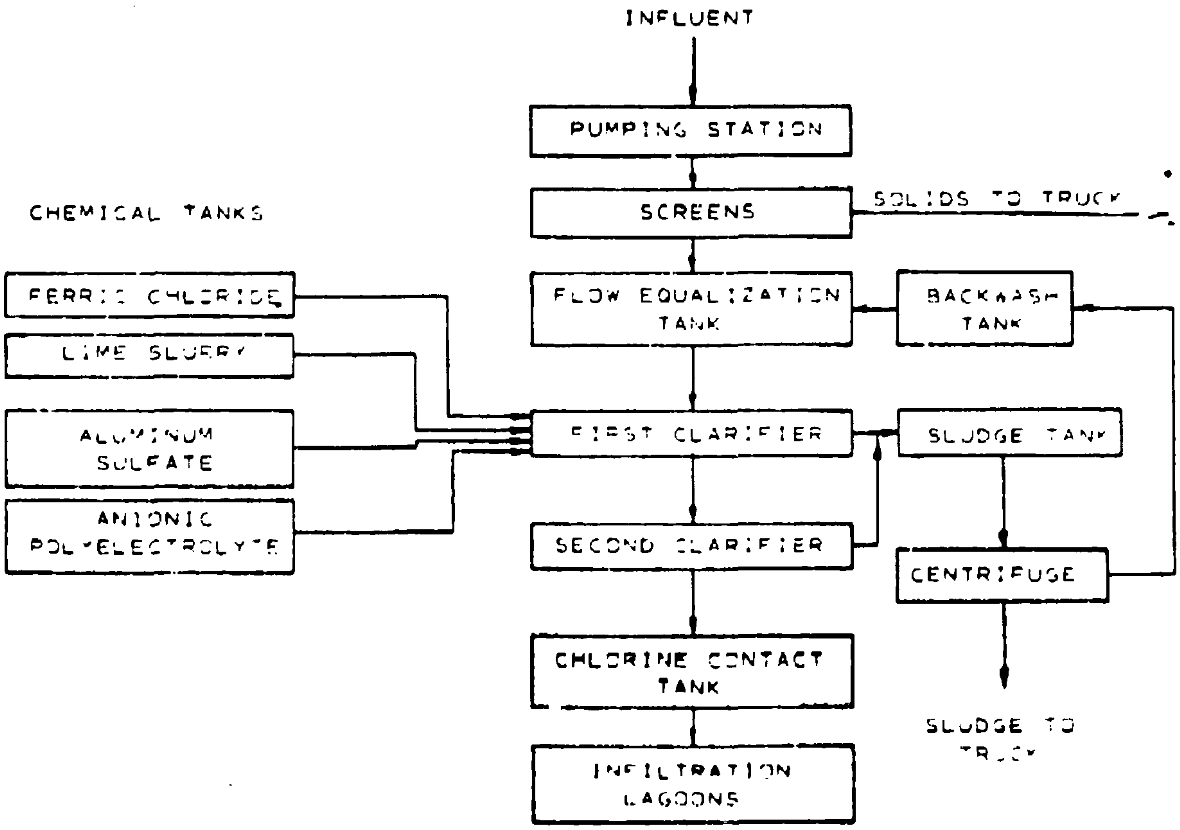


FIGURE 22B

PHYSICAL - CHEMICAL TREATMENT OF
BAKERY WASTES - SUBCATEGORY C2

method in the location of the bakery, additional refinement of this system and/or additional treatment modules will have be incorporated to accommodate surface discharge. Thus, this physical chemical approach may serve as a pre-treatment to a conventional biological system, but will not provide the degree of treatment needed for surface discharge, at least in its present configuration.

Sludge disposal is receiving some attention by bakeries in this and other subcategories. One bakery spray irrigates its sludge. Two plants are experimenting with feeding the sludge to cattle.

Selection of Control and Treatment Technology

In Section V, a model plant was developed for the production of cakes, pies, doughnuts, and sweet yeast goods utilizing pan washing. The wastewater was screened prior to discharge, and its characteristics after screening were assumed to be as follows:

BOD 28,000 mg/l or 94.2 kg/kkg

SS 5,000 mg/l or 16.8 kg/kkg

Oil & Grease 500 mg/l or 1.7 kg/kkg

pH 6.0 to 7.0

N 2 mg/l

P 20 mg/l

Flow 0.45 mld (120,000 gpd)

Production 135 kkg/day (150 tons/day)

Table 131 lists the effluent characteristics and the estimated operating efficiency of each of the treatment trains selected for this subcategory.

Alternative C 1 - I - This alternative provides no additional treatment to the wastewater.

Alternative C 1 - II - This alternative consists of the treatment modules used in the physical-chemical treatment system described above. Exceptions are the elimination of the chlorine contact tank, infiltration lagoons and associated equipment. Solids and sludge are assumed to be truck hauled to a sanitary landfill.

TABLE 131

SUMMARY OF TREATMENT TRAIN ALTERNATIVES - SUBCATEGORY C 1

Treatment Train Alternative		Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O & G kg/kkg	Percent BOD Reductions	Percent SS Reductions	Percent O & G Reductions
C 1 - I	A	94.2	16.8	1.7	0	0	0
C 1 - II	BCDEEOV	4.7	0.50	0.02	95	97	99
C 1 - III	BCDEEHIKQSVO	0.47	0.34	0.01	99	98	99
C 1 - IV	BCDEEHIKQSVWO	0.24	0.17	0.005	99	99	99

DRAFT

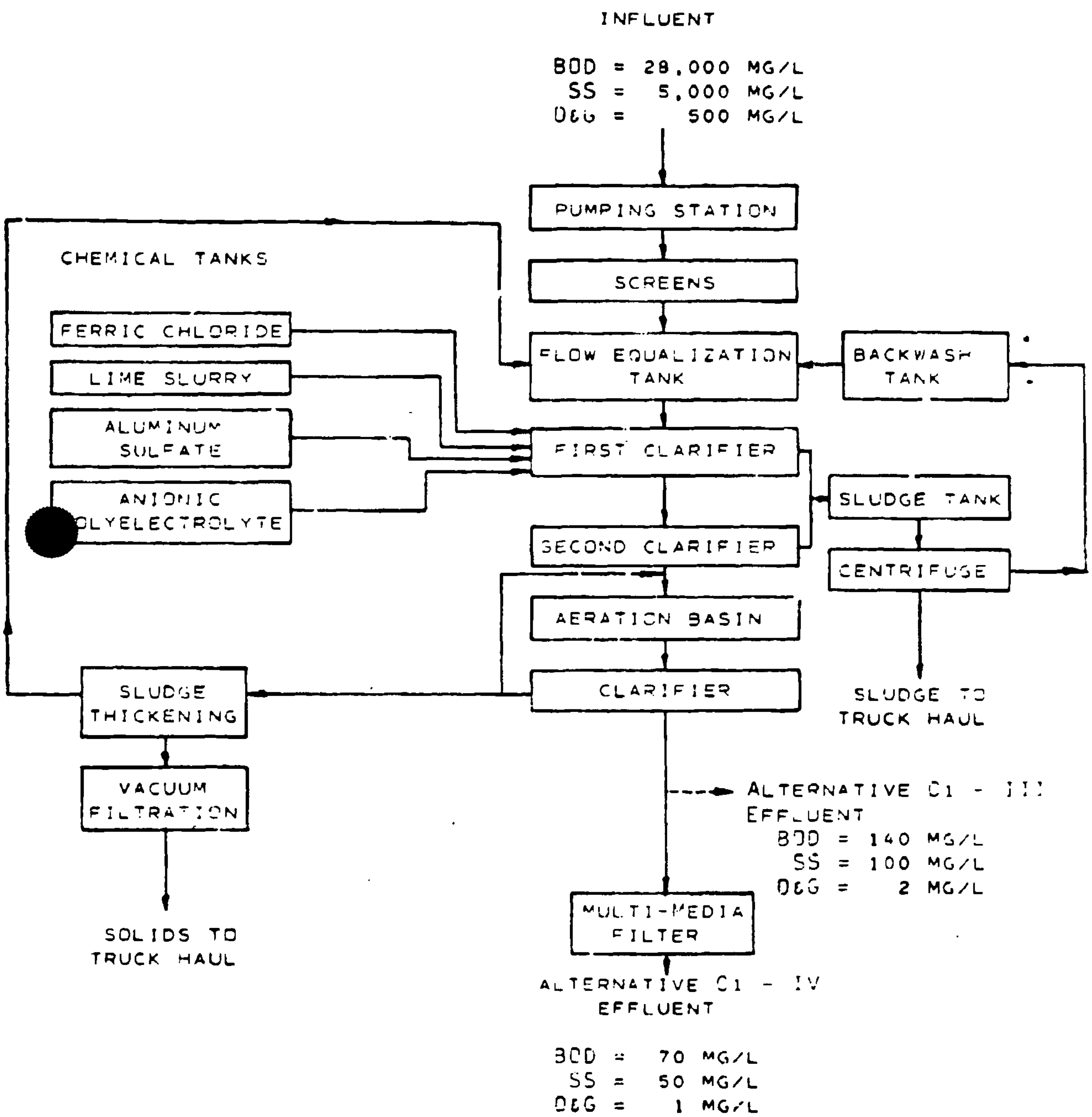


FIGURE 229

TREATMENT ALTERNATIVES C1 - III AND C1 - IV

Another potential approach is a decrease in the number of varieties of items produced in a single bakery or on a single production line. Usually when variety changes are made, several pieces of equipment must be wet cleaned. The items involved include mixers, depositors, and interconnecting pipes and pumps. These variety-induced cleanings occur as frequently as every two hours. By reducing the number of product variations, a bakery can reduce its waste load.

End-of-Line Technology

Only one bakery in this subcategory is known to have a wastewater treatment system discharging to navigable waters. This treatment plant is shown schematically in Figure 230. It has been developed and modified over several years. It has provided adequate treatment for the bakery's waste. The most recent performance data indicate BOD and suspended solids reductions averaging 99 percent and 98 percent, respectively. The plant was designed to handle 0.195 mld (50,000 gpd) with a BOD concentration of 2,500 mg/l (a BOD loading of 473 kg per day or 1,040 lb per day). Currently, the average daily flow is approximately 90 percent of design and BOD concentrations average 2,210. The BOD concentrations in the effluent currently average 8 mg/l and range from 7 to 9 mg/l. No design parameters were established for suspended solids; however, current influent concentrations average approximately 1,020 mg/l, and the effluent averages 12 mg/l with ranges from 6 to 15 mg/l. Similarly, no design criteria was established for oil and grease. The current influent oil and grease concentration averages about 695 mg/l while the effluent contains an average of 8 mg/l and ranges from 2 to 18 mg/l.

The design of this treatment facility appears to be particularly appropriate to bakery wastes for the following reasons:

1. The air flotation unit is effective in removal of oil and grease and suspended solids.

2. The plastic media trickling filter is credited by plant personnel with removal of significant amounts of oil and grease, and an adjustment of the pH such that no chemical neutralization is required. Measurements of filter influent and effluent (141) indicate near neutralization of the raw waste's pH of 5 by the unit. The filter is also effective in handling the shock loading applied by the bakery.

Selection of Control and Treatment Technology

In Section V, a model plant was developed for the production of cakes and other bakery products using methods that did not involve pan washing. It was assumed that screening was provided all wastewater before discharge. The raw wastewater characteristics after screening were as follows:

DRAFT

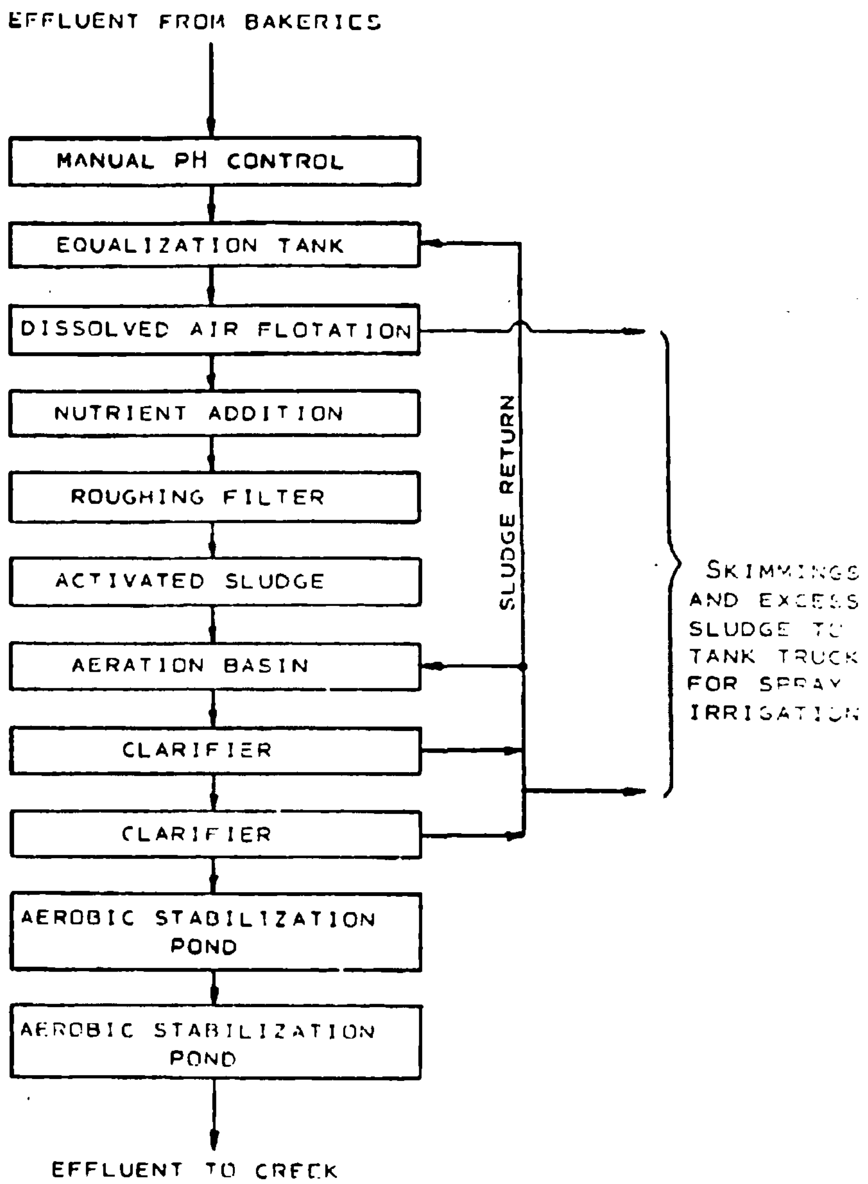


FIGURE 230

EXISTING TREATMENT TECHNOLOGY - SUBCATEGORY C 2

TABLE 132

SUMMARY OF TREATMENT TRAIN ALTERNATIVES SUBCATEGORY C 2

DRAFT

Treatment Train Alternative		Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
I	A	2.0	0.94	0.63	0	0	0
II	BCJV	1.0	0.28	0.19	50	70	70
III	BCJVHX	0.50	0.14	0.085	75	85	85
IV	BCJSVHXK	50	0.042	0.026	97	95	95
V	BCJSVHXKN	0.025	0.011	0.013	99	99	98
VI	BCJSVHKM	0.025	0.022	0.013	99	98	98
VII	BHL	0.20	0.28	0.19	90	70	70
VIII	BHLU	N/A	N/A	N/A	100	100	100

DRAFT

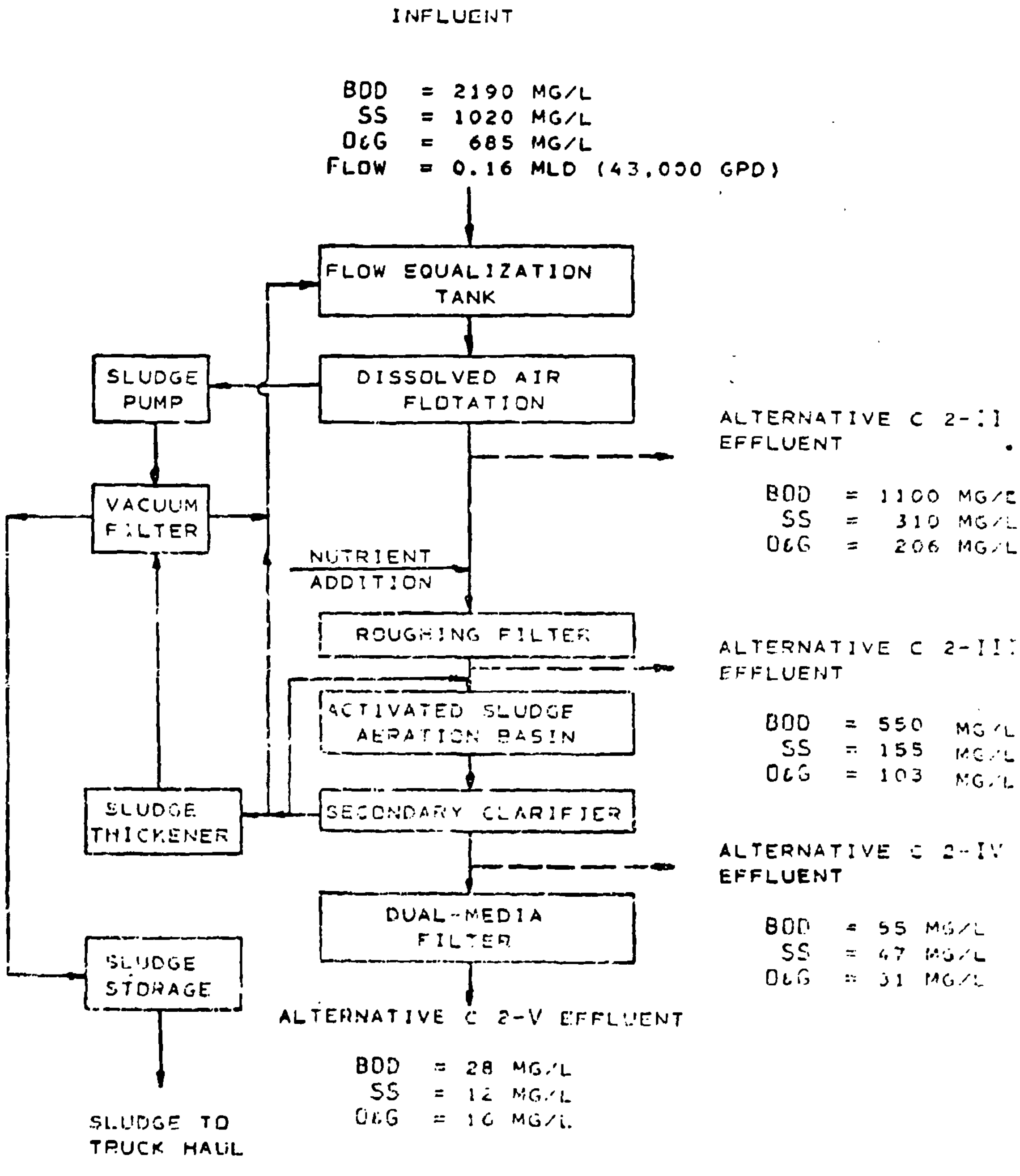


FIGURE 237

TREATMENT ALTERNATIVES C 2-II THROUGH C 2-V

3. Sludge thickener

4. Additional capacity for vacuum filtration

Alternative C 2-V - This alternative includes the treatment modules in Alternative C 2-IV with the addition of a dual media pressure filtration system.

Alternative C 2-VI - This alternative includes the treatment modules in Alternative C 2-V with two aerobic stabilization ponds replacing the dual media pressure filtration system.

Alternative C 2-VII - This alternative consists of the following:

1. Caustic neutralization

2. Nutrient addition (nitrogen)

3. An aerated lagoon system

Figure 232 illustrates this alternative schematically.

Alternative C 2-VIII - This alternative includes the treatment modules in Alternative C 2-VII with the addition of spray irrigation (see Figure 233).

SUBCATEGORY C 3 - BREAD AND BUNS

In-Plant Technology

At the present time, many bread and bun bakeries are aware of their wastewater problem. Sanitary, contact, and non-contact wastewaters have been separated in many plants. Some plants emphasize dry cleaning of equipment and floors prior to wet cleaning.

In addition, wastewater flow and strength could be reduced if all floors were vacuumed, scraped, or swept before wet cleaning. Where CIP systems are used, if the final rinse water from one cleaning operation were utilized as the pre-rinse water for the subsequent cleaning operation, the volume of wastewater would be reduced.

End-of-Line Technology

No bakery in this subcategory is known to have a wastewater treatment system that approaches the degree of treatment required for discharge to navigable waters. All of the bakeries surveyed in this subcategory discharge to municipal sewage systems, and none of them provided treatment other than screening.

DRAFT

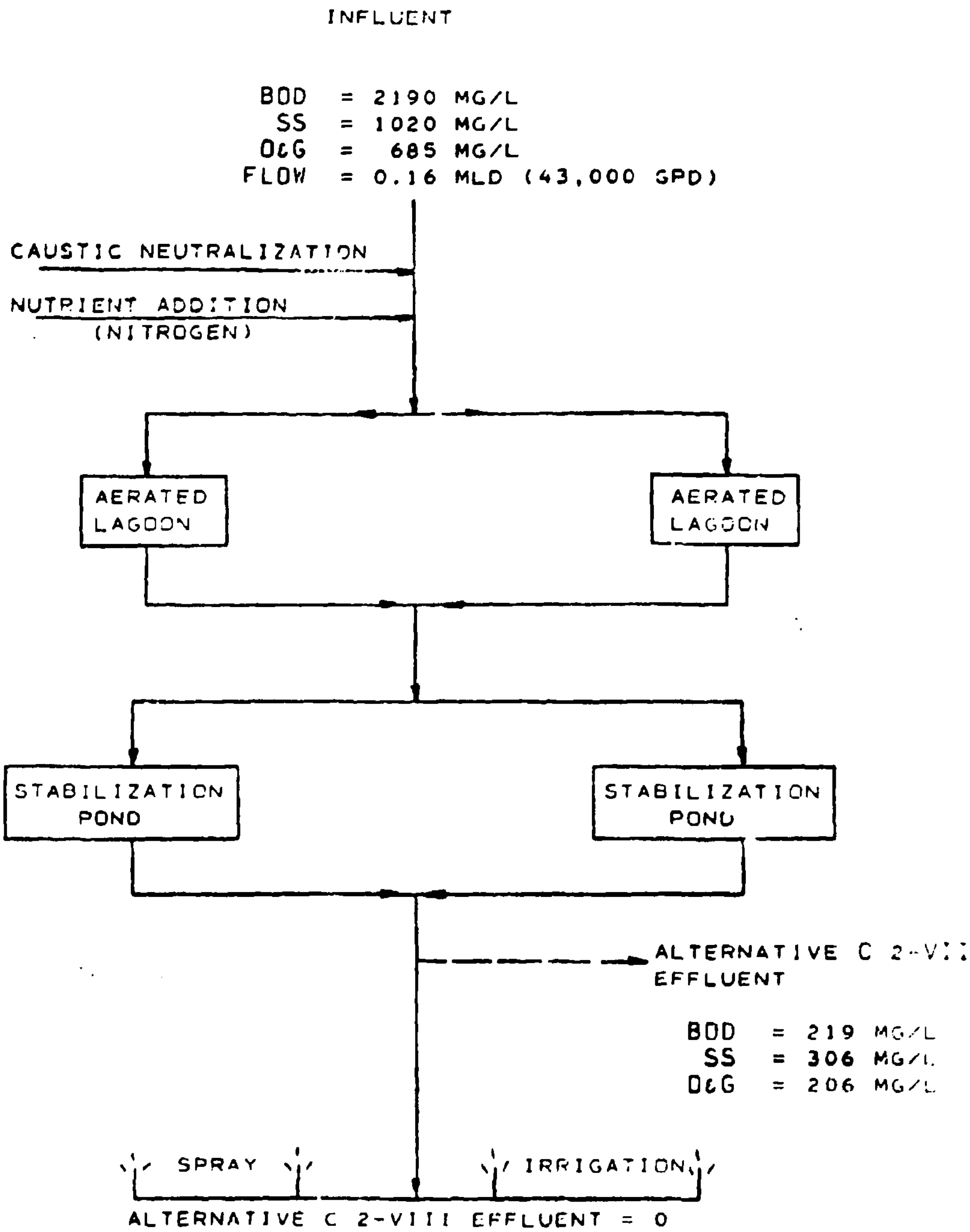


FIGURE 232

TREATMENT ALTERNATIVES C 2-VII AND C 2-VIII

Selection of Control and Treatment Technology

In Section V of this document, a model plant was developed for bread and bun bakeries. The raw waste characteristics after screening were assumed to be as follows:

1. Flow - 0.10 mld (0.026 mgd)

2. BOD - 422 mg/l

3. SS - 214 mg/l

4. pH - 6.0 to 9.0

5. P - 0 mg/l (deficient)

6. N - 0 mg/l (deficient)

Since all known bread and bun bakeries currently discharge to municipal sewers, a transfer of treatment technology is required. Plants in Subcategory C 2, manufacturing cakes and pies without utilizing pan washing, have a waste strength greater than, and a waste source similar to, plants producing bread and buns. In addition, the waste strength of bread and bun bakeries is less than twice that of municipal sewage. Since there is no indication of any particular complicating characteristics of bread bakery wastewater, the treatment alternatives discussed below were selected based on their satisfactory performance in treating municipal sewage and wastes from Subcategory C 2 .

Table 133 lists the pollutant effluent loading and the estimated operating efficiency of each of the four treatment trains selected for this subcategory.

Alternative C 3 - I - This alternative provides no additional treatment to the screened wastewater.

Alternative C 3 - II - This alternative consists of a pumping station, flow equalization basin, primary clarifier, nitrogen addition, phosphorus addition, activated sludge aeration basin, secondary clarifier, sludge pump, sludge thickener, vacuum filter, and sludge storage. A schematic diagram of Alternative C 3 - II is shown in Figure 233.

Alternative C 3 - III - This alternative consists of the treatment modules of Alternative C 3 - II with the addition of a dual media filter and associated pumping station. A schematic diagram of Alternative C 3 - III is shown in Figure 233.

Alternative C 3 - IV - This alternative consists of a pumping station, nitrogen addition, phosphorus addition, aerated lagoon, two settling ponds, pumping station, and dual media pressure filter. A schematic diagram of Alternative C 3 - IV is shown in Figure 234.

TABLE 133

Summary of Treatment Train Alternatives

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent BOD Reduction	Percent SS Reduction
C 3 - I	0.88	0.46	0	0
C 3 - II BCEHIKQSVY	0.045	0.045	95	85
C 3 - III BCEHIKNQSVY	0.012	0.011	98	98
C 3 - IV BHILN	0.044	0.044	95	88

DRAFT

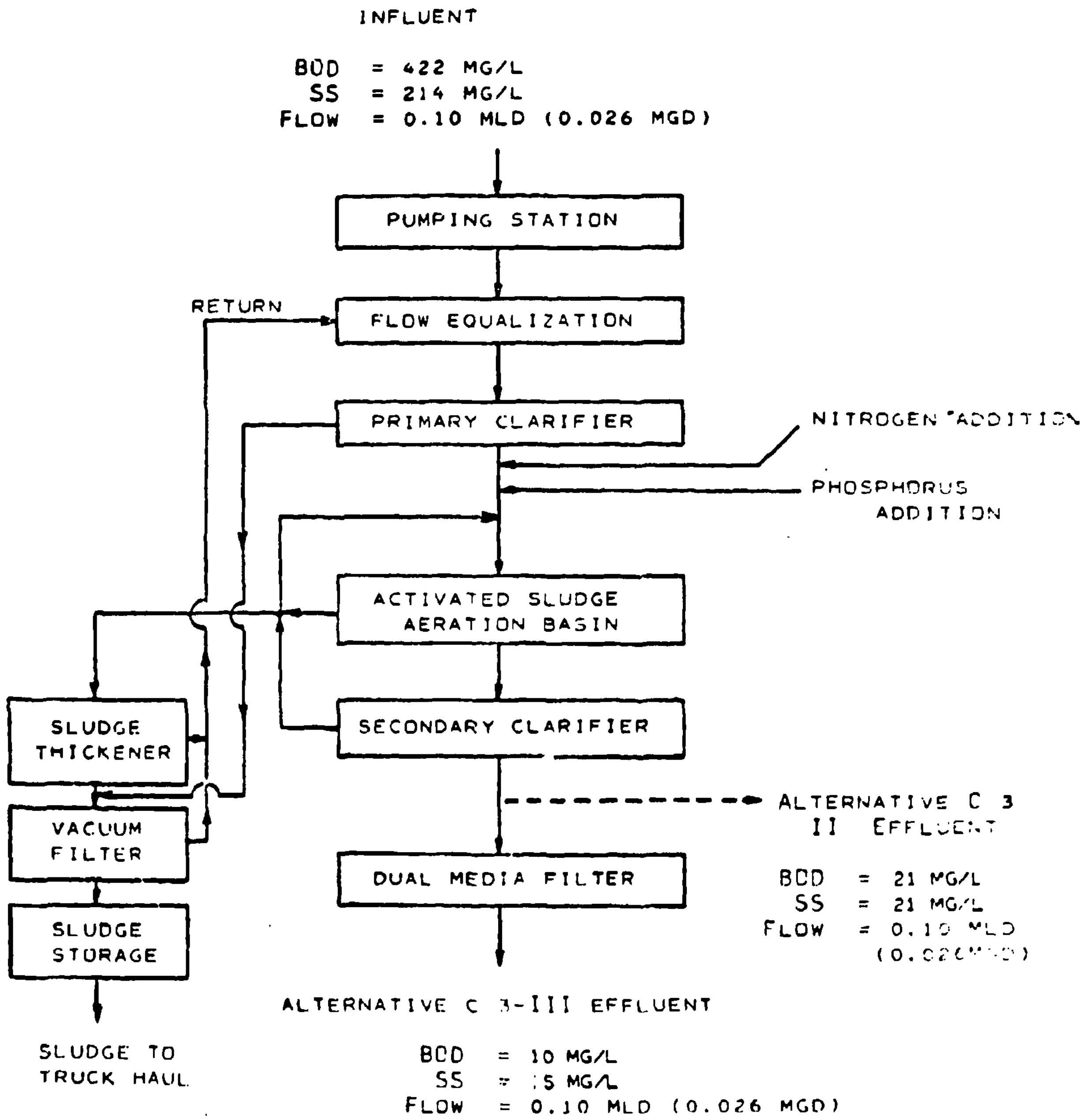


FIGURE 233

CONTROL AND TREATMENT ALTERNATIVES C 3-II AND III

DRAFT

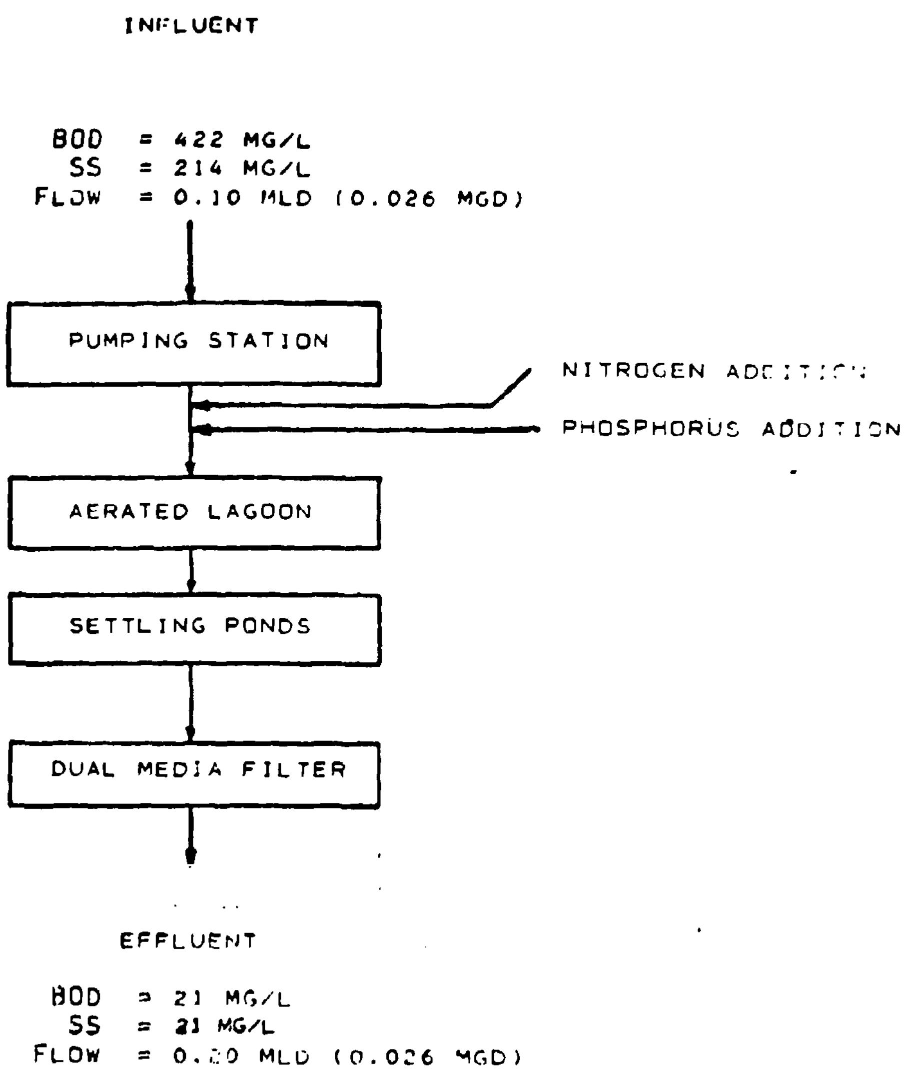


FIGURE 234

CONTROL AND TREATMENT ALTERNATIVE C 3 - IV

DRAFT

SUBCATEGORY C 7 - COOKIE AND CRACKER MANUFACTURING

In-Plant Technology

Additional measures could be taken to reduce wastewater flow and strength. If all floors were vacuum cleaned before being wet cleaned, the strength of the wastewater from the plant would be reduced. Utilization of CIP systems in which the final rinse water from one cleaning operation was utilized as the pre-rinse water for the subsequent cleaning operation would reduce the volume of wastewater generated by the cleaning of the icing handling equipment. Since cleaning of the icing equipment is usually necessary before changing to the production of a different variety of cookie, changes of product should be made as infrequently as possible in order to reduce both volume and strength of wastewater.

End-of-Line Technology

No bakery in this subcategory is known to have a wastewater treatment system that approaches the degree of treatment required for discharge to navigable waters. All of the bakeries surveyed in this subcategory discharge to municipal sewage systems. Most plants have grease traps as a form of pre-treatment to reduce sewer blockages resulting from the high (average 500 mg/l) concentrations of animal and vegetable fats in the waste stream. However, grease traps appear to be high-maintenance items if they are to operate properly. One cookie and cracker bakery removed their traps when air floatation was installed.

Some plants successfully utilize flow equalization and air floatation as pre-treatment modules. They have been shown to reduce the concentration of oil and grease being discharged to the municipality to less than 100 mg/l. The sludge generated from the air floatation treatment process is normally hauled by a disposal contractor to a rendering service.

Selection of Control and Treatment Technology

In Section V a model plant was developed for cookies and cracker production. The raw wastewater characteristics after screening were assumed to be as follows:

BOD	1200 mg/l	or	2.0	kg/kkg
SS	900 mg/l	or	1.5	kg/kkg
O&G	500 mg/l	or	0.85	kg/kkg
pH	6.3 - 8.7			
Flow	0.34 mld	(0.09 mgd)		

At present no cookie and cracker manufacture has a complete treatment system, because all such plants currently discharge to municipal sewage treatment systems. As a result, a transfer of treatment technology from a similar industry is required. Plants in subcategory

C 2, manufacturing cakes and pies without utilizing pan washing, have both a waste strength and waste sources (raw materials involved as well as operations generating the wastes) similar to plants manufacturing cookies and crackers. The treatment modules of the treatment alternatives discussed below were selected based on their satisfactory performance in treating wastes from subcategory C 2. Alternative C 7-II is considered to be an effective method of pre-treatment due to its current widespread usage as a method of pretreatment in the cookie and cracker industry.

Table134lists the pollutant effluent loading and the estimated operating efficiency of each of the six treatment trains selected for this subcategory.

Alternative C 7 - I - This alternative provides no additional treatment to the screened wastewater.

Alternative C 7 - II- This alternative consists of flow equalization, air floation, a pumping station, and storage for separated solids and grease. It is assumed that the separated solids are truck hauled to a rendering company at no cost to the bakery.

Alternative C 7 - III - This alternative consists of the treatment modules of Alternative C 7 - II with the addition of an aerated lagoon and the associated settling ponds. The schematic diagram of Alternative C 7 - III is shown in Figure 235.

Alternative C 7 - IV - This alternative consists of the treatment modules of Alternative C 7 - II with the addition of activated sludge, secondary clarifier, sludge pumping, sludge thickening, and vacuum filtration.

Alternative C 7 - Vi - This alternative consists of the treatment modules of Alternative C 7 - V with the addition of dual media pressure filtration and the associated pumping station. The schematic diagram of Alternative C 7 - VI is shown in Figure 236.

SUBCATEGORY C 12 - SANDWICHES

In-Plant Technology

Sandwich manufacturers generate relatively small volumes of wastewater (a few thousand liters per day at most), and consequently have not made any particular effort to reduce their waste load.

Virtually all wastewater from sandwich plants is a result of cleanup operations. Therefore, efficient cleanup procedures (water conservation practices) and training of the cleanup personnel would be the primary means of reducing sandwich producer's process wastewater.

DRAFT

TABLE 134

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent O&G kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent O&G Reduction
C 7 - I A	2.0	1.5	0.85	0	0	0
C 7 - II CJ	0.8	0.45	0.3	60	70	65
C 7 - III CJL	0.1	0.15	0.09	95	90	90
C 7 - IV CJLN	0.05	0.06	0.05	98	96	94
C 7 - V CJKQSV	0.1	0.10	0.09	95	93	90
C 7 - VI CJKQSUN	0.05	0.03	0.05	98	96	94

DRAFT

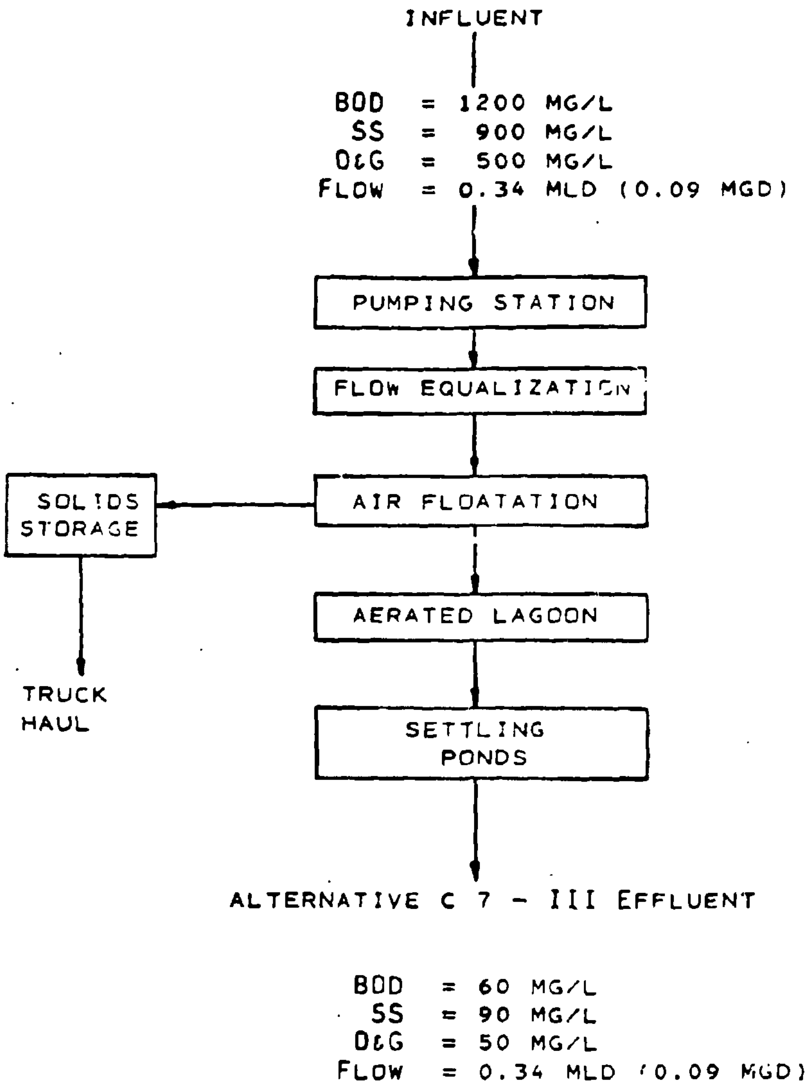


FIGURE 235

CONTROL AND TREATMENT ALTERNATIVES C 7 - III

DRAFT

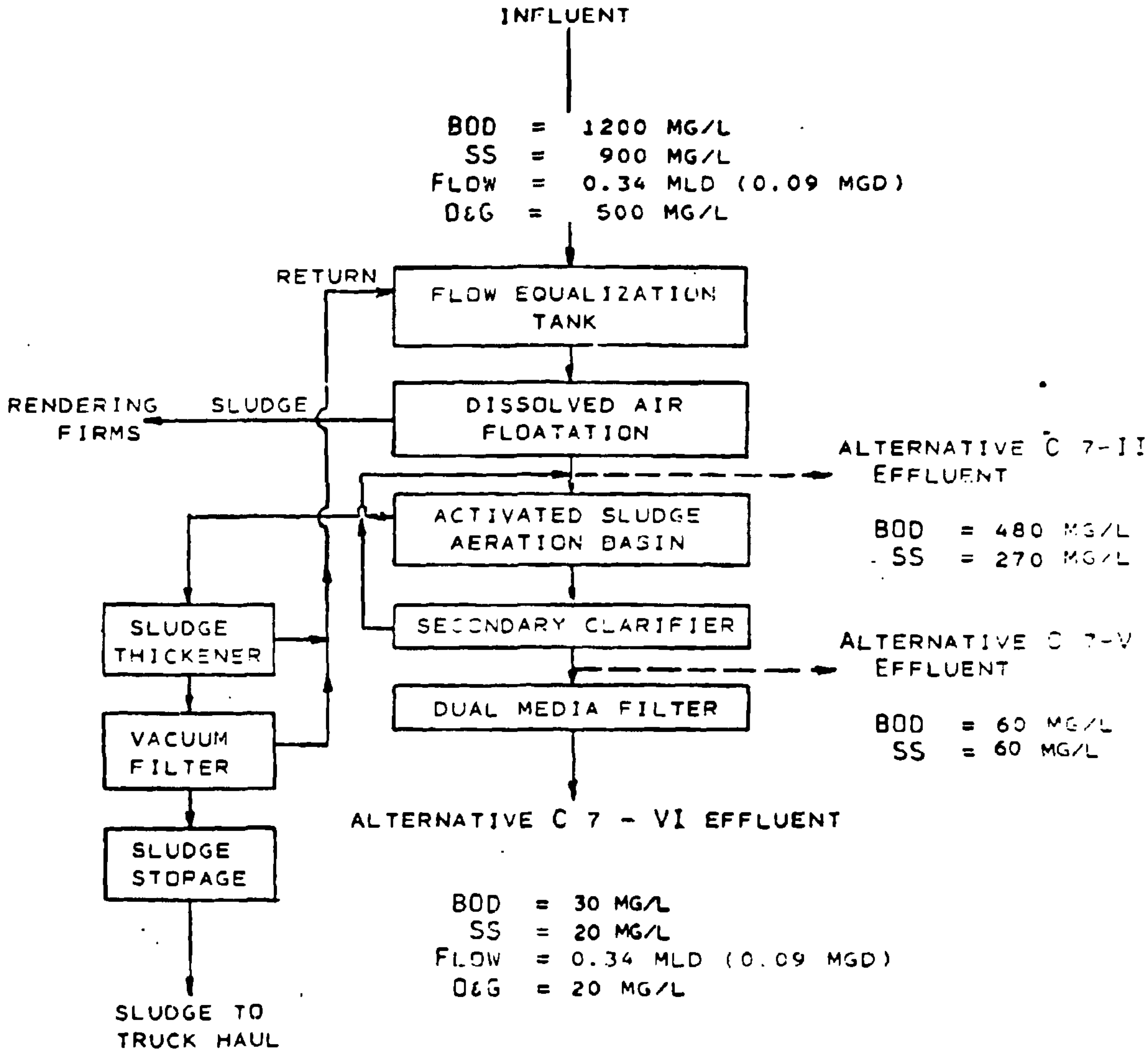


FIGURE 236

CONTROL AND TREATMENT ALTERNATIVES C7-II, V, AND VI

End-of-Line Technology

All of the plants contacted during this study discharge their wastewater to municipal sewers. No particular problems were reported by these municipalities in treating the wastewater. Some plants utilize grease traps to prevent clogging of sewer lines, but this is the only method of pre-treatment currently in use. No studies of the treatability or characteristics of the wastewater have been performed.

Selection of Control and Treatment Technology

In Section V, a model plant was developed for sandwich manufacturing. The flow from the model plant is 7,600 l (2,000 gal) per day. This volume of wastewater is small enough and the strength great enough that direct treatment is impractical. As a result, the wastewater should be treated by a municipal system.

Alternative C 12 - I - This alternative provides no additional treatment to the screened wastewater.

Alternative C 12 - II - This alternative consists of a storage tank and truck hauling of the wastewater to a municipal treatment facility.

SUBCATEGORY D 1 - CANDY AND CONFECTIONARY

Existing In-Plant Technology

Two plants have screening, filtration, centrifugation and reverse osmosis units which result in no discharge of wastewaters from processing areas, specifically from candy forming machines which require constant cleansing. The plants utilizing reverse osmosis also incorporated screening, diatomaceous earth filtration, centrifugation and in-process reuse of recovered materials. Wire mesh screening and centrifuging were primarily used for removal of particulate materials and oil substances, respectively. Filtration with diatomaceous earth was employed prior to reverse osmosis for removal of suspended solids; thereby preventing clogging of reverse osmosis membranes.

Sugars recovered from the reverse osmosis equipment are condensed in evaporators and recycled to the processing line. Defective candy from certain other plants are frist dissolved and then filtered through diatomaceous earth to remove coloration, etc. The reclaimed syrup is then reused in preliminary steps of processing.

Cooling and condenser water were recycled in 85 percent of the plants visited. Compressor and steam condensate water were reused in over 50 percent of the plants.

Washdown water is the primary source of waste effluent from this industry. Most plants employ various methods of in-plant controls to reduce its impact. All plants use dry collection of solids by sweeping or vacuuming prior to washdowns. Actual washdown with hoses is limited generally to the kitchen area. Alternatively, wet mopping or wiping is done in the remainder of the plant areas. Furthermore, many plants have blocked sewer outlets and eliminated hoses to reduce water usage in specific areas.

Edible solids such as starches and contaminated candies are generally disposed of by contract haulers for animal feed supplement. Non-edible solids and paper are generally hauled away to landfill areas or, in certain instances when liquid wastes (sludges) are involved, are taken to farm lands to be used as fertilizer.

Potential In-Plant Technology

Plants can usually realize substantial savings in treatment or in sewer costs through either reducing usage or recycling certain processing waters. Recycling of cooling or condenser waters should be considered by all plants as an economical method of reducing wastewater. Much of the waste currently being discarded or lost in plant effluent can be reused when processed or reclaimed in an acceptable manner. For example, preliminary wash waters from the "kitchen" cooking kettles and holding tanks can be recovered and, with a minimum amount of reprocessing, most sugar can be removed and reused. This is currently being done in a few plants with substantial savings being realized, not only from a treatment standpoint, but also in product recovery.

Clean-in-place (CIP) units and flow control valves which are used on certain types of equipment are water and cost saving devices that can be employed by all plants.

Reducing the use of water in generaly by increasing workers' awareness is another basic step in good water management. Water use could be minimized by common sense techniques like turning off faucets and hoses when not in use, by using high-pressure, low-volume water supply systems, and by dry clean-up in-plant valves are a valves are a valuable contribution to water conservation measures.

End-of-Line Technology

Of the total of 20 plants visited during this study, 15 had no form of pre-treatment measures. Every plant visited discharged the majority of its wastes directly to municipal sewage systems. Pre-treatment systems that were observed consisted of three plants which utilized grease and oil removal systems. These systems varied in degree of sophistication from an ordinary grease trap to a small aerobic system.

Grease and oils, as mentioned in Section V, are the primary concern of certain manufacturers in this subcategory. Test results from one plant utilizing a name brand filter show reductions in grease and oil loadings of 89 percent. Ordinary grease traps have been found to be effective in removal of oils and greases to acceptable levels for subsequent biological treatment. Suspended solids and BOD were reduced by 87 and 92 percent, respectively, at the one plant utilizing an aerobic treatment system.

Two plants currently have treatment systems either proposed or under construction. One plant has under design a dissolved air flotation unit with recycle; and the other plant is constructing an aerobic digestion system with an 825,000 gallon capacity.

Dissolved air flotation treatability results show an average concentration reduction in hexane solubles of 100 mg/l to 40 mg/l with a corresponding 10 percent reduction. Maximum hexane soluble loadings wererreduced from 750 mg/l to 100 mg/l, during these tests, corresponding to 86 percent reduction.

Selection of Control and Treatment Technology

In Section V a model plant was developed for candy and confectionery processing. The raw wastewater characteristics after screening and grease trap were taken as follows:

BOD	1300 mg/l
SS	170 mg/l
O&G	555 mg/l
Flow	375 cu m/day (0.099 MGD)

Table 135 lists the pollutant effluent loading and estimated operating efficiency of each of the seven treatment trains selected for this subcategory.

Alternative D 1-I - This alternative provides no additional treatment to the screened wastewater.

Alternative D 1-II - This alternative consists of a pumping station, flow equalization, and an aerated lagoon system with nitrogen addition.

Alternative D 1-III - This alternative replaces the aerated lagoon system of Alternative D-II with an activated sludge unit. In addition, the treatment train incorporates sludge thickening, aerobic digestion and truck hauling or dewatered sludge.

Alternative D 1-IV - Alternative D 1-IV is identical to Alternative D 1-III except for the addition of sand drying beds for sludge disposal.

Alternative D 1-V - This alternative provides the addition to Alternative D 1-IV a dual media pressure filtration system as a final treatment step.

Alternative D 1-VI - This alternative adds, to Alternative D 1-II, a dual media pressure filtration system.

TABLE 135

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY D 1

Treatment Train Alternative	Effluent BOD mg/l	Effluent SS mg/l	Percent BOD Reduction	Percent SS Reduction
D1-I	1300	170	0	0
D1-II	65	30	95	82
D1-III	39	20	97	88
D1-IV	39	20	97	88
D1-V	20	10	98.5	94
D1-VI	26	10	98	94

SUBCATEGORY D 2 CHEWING GUM

Existing In-Plant Technology

Of the total of 14 plants contacted or for which data were supplied by the National Association of Chewing Gum Manufacturers, 50 percent recycled all or most of their cooling and chill waters. Three of these plants discharged wastewater from cooling directly to municipal sewage systems along with their waste streams. Two plants discharged cooling waters into storm sewers, and the remaining two plants either spray irrigated or eliminated this waste through well disposal. Cooling waters comprise the largest flow volumes associated with this industry (i.e. 70 percent of the plants contacted discharged over half their water as non-contact cooling water, either in the form of overflows or once through discharges). Non-contact cooling water does not fall within the definition of process wastewater used in this study.

In terms of waste loadings, the two most significant sources of wastewaters in this industry are air scrubbers and clean-up waters. Air scrubbers were used by 75 percent of the plants contacted. One of the primary uses of air scrubbers is to clean ambient air of foreign substances, primarily sugar particles. Many techniques were observed to be used by various plants to minimize the effect of this source of effluent on waste loadings. One method employed by several plants was to recirculate the air scrubber water until saturated, then to purge the holding tanks completely and refill. Other plants continually supplied fresh make-up waters to the scrubbers; thereby keeping concentrations at certain levels by regulating make-up water volumes. One plant contacted used a completely dry technique to capture sugar dust in the air, eliminating the use of water altogether. This system even segregated sugars by flavor and color.

Clean-up operations varied significantly from plant to plant. Because gum in contact with water forms a sticky mass, most plants employ dry cleaning by scraping or sweeping. Minimal wet cleaning is employed at the plants, and generally wet cleaning was done by mopping or scrubbing with solvents (SAV-A-SAL), disinfectants, and water subsequent to dry removal by scraping or sweeping. Cleaning rooms were utilized by almost all plants to clean machinery and equipment. This equipment was periodically dismantled and subjected to extensive steam or hot water cleanings with the optional use of solvents or cleaners.

Damaged or defective chewing gum was usually recycled to the processing line. At one plant the "bowl cake" (by-product left after gum bases have been melted and screened), was retained and returned to the gum base refinery to be reprocessed. Other waste solids, with the exception of paper in certain instances, were disposed at sanitary landfill sites. Two plants visited separated and recycled paper products. This procedure may be employed at other plants to reduce solid wastes.

Damaged or defective chewing gum was usually recycled to the processing line. At one plant the "bowl cake" (by-product left after gum bases have been melted and screened), was retained and returned to the gum base refinery to be reprocessed. Other waste solids, with the exception of paper in certain instances, were disposed at sanitary landfill sites. Two plants visited separated and recycled paper products. This procedure may be employed at other plants to reduce solid wastes.

Potential In-Plant Technology

Plants not currently recycling cooling, condensor or chill water should consider this as a major step in water management. Recycling of steam condensate, which was done at one plant visited by the contractor, should also be a step towards water conservation. Air scrubber water can possibly be eliminated and substituted by dry collection by sugar particles except in cases where humidity control is desired.

Minimizing the use of water in clean-up operations has been pursued by most plants contacted; however, educating plant personnel of the necessity for water conservation would be helpful toward accomplishment of desirable water management policies.

End-of-Line Technology

Of the total number of plants contacted, only five employed some type of treatment for their wastewaters. Two plants simply treat their wastewaters by employing settling basins before discharging to municipal systems. Settled matter is generally hauled away under contract. One plant discharges only domestic waste to a municipal system and stores all processing and clean-up wastes in a holding tank, which is taken to a sanitary landfill for disposal. Two plants utilize activated sludge with aeration lagoons and final spray irrigation to treat and dispose of wastes. These practices have resulted in no discharge of process wastewater pollutants to surface waters from these two plants. Reductions from the activated sludge system averaged 96 percent BOD removal, 90 percent removal of suspended solids and 88 percent volatile solids removals. Influent pH averaged 8.6 and decreased to 7.6 after treatment and prior to irrigation.

Selection of Control and Treatment Technology

In Section V a model plant was developed for chewing gum processing. The raw wastewater characteristics after screening were assumed to be as follows:

BOD	900 mg/l
SS	95 mg/l
O&G	50 mg/l
Flow	322 cu m/day (0.085 MGD)

Table 136 lists the pollutant effluent loading and estimated operating efficiency of each of the eight treatment trains selected for this subcategory.

Alternative D 2-I - This alternative provides no additional treatment of the screened wastewater.

Alternative D 2-II - This alternative consists of a pumping station, a flow equalization basin, and an aerated lagoon system with nitrogen addition.

Alternative D 2-III - This alternative replaces the aerated lagoon system of Alternative D 2-II with an activated sludge unit. In addition, the treatment train incorporates sludge thickening, aerobic digestion, and truck hauling.

Alternative D 2-IV - Alternative D 2-V is identical to Alternative D 2-III except for the addition of sand drying beds for sludge disposal.

Alternative D 2-V - This alternative adds, to Alternative D 2-IV, a dual media pressure filtration system as a final treatment step.

Alternative D 2-VI - This alternative adds a pumping station, pipe line and spray irrigationttc the treatment train of Alternative D 2-II.

Alternative D 2-VII - This alternative adds a pumping station, pipe line, and spray irrigation to the treatment train of Alternative D 2-III.

SUBCATEGORY D 3 GUM BASE

Existing In-Plant Technology

As explained in Section V of this report, only three plants in this subcategory were considered of significant benefit for establishing in-plant technology. Process cooling water is recirculated at two of these plants. The other plant identified from the National Association of Chewing Gum Manufacturers survey did not indicate any recycling of cooling water.

The primary waste sources in this industry are derived from washdowns and processing. Dry cleaning methods are a preliminary step used by all plants before the major washdown process. Dry cleaning methods include dry-scraping and vacuuming. Cleansing agents such as tri-sodium phosphate are spread on the floor to remove the softened gum deposits. These washdown flows averaged 15 percent of the plant flows and are high in waste pollutant loading. Reductions in the use of solvents has been initiated at one plant with a 45 percent decrease over a three-year period.

TABLE 136

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY D 2

Treatment Train Alternative	Effluent BOD mg/l	Effluent SS mg/l	Percent BOD Reduction	Percent SS Reduction
D2-I	900	95	0	0
D2-II	45	30	95	68
D2-III	30	20	97	79
D2-IV	30	20	97	79
D2-V	20	10	98	89
D2-VI	0	0	100	100
D2-VII	0	0	100	100

Potential In-Plant Technology

Air scrubbers were found to be used at only one gum base plant. Controlling the effluent discharged from this source by recycling would help minimize the discharge.

Another source of contaminated water comes from the repeated hot water washing of natural gum materials. By limiting the number of washings or by recycling of this water (i.e. by reusing the final wash water for the preliminary wash of a new batch of gum), significant reductions could be realized in flow. As mentioned previously, increasing workers' awareness of pollutional problems will help significantly in water management.

End-of-Line Technology

Significant advances in treatment have been accomplished in this industry, particularly at one plant which handles about 80 cu m/day (20,000 gpd) of the wastewater with a BOD of 1500 to 2500 mg/l. The system used at this plant employs screening, settling, mixing, digestion, clarification and final chlorination to achieve 90.1 percent removal of BOD. According to Oxford (142), this percentage of BOD removal can be increased to 95 percent by proper management. This plant discharges to a municipal sewage system. One plant that does not currently have a treatment system discharges directly into surface waters. This plant has a preliminary treatment system designed and will discharge their treated waste to a municipal plant when the municipal facility is constructed. This system is designed primarily to collect all processing wastes and separate by settling all precipitated $CaCO_3$ and settled gum base, which is then stored and transported by trucks for land disposal. In addition, the solvent phase in the settling tank may be drained for further amelioration of the effluent.

Selection of Control and Treatment Technology

In Section V a model plant was developed for chewing gum base processing. The raw wastewater characteristics after screening were assumed to be as follows:

BOD	430 mg/l
SS	355 mg/l
O&G	30 mg/l
Flow	356 cu m/day (0.094 MGD)

Table 137 lists the pollutant effluent loading and estimated operating efficiency of each of the eight treatment trains selected for this subcategory.

Alternative D 3-I - This alternative provides no additional treatment to the screened wastewater.

DRAFT

TABLE 137

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY D 3

Treatment Train Alternative	Effluent BOD mg/l	Effluent SS mg/l	Percent BOD Reduction	Percent SS Reduction
D3-I	430	355	0	0
D3-II	30	30	93	92
D3-III	25	25	94	93
D3-IV	25	25	94	93
D3-V	10	10	98	97
D3-VI	0	0	100	100
D3-VII	0	0	100	100

Alternative D 3-II - This alternative consists of a pumping station, a flow equalization basin, and an aerated lagoon system with nitrogen addition.

Alternative D 3-III - This alternative replaces the aerated lagoon system of Alternative D 3-III with an activated sludge unit. In addition, the treatment train incorporates sludge thickening, aerobic digestion and truck hauling.

Alternative D 3-IV - Alternative D 3-V is identical to Alternative D 3-III except for the addition of sand drying beds for sludge disposal.

Alternative D 3-V - This alternative adds, to Alternative D 3-IV, a dual media pressure filtration sytem as a final treatment step.

Alternative D 3-VI - This alternative adds a pumping station, pipe line and spray irrigation to the treatment train of Alternative D 3-II.

Alternative D 3-VII - This alternative adds a pumping station, pipe line and spray irrigation to the treatment train of Alternative D 3-III.

SUBCATEGORIES D 5 AND D 5 CHOCOLATE

Existing In-Plant Technology

The open use of water as mentioned in Section III is not compatible with the production of chocolate products; therefore, the use of water in-plant is extensively regulated to prevent entrainment in the product.

Since washdowns are the primary source of wasteloading, stringent dry cleaning and mopping are employed at all plants. A variable amount of clean-up water is used during the cleaning of mixing tanks, transfer buggies, milk condensing pans, and certain production areas. Steps taken by plants to limit water use in these cleaning operations include: installing water saver hose nozzles, sealing off drains, and in one case utilizing a high-pressure steam heated washdown system.

Three plants which process condensed milk use clean-in-place units in their condensory system. One plant has a unique system, in which they recycle cooling waters for use in domestic sanitation.

Potential In-Plant Control

Currently, few chocolate plants recycle non-contact cooling and condensing water, but discharge them directly to local tributaries. Recycling of these waters may or may not be economically advantageous, depending primarily upon the source of plant water supply.

Due to the problems encountered when chocolate is contaminated with excess moisture, workers in this industry are very aware of the detrimental effects of excess water on the finished product. However, less success has been gained in achieving awareness of employees as to the necessity for good housekeeping, reduced water usage, proper maintenance, and correct disposal or salvaging of products that can be reused in the process.

End-of-Line Technology

All plants visited discharged to municipal treatment systems; two provided pretreatment of their waste streams. One of these plants utilized a grease trap which was cleaned monthly by a sanitary service. The other plant employed a dissolved air flotation system for oil and grease removal. One large plant is planning to purchase a municipal treatment plant for use as an industrial pretreatment plant.

Selection of Control and Treatment Technology for Subcategory D 5

In Section V a model plant was developed for chocolate manufacture with condensory processing. The raw wastewater characteristics after screening were assumed to be as follows:

BOD	1840 mg/l
SS	415 mg/l
O&G	170 mg/l
Flow	761 cu m/day (0.201 MGD)

Table 138 lists the pollutant effluent loading and estimated operating efficiency of each of the treatment trains selected for this subcategory.

Alternative D 5-I - This alternative provides no additional treatment to the screened wastewater.

Alternative D 5-II - This alternative consists of a pumping station, a flow equalization basin, and air flotation with chemical addition.

Alternative D 5-III - This alternative replaces the air flotation module in Alternative D 5-II with an aerated lagoon system with nitrogen addition.

Alternative D 5-IV - This alternative replaces the aerated lagoon system of Alternative D 5-III with an activated sludge unit. In addition, the treatment train incorporates sludge thickening, aerobic digestion and truck hauling.

Alternative D 5-V - Alternative D 5-V is identical to Alternative D 5-IV with the addition of sand drying beds for sludge disposal.

Alternative D 5-VI - Air flotation with chemical addition is utilized between the equalization basin and the activated sludge unit of Alternative D 5-IV.

Alternative D 5-VII - This alternative adds, to Alternative D 5-VI, a dual media pressure filtration system as a final treatment step.

DRAFT

TABLE 138

—SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY D 5

Treatment Train Alternative	Effluent BOD mg/l	Effluent SS mg/l	Effluent OBG mg/l	Percent BOD Reduction	Percent SS Reduction	Percent OBcG Reduction
D5-I	1840	415	170	0	0	0
D5-II	1288	287	68	30	30	60
D5-III	92	60	17	95	85	90
D5-IV	60	40	17	97	90	90
D5-V	60	40	17	97	90	90
D5-VI	40	29	7	98	93	96
D5-VII	20	10	2	99	98	99
D5-VIII	64	43	7	97	90	96

Alternative D 5-VIII - In this treatment train air flotation with chemical addition precedes the aerated lagoon system of Alternative D 5-III. Trucking of flotation solids is required with this alternative.

Selection of Control and Treatment Technology for Subcategory D 6

In Section V a model plant was developed for chocolate without condensory processing. The raw wastewater characteristics after screening were assumed to be as follows:

BOD	705 mg/l
SS	230 mg/l
O&G	160 mg/l
Flow	920 cu m/day (0.243 MGD)

Table 139 lists the pollutant effluent loading and estimated operating efficiency of each of the treatment trains selected for this subcategory.

Alternative D 6-I - This alternative provides no additional treatment to the screened wastewater.

Alternative D 6-II - This alternative consists of a pumping station and a flow equalization basin.

Alternative D 6-III - This alternative consists of Alternative D 6-II followed by air flotation with chemical addition.

Alternative D 6-IV - This alternative adds to Alternative D 6-II an aerated lagoon system with nitrogen addition.

Alternative D 6-V - This alternative replaces the aerated lagoon system of Alternative D 6-IV with an activated sludge unit. In addition, the treatment train incorporates sludge thickening, aerobic digestion and truck hauling.

Alternative D 6-VI - Alternative D 6-VI is identical to Alternative D 6-V with the addition of sand drying beds for sludge disposal.

Alternative D 6-VII - Air flotation with chemical addition is utilized between the equalization basin and the activated sludge unit of Alternative D 6-VI.

Alternative D 6-VIII - This alternative adds, to Alternative D 6-VII, a dual media pressure filtration system as a final treatment step.

Alternative D 6-IX - In this treatment train, air flotation with chemical addition precedes the aerated lagoon system of Alternative D 6-IV.

DRAFT

TABLE 139

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY D 6

Treatment train Alternative	Effluent BOD mg/l	Effluent SS mg/l	Effluent OBG mg/l	Percent BOD Reduction	Percent SS Reduction	Percent BOcG Reduction
D6-I	705	230	160	0	0	0
D6-II	494	161	64	30	30	60
D6-III	35	35	16	95	95	90
D6-IV	30	30	16	96	87	90
D6-V	30	30	16	96	87	90
D6-VI	25	20	5	96	91	97
D6-VII	10	10	2	99	96	99
D6-VIII	25	24	5	96	90	97

PET FOODS

SUBCATEGORY B 5 LOW-MEAT CANNED PET FOOD

In-Plant Control Technology

The main sources of pollutants in the pet food industry are general plant cleanup, including housekeeping and end-of-shift cleanup. Therefore, in-plant procedures to reduce waste loads in this subcategory must of necessity center around these areas. It is essential that proper employee training and efficient management practices are observed.

Substantial reduction in both processing raw waste load (flow and pollutant content) and wastewater treatment cost can be realized by careful in-plant water management and reuse including:

1. Installation of automatic shut-off valves on water hoses may save up to 60 gallons per minute per hose. Without automatic shut-off valves, employees do not turn off hoses. Cost for a long life valve is approximately $40.

2. Installation of general cleanup systems (valved or triggered hoses). These commercial systems generate a controlled high pressure supply of hot or warm water containing a detergent. They are reported to clean better with less volume of water used.

3. That portion of very dilute wastewater (cooling water, defrost water, etc.) which is not reused or recirculated, should be discharged separately from the process wastewater. Care should be exercised, however, to prevent the direct discharge of high-temperature cooling water without adequate cooling.

4. Good housekeeping is an important factor in normal pollution control. Spills, spoilage, trash, etc. resulting from sloppy operation may be heavy contributors to liquid waste loads. Improvements will result from educating operating personnel in proper attitudes toward pollution control and providing strategically located waste containers, the basic aim being to avoid loss of product and normal solid waste into the liquid waste stream

5. In addition to implementation of water conservation and reuse, the processor should look at his handling of solid waste. A well-operated plant will, insofar as possible, avoid solid waste contact with the liquid waste stream. Where this is not feasible, the solid waste is removed prior to reaching the waste treatment system. Screens of 20 mesh or smaller are usually adequate to remove a large portion of settleable solids. Continuous removal of the screenings is desirable to avoid excessive leaching of solubles by the liquid waste stream from separated solids.

End-of-Line Technology

Only one existing secondary treatment plant 47N64 discharging to surface waters was identified. As far as known, all other manufacturing plants in this subcategory discharge to municipal-owned sewage works. The one existing secondary treatment plant is located in the northeast and utilizes extended aeration activated sludge treatment preceded by screening and primary gravity clarification. Table 140 provides data pertinent to design of individual treatment units. Note the approximate 2:1 dilution of the wastewater by cooling water after primary treatment and prior to the aeration basin. An analysis of weekly and bi-weekly reported treatment performance over the period January to August, 1974, shows the following effluent quality characteristics:

BOD, average 30 mg/l, range 5 to 75 mg/l
SS, average 48 mg/l, range 12 to 104 mg/l

The above results reflect approximately the following average percent removals: BOD 92 percent and suspended solids 84 percent based upon average reported raw waste BOD of 370 mg/l and suspended solids of 300 mg/l.

The relatively poor suspended solids removal in comparison to the BOD removal performance is an inherent problem in the extended aeration process where little or no sludge removal from the secondary system is practiced. The extended detention time in the aeration basins tends to develop fine, inert suspended solids which are difficult to settle and pass easily over the secondary clarifier weirs.

Selection of Control and Treatment Technology

A model plant for low-meat canned pet food was developed in Section V. The raw wastewater characteristics were as follows:

Flow	(0.3 MGD)
BOD	1,100 mg/l
SS	700 mg/l
O&G	400
pH	6 to 9

TABLE 140

SUMMARY OF TREATMENT ALTERNATIVES FOR SUBCATEGORY B5

LOW MEAT CANNED PET FOOD

Alt.	Treatment unit	Unit influent Characteristics, mg/l BOD	TSS	O&G	Cumulative percent removal BOD	TSS	O&G
B5-I	None	1,100	700	400	0	0	0
B5-II	Flow Equal.	1,100	700	400	0	0	0
	Dis. Air Flot.	1,100	700	400	70	80	50
B5-III	Act. Sludge	330	140	200	97	96	90
B5-IV	Filtration	33	28	40	98	98	95
Fin. Effl.		17	14	20	98	98	95

DRAFT

The following treatment alternatives have been selected for this subcategory:

Alternative B 5-I - This alternative assumes no additional treatment.

Alternative B 5-II - This alternative provides flow equalization, dissolved air flotation, and vacuum filtration of sludge. The expected BOD removal benefit is 70 percent.

Alternative B 5-III - This alternative provides complete mix activated sludge and sludge thickening addition to Alternative B 5-II. The expected BOD removal benefit is 97 percent.

Alternative B 5-IV- This alternative adds dual media filtration to Alternative B 5-III. The expected BOD removal benefit is 98 percent.

A summary of the pollutant removals expected is presented in Table 140. A schematic diagram of Alternatives B 5-I through B 5-IV is presented in Figure 237.

SUBCATEGORY B 6- HIGH-MEAT CANNED PET FOOD

In-Plant Technology

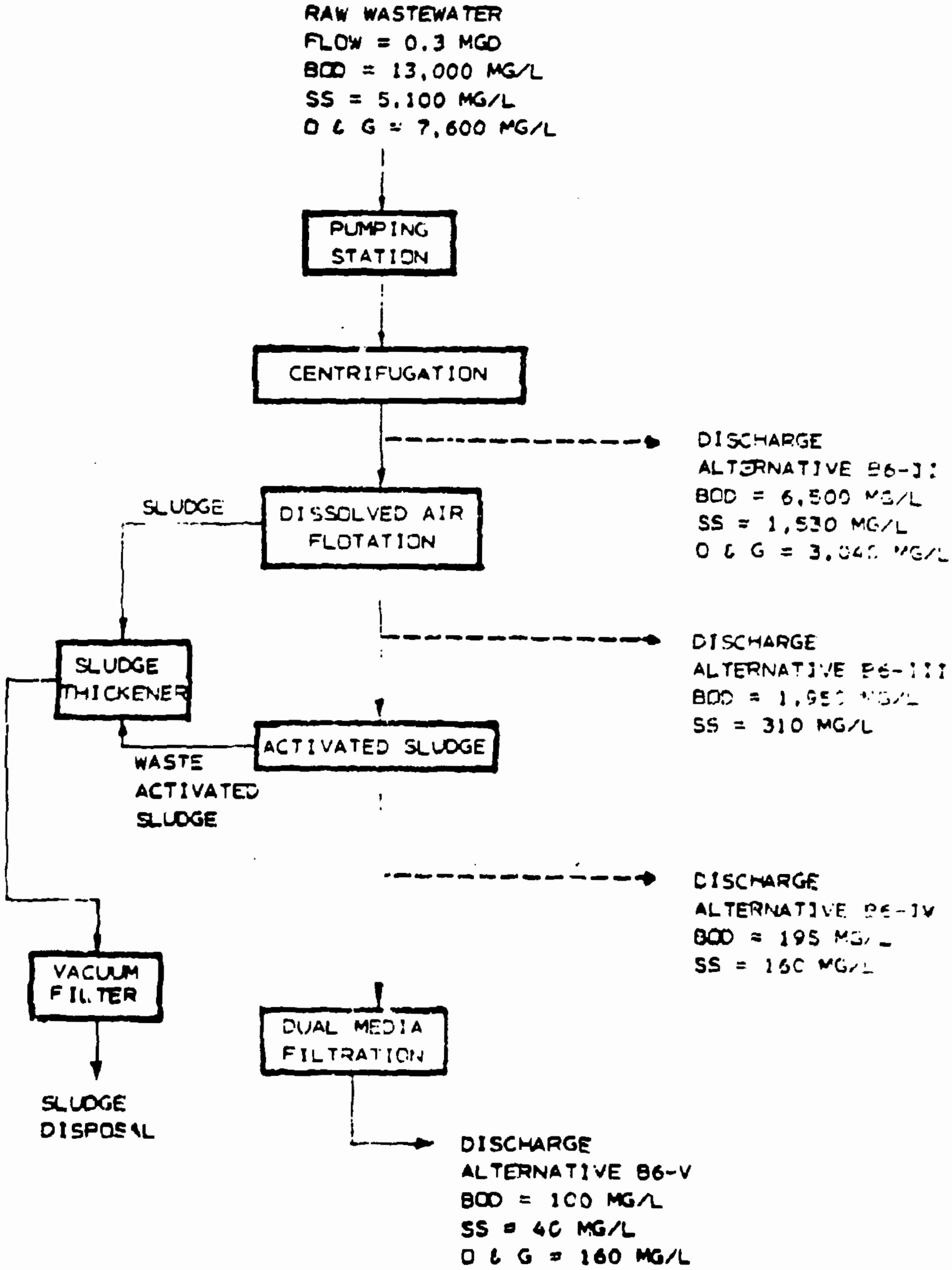
The existing and potential in-plant technology for Subcategory B 6 is the same as for Subcategory B 5.

End-of-Line Technology

This subcategory is characterized by extremely strong wastes in terms of BOD, SS, and Oils and Greases. Nevertheless, two existing secondary treatment plants (47N-78 and 47N-79) are achieving excellent removals with activated sludge treatment preceded by well designed primary treatment units. The key to the success of these plants appears to be the high percentage removals of SS and Oils and Greases in their primary treatment units and the extended detention time provided in the activated sludge aeration basins. The two existing plants referred to are owned by the same company and are virtually exact copies of each other -- one is located in the northeast and the other in the middle west. Table 141 provides data pertinent to design of individual treatment units. An analysis of weekly reported treatment performance over the period April, 1971 to December, 1972 for plant 47N-79 shows the following effluent quality characteristics:

BOD, average 8 mg/l, range 1-50 mg/l
SS, average 80 mg/l, range 1-2000 mg/l
O&G, average 800 mg/l, range 80-8000 mg/l
COD, average 90 mg/l, range 30-2000 mg/l
pH, 6 to 8

DRAFT



FIGURE

CONTROL AND TREATMENT ALTERNATIVES
B6-I THROUGH B6-V

TABLE 141

SUMMARY OF TREATMENT ALTERNATIVES FOR SUBCATEGORY B6

HIGH MEAT CANNED PET FOOD

DRAFT

Alt.	Treatment unit	Unit influent Characteristics, mg/l BOD	SS	O&G	Cumulative percent removal BOD	SS	O&G
B6-I	None	13,000	5,100	7,600	0	0	0
B6-II	Flow Equal. Centrifuges	13,000	5,100	7,600	50	70	60
B6-III	Dis. Air Flot.	6,500	1,500	3,000	85	94	86
B6-IV	Act. Sludge	1,950	310	1,060	99	97	96
B6-V	Filtration	195	160	320	99	99	98
Fin. Effl.		100	40	160	99	99	98

The above results are prior to installation of chlorination and sand filter tertiary treatment units.

Percent removals reflected by the above results are approximately as follows: BOD, 99 percent plus; SS, 98 percent, O&G, 96 percent, and COD, 98 percent.

Obviously, oil and grease removal is the major problem still facing this plant, and it is expected that the use of chlorine and sand filters as teritary treatment will reduce the oil and grease loads.

Selection of Control and Treatment Technology

A model plant for high-meat canned pet food was developed in Section V. The plant was assumed to produce 270 kkg/dry (300 ton/day) of product and have a wastewater with the following characteristics:

BOD	13,000 mg/l
SS	5,100 mg/l
O&G	7,600 mg/l
pH	6.8 to 8.4
N	640 mg/l
P	210 mg/l

The following treatment alternatives have been selected for this subcategory:

Alternative B 6-I - This alternative assumes no treatment in addition to screening already incorporated into the processing plant.

Alternative B 6-II - This alternative consists of a pumping station, a flow equalization basin, centrifugation, and sludge storage. As shown in Table 141, the expected BOD reduction benefit for this alternative is 50 percent.

Alternative B 6-III - This alternative provides the addition of dissolved air flotation and vacuum filtration to Alternative B 6-II. The BOD reduction benefit expected for this alternative is 85 percent.

Alternative B 6-IV - This alternative provides the addition of complete mix activated sludge to Alternative B 6-III. The expected BOD reduction benefit is 99 percent.

Alternative B 6-V - This alternative provides the addition of dual media filtration to Alternative B 6-IV. The expected BOD reduction benefit is 99 percent.

A schematic diagram of Alternatives B 6-I through B 6-V is presented in Figure 238.

DRAFT

SUBCATEGORY B 7 - DRY PET FOODS

In-Plant Technology

In-plant technology for Subcategory B 7 is the same as for Subcategory B 5.

End-of-Line Technology

This subcategory is characterized by low volume flows of weak to moderate strength as was described in Section V of this document. All existing dry pet food manufacturing plants which were identified during this investigation discharge to municipal systems. One plant (47M-65) which manufactures both dry and soft-moist pet food, provides extensive pretreatment prior to municipal discharge; however, approximately 90 percent of its flow volume is generated by manufacture of soft-moist pet food. It was not possible, therefore, to draw any conclusions regarding dry pet food wastewater treatability from this plant. The model treatment plant design is based upon utilization of the activated sludge process for treatment of wastewater from a dry pet food manufacturing plant.

Selection of Control and Treatment Technology

In Section V a model plant was developed for dry pet food. It has a production of 270 kkg/day (300 ton/day), a wastewater flow of 114 cu m/day (0.03 MGD), and the following wastewater characteristics:

BOD	200 mg/l
SS	100 mg/l
O&G	250 mg/l
pH	6 to 9
N & P	Sufficient for biological treatment

Table 142 lists the pollutant effluent loading and the estimated operating efficiency for the four alternatives selected. The alternatives are schematically presented in Figure 239.

Alternative B 7-I - This alternative provides no additional control and treatment technology above current practices.

Alternative B 7-II - This alternative provides a pumping station, a 114 cu m (30,000 gal) capacity equalization basin, and a dissolved air flotation unit. The expected BOD reduction benefit is 50 percent.

Alternative B 7-III - This alternative provides, in addition to Alternative B 7-II, a complete mix activated sludge system. The aeration basin has a detention time of 30 hours and an aeration of 1.4 kw (2 hp). The expected BOD removal benefit is 90 percent.

TABLE 142

SUMMARY OF TREATMENT ALTERNATIVES FOR SUBCATEGORY B7

DRY DOG AND CAT FOOD

Alt.	Treatment unit	Unit influent Characteristics, mg/l BOD	TSS	O&G	Cumulative percent removal BOD	TSS	O&G
B7-I	None	200	100	250	0	0	0
B7-II	Flow equal.	200	100	250	0	0	0
	Dis. Air Flot.	200	100	250	50	80	50
B7-III	Act. Sludge	100	20	125	90	86	85
B7-IV	Filtration	20	14	38	95	96	92
Fin. Effl.		10	4	19	95	96	92

DRAFT

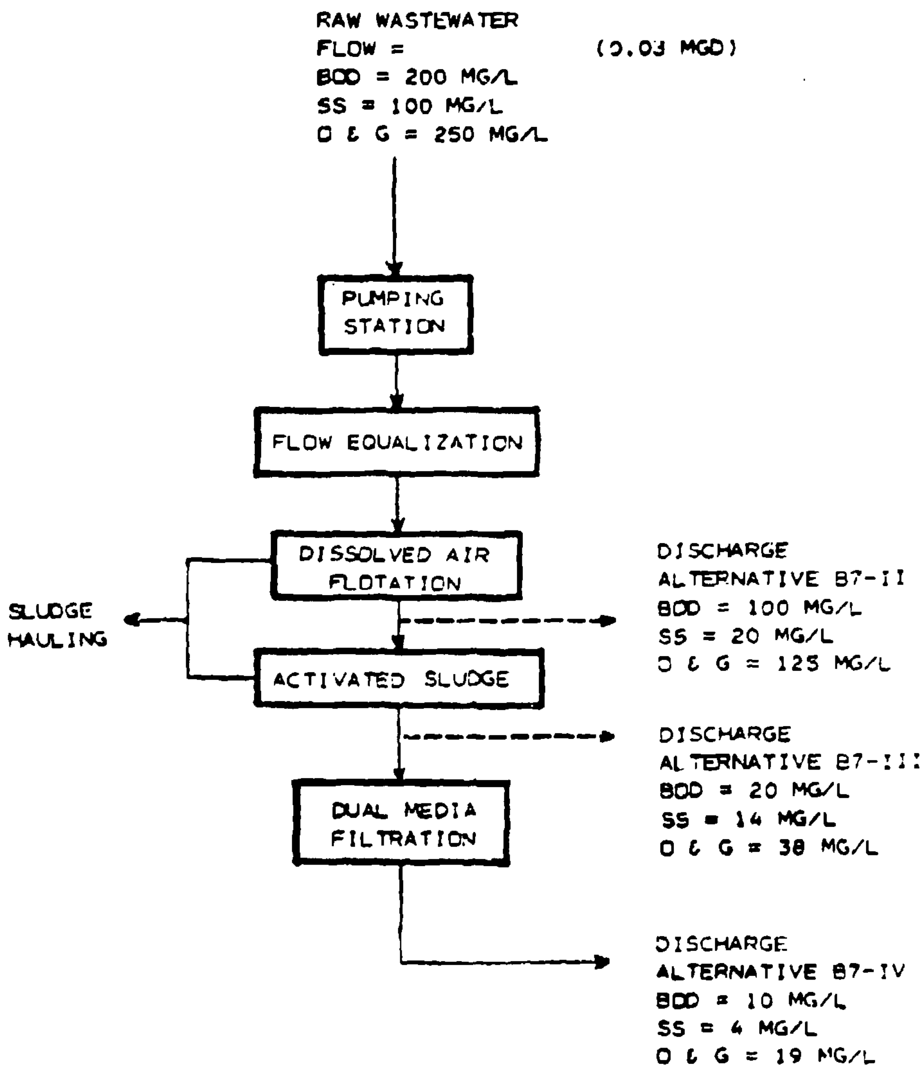


FIGURE 239

CONTROL AND TREATMENT ALTERNATIVES
B7-I THROUGH B7-IV

DRAFT

Alternative B 7-IV - This alternative adds dual media filtration to Alternative B 7-III. The expected BOD reduction benefit is 95 percent.

SUBCATEGORY B 8 - SOFT-MOIST PET FOOD

In-Plant Technology

In-plant technology for Subcategory B 8 is the same as for Subcategory B 5.

End-of-Line Technology

All existing soft-moist pet food manufacturing plants which were identified during this investigation discharge to municipal sewage systems. One plant (47M-65) provides extensive pretreatment prior to municipal discharge, and data from this plant are helpful in assessing primary treatment pollutant removal capabilities. The same plant also provides secondary aeration and clarification of the primary effluent; however, the secondary treatment is relatively ineffective because the activated sludge from the secondary clarifier is not recirculated into the aeration basin. Design information for this plant is given in Table 142. The plant should not, however, be considered a representative overall facility as it is presently designed and operated. Though certain individual unit processes perform adequately, major difficulties are experienced because: (1) there is no aerated equalization basin at the beginning of the treatment chain to control surges, lower temperatures, and prevent anaerobic degradation; (2) there is no return of secondary clarifier sludge into the aeration basins; and (3) solids (sludge) removal and treatment equipment is inadequate.

The treatment plant described is required by city ordinance to meet the following criteria: BOD - 400 mg/l, SS - 450 mg/l, and O&G - 100 mg/l. This requirement must be met after the treatment facility waste is diluted by 1.5:1 or 2:1 by cooling water and sanitary waste.

An analysis of six effluent samples, three in July, 1972 and three in July 1974, shows the following effluent quality characteristics:

BOD, average 703 mg/l, range 216-1, 479 mg/l
SS, average 880 mg/l, range 372-1, 916 mg/l
O&G, average 300 mg/l, range 83-816 mg/l
pH, 6 to 7
Temperature, 86-90°F

The above results reflect approximately the following average percent removals: BOD, 82 percent; SS, 59 percent; O&G, 61 percent; based upon average reported raw waste BOD of 3,860 mg/l, SS of 2,120 mg/l, and oil and grease of 770 mg/l.

Cost of this pretreatment facility is reported by the owner as $750,000 in 1964. Equivalent 1974 cost would be close to $2 million,

DRAFT

TABLE 143

SUMMARY OF TREATMENT ALTERNATIVES FOR SUBCATEGORY B8

SEMI-MOIST PET FOOD

Alt.	Treatment unit	Unit influent Characteristics, mg/l			Cumulative percent removal		
		BOD	TSS	O&G	BOD	TSS	O&G
B8-I	None	3,900	2,100	800	0	0	0
B8-II	Flow Equal.	3,900	2,100	800	0	0	0
	Dis. Air Flot.	3,900	2,100	800	60	80	80
B8-III	Act. Sludge	1,560	420	160	96	90	94
B8-IV	Filtration	160	210	50			
Fin. Effl.		80	53	25	98	97	97

if construction indexes are applied to compensate for inflation in costs. Present annual operating costs are reported as $407,000/year including a $150,000 cost for solids trucking and disposal, with the remaining $275,000 tagged for labor, maintenance, and energy.

Selection of Control and Treatment Technology

A model plant for soft-moist pet food was developed in Section V. It was assumed to have a production of 500 kkg/day (550 ton/day) of finished product and to generate 114 cu m/day (0.03 MGD) of wastewater with the following characteristics:

BOD	3,900 mg/l
SS	2,100 mg/l
O&G	800 mg/l
pH	6 to 7
N & P	Sufficient for biological treatment

Table 143 lists the pollutant effluent loading and the estimated operating efficiency of each of the alternatives. Figure 240 illustrates the treatment alternatives.

Alternative B 8-I - This alternative provides no additional control and treatment technology.

Alternative B 8-II - This alternative provides flow equalization, dissolved air flotation, and vacuum filtration of sludge. The expected BOD reduction benefit is 60 percent.

Alternative B 8-III - This alternative provides, in addition to Alternative B 8-II, a complete mix activated sludge system. The expected BOD reduction benefit is 96 percent.

Alternative B 8-IV - This alternative provides, in addition to Alternative B 8-III, dual media filtration. The expected BOD reduction benefit is 98 percent.

MISCELLANEOUS AND SPECIALITY PRODUCTS

SUBCATEGORY A 29 - THE PRODUCTION OF FINISHED FLAVORS BY THE BLENDING OF FLAVORING EXTRACTS, ACIDS, AND COLORS

Existing In-Plant Technology

The known in-plant technology practiced at flavoring extract plants consists of the following: solvent recovery, separation of non-contact water from the process wastestream, and separation of cleanup water used in solvent process areas from the process wastestream. It is assumed that solvent recovery is practiced throughout the entire industry. However, it is not known to what extent separation of

DRAFT

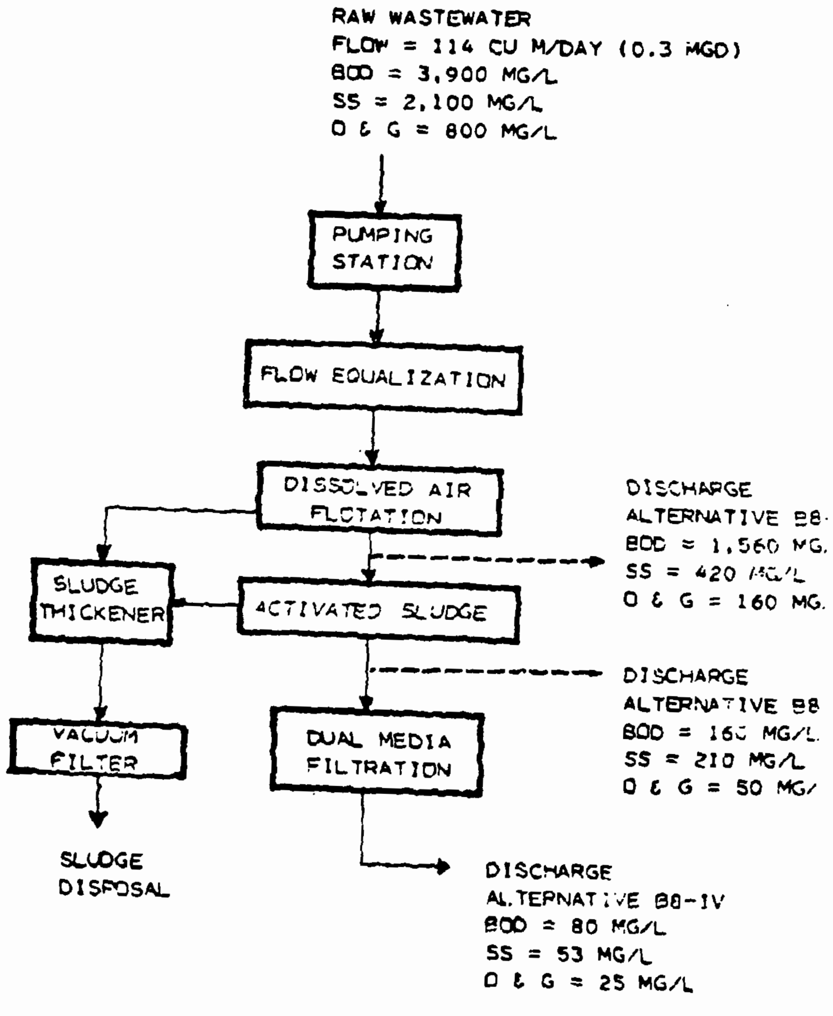


FIGURE 240

CONTROL AND TREATMENT ALTERNATIVES
B8-I THROUGH B8-IV

non-contact water and cleanup water used in solvent process areas is practiced in the flavoring extract industry.

Potential In-Plant Technology

Recycling of non-contact cooling water or at least separation of this water from the process wastestream could reduce the quantity of wastewater generated at a given plant. Additionally, the possibility of reusing rinse water as makeup for wash water should not be overlooked. The use of high pressure, low volume nozzles for hosing of floors and external equipment cleanup would also reduce the quantity of waste flow.

End-of-Line Technology

Two plants 87E03 and 87E04 operate treatment systems prior to discharge to navigable waters. From available information the remainder of the industry discharges to municipal treatment systems. The treatment system at Plant 87E03 is a physical system consisting of the following sequential components:

1. A holding tank.
2. A centrifuge with centrifuged solids being discarded as solid waste.
3. A sand-gravel filter for dewatering.
4. Two identical activated carbon systems in series each containing 0.9 kkg (1.0 ton) of carbon.

Flow in the sand-gravel filter and the activated carbon systems is from bottom to top. The treated effluent from the final activated carbon unit is mixed in a 1:10 ratio with non-contact water prior to discharge into a river. The average BOD of the mixed effluent is 24 mg/l. Assuming that the non-contact water has a BOD of 10 mg/l (a very logical approach), the BOD of the treated effluent will be approximately 160 mg/l. The average BOD of the raw waste effluent was determined to be 1360 mg/l, and thus the treatment efficiency of this system is estimated to be about 88 percent.

Plant 87E04, with a treatment system consisting of partial sedimentation followed by an aerated lagoon, reported average treated effluent concentrations of 35 mg/l BOD and 52 mg/l suspended solids. However, no raw wasteload data were available for this particular plant and therefore treatment efficiencies could not be determined.

As discussed in Section V, Plants 87E03, and 87E05 segregate the waste streams from the cleaning of vacuum distillation units, and organic synthesis equipment, and following neutralization, this waste is removed by an environmental sanitation service. One plant reports that the waste is subsequently disposed of by discharge, while the other reports that the waste is treated at one of the private service's treatment plants.

Selection of Control and Treatment Technology

A model plant was developed for flavoring extracts manufacturing in Section V. The raw wastewater characteristics were assumed as follows:

BOD	1350 mg/l
SS	130 mg/l
pH	7.1

Table 144 lists the pollutant effluent loading and the estimated operating efficiency of each of the eleven treatment alternatives selected for this subcategory. The alternatives are illustrated in Figures 241 and 242.

Alternative A 29-I - This alternative provides no treatment.

Alternative A 29-II - This alternative consists of spray irrigation of the waste effluent requiring 2.7 ha (6.6 acres) of land. The overall benefit of this alternative is a pollutant reduction of 100 percent to navigable waters.

Alternative A 29-III - This alternative consists of a pumping station, a flow equalization tank, a complete mix activated sludge system, a sludge thickener, vacuum filtration, and a sludge storage tank. The flow equalization tank is provided to dampen shock loadings to the system due to intermittent cleanup operations within the plant. The activated sludge system would be expected to provide a BOD removal of 92.6 percent and a suspended solids removal of 76.9 percent. Vacuum filtration is provided to decrease sludge volume, thereby decreasing sludge hauling costs. A seven-day sludge storage tank to decrease frequency of hauls is provided, further decreasing hauling costs.

The overall benefit of this system is a BOD reduction of 92.6 percent and a suspended solids reduction of 76.9 percent.

Alternative A 29-IV - This alternative consists of the same modules as Alternative A 29-III except vacuum filtration is replaced by an aerobic digestor followed by sand drying beds. This results in twice the sludge volume produced per day than in Alternative A 29-III. A three day sludge storage tank is provided.

The overall benefit of this alternative is a BOD reduction of 92.6 percent and a suspended solids reduction of 76.9 percent.

Alternative A 29-V - This alternative consists of a pumping station, a flow equalization tank, and an aerated lagoon. The efficiency of the aerated lagoon is assumed to be the same as that for the activated sludge system included within Alternatives A 29-III and A 29-IV. The overall benefit of this alternative is a BOD reduction of 92.6 percent and a

DRAFT

TABLE 144

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY A29

FLAVORING EXTRACTS

Alternative	Effluent BOD kg/cu m	Effluent SS kg/cu m	Percent BOD removal	Percent SS removal
A29-I			0	0
A29-II	0	0	100	100
A29-III	0.041	0.0123	92.6	76.9
A29-IV	0.041	0.0123	92.6	76.9
A29-V	0.041	0.0123	92.6	76.9
A29-VI	0.020	0.0062	96.3	88.5
A29-VII	0.020	0.0062	96.3	88.5
A29-VIII	0.020	0.0062	96.3	88.5
A29-IX	0.0123	0.004	97.8	92.3
A29-X	0.0123	0.004	97.8	92.3
A29-XI	0.0123	0.004	97.8	92.3

DRAFT

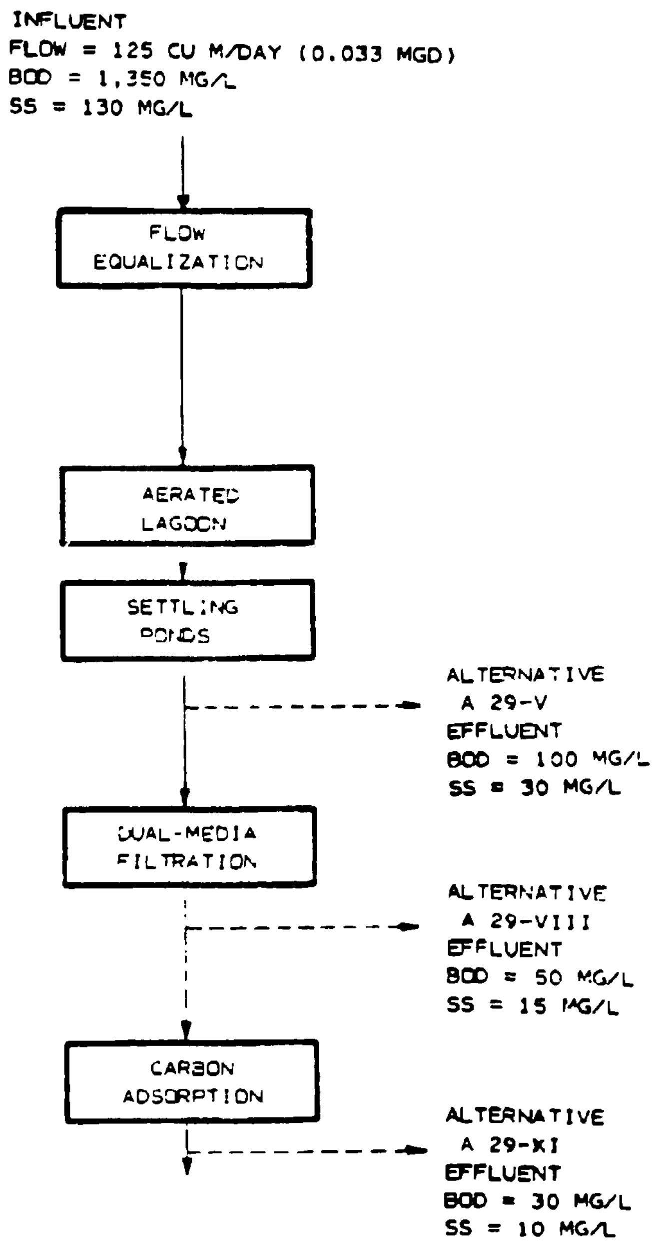


FIGURE 242

SUBCATEGORY A29
TREATMENT ALTERNATIVES V, VIII, XI

suspended solids reduction of 76.9 percent. This alternative is Alternative A 29-III with the addition of dual-media filtration which would provide an additional COD and suspended solids reduction of 3.7 and 11.6 percent, respectively.

Alternative A 29-VI - This alternative consists of the same treatment modules as Alternative A29-III with the addition of dual-media filtration.

The overall benefit of this alternative is a BOD reduction of 96.3 percent and a suspended solids reduction of 88.5 percent.

Alternative A 29-VII - This alternative consists of the same treatment modules as Alternative A29-IV with the addition of dual-media filtration.

The overall benefit of this alternative is a BOD reduction of 96.3 percent and a suspended solids reduction of 88.5 percent.

Alternative A 29-VIII - This alternative is identical to Alternative A 29-V with the addition of activated carbon which would provide an additional BOD and suspended solids reduction of 1.5 and 3.8 percent, respectively.

The overall benefit of this alternative is a BOD reduction of 97.8 percent and a suspended solids reduction of 92.3 percent.

Alternative A 29-IX - This alternative consists of the same modules as Alternative A 29-VI with the addition of activated carbon as illustrated in Figure 242.

The overall benefit of this alternative is a BOD reduction of 97.8 percent and a suspended solids reduction of 92.3 percent.

Alternative A 29-X - This alternative is identical to Alternative A 29-VII with the addition of activated carbon.

The overall benefit of this alternative is a BOD reduction of 97.8 percent and a suspended solids reduction of 92.3 percent.

SUBCATEGORY A 31 - BOUILLON PRODUCTS

In-Plant Technology

Since wastewater generated by the production of bouillon products is a result of equipment cleaning, there exists little potential in-plant technology for wastewater control. General housekeeping should be optimized; dry cleaning before wet cleaning or instead of wet cleaning should be employed as much as possible.

End-of-Line Technology

All existing bouillon manufacturers discharge to municipal treatment systems with no apparent adverse effects. The wastewater constituents are mostly highly biodegradable proteins which are well suited for biological treatment.

Selection of Control and Treatment Technology

A model plant was developed for bouillon product manufacturing in Section V. It was assumed that the model plant provided a grease trap prior to wastewater discharge. The raw wastewater characteristics after the grease trap were assumed to be as follows:

BOD	3000 mg/l
SS	200 mg/l
FOG	150 mg/l

Table 145 lists the effluent pollutant loading and the estimated operating efficiency of each of the seven treatment alternatives selected for this subcategory. Figures 243 and 244 illustrate the treatment alternatives -

Alternative A 31-I - This alternative consists of a pumping station, holding tank, and spray irrigation. The land requirement for this alternative is 2.4 ha (6.0 acres).

The overall benefit of this alternative is a 100 percent reduction of pollutants to navigable waters.

Alternative A 31-II - This alternative consists of a pumping station, a flow equalization tank, a complete mix activated sludge basin, a sludge thickener, and a vacuum filter. Flow equalization is provided to dampen the effect of shock loadings due to large cleanup flow at the end of each day. The complete mix activated sludge system would provide a BOD reduction of 95 percent, a suspended solids reduction of 80 percent and a fats and oils reduction of 73.3 percent. Sludge thickening and vacuum filtration are provided to reduce the quantity of daily sludge generated thereby reducing hauling costs. A sludge storage tank is provided to reduce the frequency of hauls and further reduce hauling costs.

The overall benefit of this alternative is a BOD reduction of 95 percent, a suspended solids reduction of 80 percent, and a fats and oils reduction of 73.3 percent.

Alternative A 31-III - This alternative consists of the same treatment modules as Alternative A 31-II with the exception that the vacuum filter is replaced by sand drying beds. This results in twice the amount of sludge to be hauled per day than that of Alternative A 31-III.

The overall benefit of this alternative is a BOD reduction of 95 percent, a suspended solids reduction of 80 percent, and a fats and oils reduction of 73.3 percent.

Alternative A 31-IV - This alternative consists of a pumping station, a flow equalization tank, and an aerated lagoon. The efficiency of this alternative would be expected to be the same as that of an activated sludge system.

DRAFT

TABLE 145

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY A31
BOUILLON PRODUCTS

Treatment Train Alternatives	BOD kg/kkg	SS kg/kkg	FOG kg/kkg	Percent BOD Removed	Percent SS Removed	Percent FOG Removed
A31-I	0.0	0.0	0.0	100	100	100
A31-II	2.34	0.626	0.626	95	80	73.3
A31-III	2.34	0.626	0.626	95	80	73.3
A31-IV	2.34	0.626	0.626	95	80	73.3
A31-V	1.09	0.313	0.313	97.6	90	86.7
A31-VI	1.09	0.313	0.313	97.6	90	86.7
A31-VII	1.09	0.313	0.313	97.6	90	86.7

DRAFT

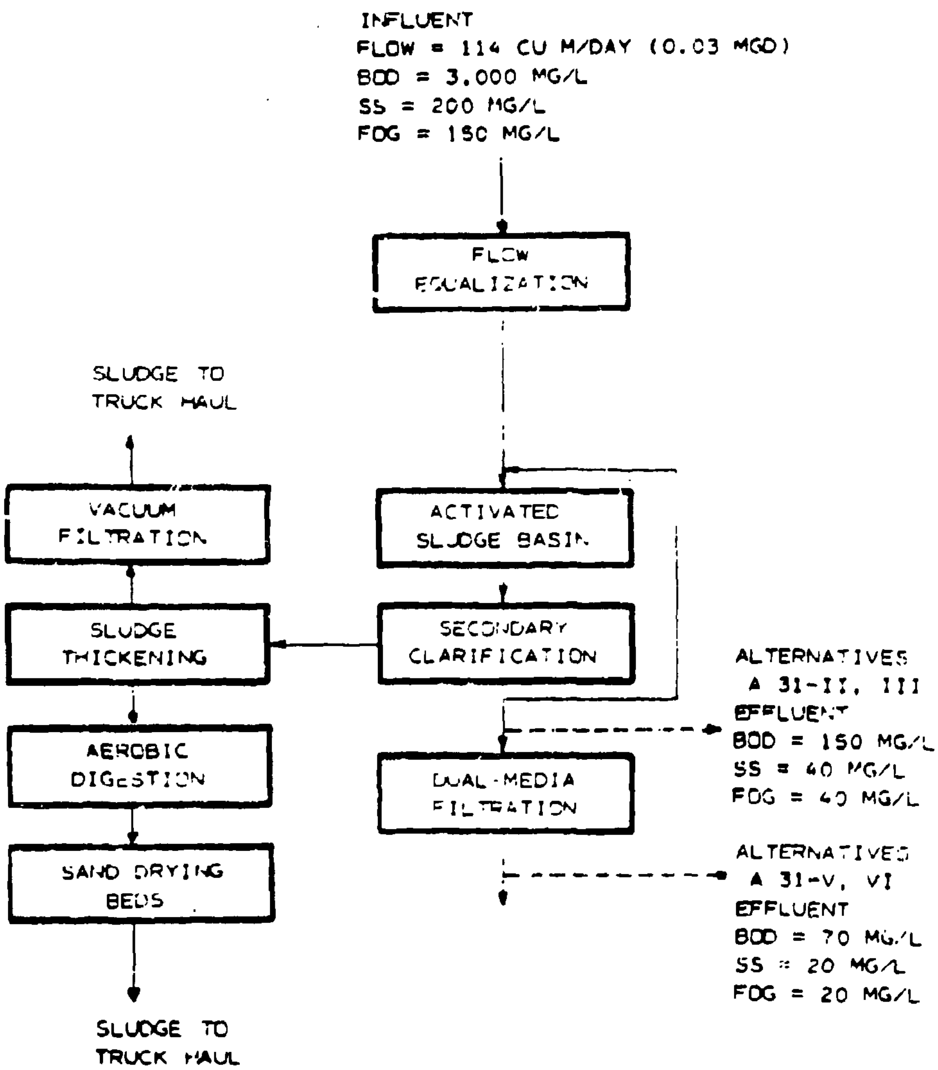


FIGURE 243

SUBCATEGORY A31
TREATMENT ALTERNATIVES II, III, V, AND VI

DRAFT

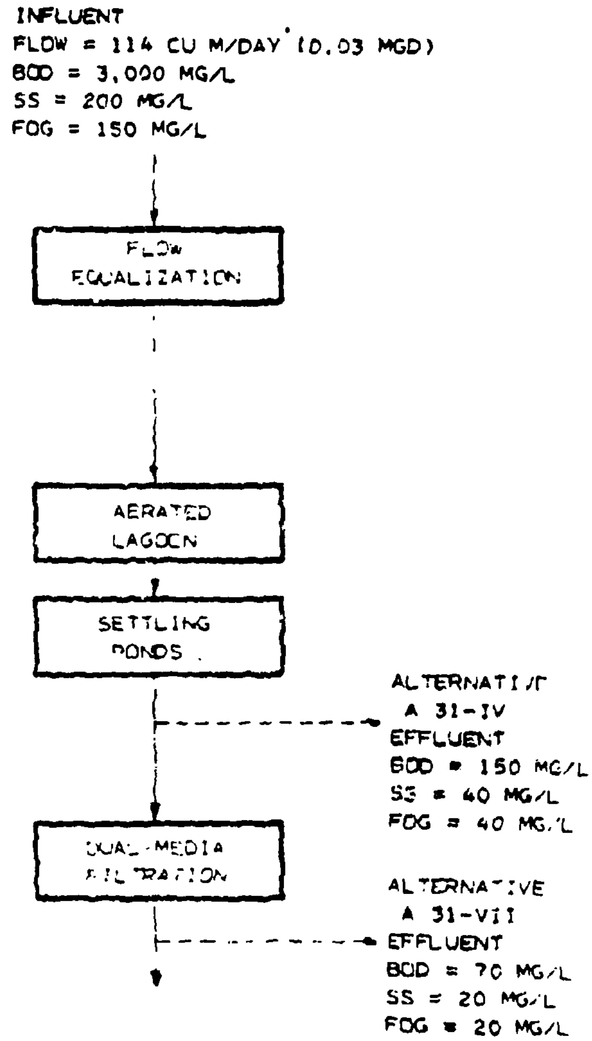


FIGURE 244

SUBCATEGORY A31
TREATMENT ALTERNATIVES IV AND VII

The overall benefit of this alternative is a BOD reduction of 95 percent, a suspended solids reduction of 80 percent, and a fats and oils reduction of 73.3 percent.

Alternative A 31-V - This alternative is identical to Alternative A 31-II with the addition of dual media filtration. The overall benefit of this alternative is a BOD reduction of 97.6 percent, a suspended solids reduction of 50 percent, and a fats and oils reduction of 86.7 percent.

Alternative A 31-VI - This alternative consists of the same modules as Alternative A 31-III with the addition of dual media filtration.

The overall benefit of this alternative is a BOD reduction of 97.6 percent, a suspended solids reduction of 90 percent, and a fats and oils reduction of 86.7 percent.

Alternative A 31-VII - This alternative consists of the same modules as Alternative A 31-IV with the addition of dual media filtration.

The overall benefit of this alternative is a BOD reduction of 97.6 percent, a suspended solids reduction of 90 percent and a fats and oils reduction of 86.7 percent.

SUBCATEGORY A 32 - NON-DAIRY CREAMER

Existing In-Plant Technology

Information was obtained from two plants during the study. Both plants used clean-in-place (CIP) systems for equipment cleanup. Plant 99NN01 recycled caustic and acid rinse water and thereby limited the CIP system wastewater discharge to 7.6 cu m/day (0.002 MGD). In contrast, plant 99NC2, a multi-product facility generated 227 cu m/day (0.06 MGD) of wastewater fr.m CIP systems. Non-contact water and boiler blowdown at one plant was separated from the process wastestream and was recycled at the other--both of these procedures being desirable practices.

Potential In-Plant Technology

The quantity of wastewater generated by clean-in-place (CIP) systems can be further reduced if final or chlorine rinse is recycled and used as initial rinse. This could conceivably reduce wastewater quantity by as much as 30 percent. Non-contact water could also be recycled, as is done at plant 99N02, so that only makeup water would be added as needed.

Improved equipment connections and packaging practices in liquid non-dairy creamer plants could result in a decreased pollutant loading by reducing product spills in packaging areas. In powdered non-dairy creamer plants, cleanup of equipment in dry product areas, as well as dry product spills should be done with air in order to reduce quantity and pollutant loading of wastewater.

End-of-Line Technology

The only known end-of-line technology currently employed in the non-dairy creamer industry is spray irrigation of waste effluent by plant 99NN03, however, this plant is a multi-product facility (cereals are also produced) an no information is available to determine the quantity or pollutants contributed to the waste stream by the liquid creamer production alone.

The remainder of the plants contacted discharge without pretreatment to municipal systems with no apparent adverse affects to the municipal treatment facilities. Consequently, the application of transfer technology in the form of biological treatment is considered to be feasible for the non-dairy creamer waste effluent.

Selection of Control and Treatment Technology

A model plant for liquid and powdered non-dairy creamer processing was developed in Section V. The quantity of wastewater generated was determined based on the assumptions of recycling of caustic and acid rinse water from clean-in-place (CIP) systems and separation of non-contact water from the process wastestream. The raw wastewater characteristics of the model plant were presented as follows:

Flow:	64.3 cu m (0.017 MGD)
BOD:	1100 mg/l
SS:	440 mg/l
O&G:	260 mg/l
N:	5.5 mg/l
P:	29 mg/l
pH:	7.0

Table 146 lists the pollutant effluent loading and the estimated operating efficiency of each of the five treatment trains selected for this subcategory. The treatment alternatives are illustrated in Figures 245 and 246.

Alternative A 32-I - This alternative consists of spray irrigation which would require a 129 cu m (0.034 MGD) holding tank and a 1.4 ha (3.4 acre) spray field. The overall benefit of this system is complete reduction of pollutants to navigable waters.

Alternative A 32-II - This alternative consists of a pumping station, nutrient addition, a flow equalization basin, air flotation, a complete mix activated sludge system, a sludge thickener, and a storage tank to retain one week's sludge production. Nutrient addition is provided to increase the BOD reduction in the activated sludge system as the BOD:N:P ratio of the wastewater entering that activated sludge system was determined to be 100:0.8:0.44, requiring the addition of 2.1 kg (4.7 lbs) of anhydrous ammonia and 0.51 kg (1.1 lbs) of phosphoric acid per day. Flow equalization is provided to dampen shock loadings which would be expected due to the intermittent cleanup practices of the non-dairy creamer plant. Removal of fats and oils is accomplished by the air flotation module. The accumulated scum would be skimmed and passed into the sludge thickener. Air flotation

TABLE 146

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
(NON-DAIRY COFFEE CREAMER)

Subcategory A 32

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Effluent F&O kg/kkg	Percent BOD Reduction	Percent SS Reduction	Percent F&O Reduction
A32-I	0	0	0	100	100	100
A32-II	0.0248	0.071	0.0425	96.8	77.2	77.4
A32-III	0.0248	0.071	0.0425	96.8	77.2	77.4
A32-IV	0.0106	0.0142	0.0142	98.6	95.5	92.5
A32-V	0.0106	0.0142	0.0142	98.6	95.5	92.5

DRAFT

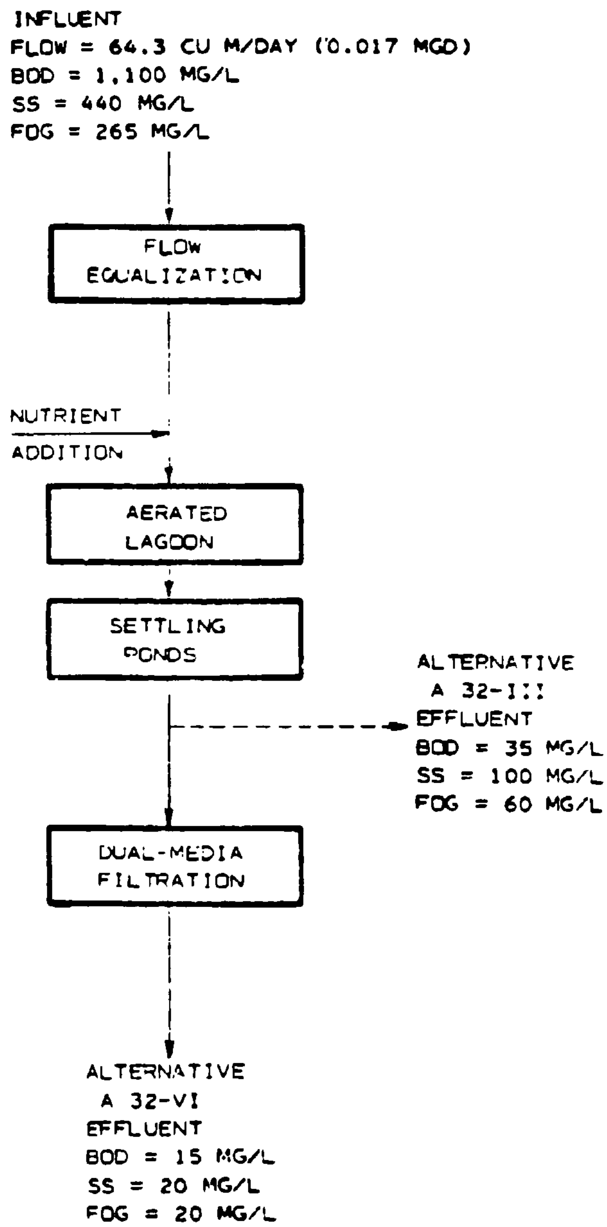


FIGURE 246

SUBCATEGORY A32
TREATMENT ALTERNATIVES III AND VI

would provide a BOD removal of 60 percent, a suspended solids reduction of 50 percent, and a fats and oils reduction of 42 percent, with the reduction of fats and oils decreasing foaming in the activated sludge process.

Due to the high biodegradability of the waste effluent, the complete mix activated sludge module would be expected to provide a BOD reduction of 94.6 percent, a suspended solids removal of 45 percent and a fats and oils reduction of 55 percent. The quantity of sludge generated by the activated sludge system would be 7070 l/day (1870 gal/day). Sludge thickening is provided to concentrate the sludge to two percent solids and decrease the sludge quantity to 1780 l/day (467 gal/day) thereby decreasing sludge hauling costs. A holding tank for seven days sludge volume was recommended to further decrease frequency and thus cost of sludge hauling.

The overall benefit of Alternative A 32-II is a BOD reduction of 96.8 percent, a suspended solids reduction of 77.2 percent and a fats and oils reduction of 77.4 percent.

Alternative A 32-III - This alternative consists of a pumping station, nutrient addition, a flow equalization tank, an aerated lagoon, and two settling ponds. The nutrient addition module and flow equalization tank perform the same functions as indicated for Alternative A 32-II. Due to longer retention and settling time, removal of fats and oils prior to aerating is unnecessary. The quantity of sludge which would need to be removed by draining and dredging settling ponds every five years is estimated to be 25.8 cu m (33.7 cu yds).

The overall effect of Alternative A 32-III would be expected to be the same as that for Alternative A 32-II.

Alternative A 32-IV - This alternative consists of the treatment modules of Alternative A 32-III with the addition of sand filtration. Sand filtration provides an additional BOD removal of 1.8 percent, suspended solids removal of 18.3 percent and a fats and oils removal of 15.1 percent.

The overall benefit of this alternative is a BOD reduction of 98.6 percent, a suspended solids reduction of 95.5 percent, and a fats and oils reduction of 92.5 percent.

Alternative A 32-V - This alternative consists of the treatment modules of Alternative A 32-II with the addition of sand filtration.

The overall benefit of this alternative is the same as that of Alternative A 32-IV.

SUBCATEGORY A 33 - YEAST

This discussion relates directly to the process for yeast product described in Section III and details existing and potential in-plant modifications for reducing volume and strength of wastewater discharges. Treatment methods used by the industry are reviewed, and treatment alternatives are presented for the model plant defined in Section V.

In-Plant Technology

In-plant process controls for the reduction of wastewater generation primarily consist of segregation process wastewater from other sources reuse of cooling water and boiler condensate, and recovery or dry hauling of spent filter aids. Dry hauling of molasses clarifier sludge and reuse of third separation spent beer in the second separation process are other important methods of reducing wastewater generation. Third separation beer, resulting from final cold water washing and centrifugal separation of yeast cream from spent nutrients, can either be discharged or used as dilution water during the second separation since it is of relatively low pollutant strength. While no significant reduction of pollution load results, overall water use may be lowered up to 50 percent with recycling. One major producer (99Y20) is currently conducting a bacteriological survey to determine the feasibility of reusing spent beer at their plants. This is especially important for plants that practice by-product recovery and biological treatment of resulting low strength wastes, since lower overall water use would significantly reduce hydraulic loading of the treatment system. The wastewater characteristics of two plants (99Y02 and 99Y05) that currently reuse final spent beer are compared with the waste load of a plant (99Y20) that discharges all separation water in Table 147.

Filter aids used in rotary vacuum filters and filter presses for yeast dewatering include such materials as potato starch and diatomaceous earth. Spent filter precoat may be handled dry and trucked directly to land disposal, mixed with water and the slurry discharged, or the slurry supernatent may be discharged after settling. One plant (99Y23) recovers potato starch vacuum filter precoat as a by-product after settling

The sludge produced by mechanical clarification of molasses in the preparation of feed wort may be discharged directly or collected for land disposal. At the three plants (99Y20, 99Y08, and 99Y11) that practice evaporation of spent beer, the sludge may be added directly to the molasses by-product.

A small portion of pollutant loads can be attributed to housekeeping practices that result in accidental spills or molasses losses to drains, and improperly maintained equipment and machinery. These housekeeping contributions are generally shock loads that occur during daily or weekly maintenance and washdown periods. Costs of effective in-plant control of these sources are negligible when compared to the costs of treatment of polluted effluents and lost raw materials. Measures for the control and minimization of these sources can be effected by good

DRAFT

TABLE 147

COMPARISON OF WASTEWATER CHARACTERISTICS AND SPENT BEER REUSE

		Final Spent Beer Reused	Final Spent Beer Discharged
Yeast Plant	99Y02	99Y05	99Y20
Production (kkg/day)	82.2	76.5	87.5
Flow (cu m/day)	2650	2854	5299
BOD (mg/l)	6276	6766	2813
BOD (kg/day)	16330	19310	14190
SS (mg/l)	1735	353	1250
SS (kg/day)	4513	1008	6624

housekeeping practices. The partial reuse of boiler condensate for hot water washdowns is one demonstrated method of water conservation.

Acid and caustic wastes are streams resulting from the cleaning of evaporators, molasses storage tanks, and other equipment. Acid and caustic waters are presently discharged or recycled as part of clean-in-place systems. All evaporator cleanup at one plant (99Y23) is returned to the system. The quantities of acid and caustic wastes are not sufficient to significantly affect the pH of the combined waste flow. In general, it can be stated that there is existing technology that will allow zero discharge of acid and caustic waste.

Table 148 presents a summary of in-plant control and treatment technology for the yeast industry. It is probable that no yeast factory in the United States practices optimum in-plant control, but it is also probable that all plants practice some degree of in-plant control. Also, it is not always possible or cost effective to achieve the best in-plant controls, especially in older plants. In such cases, money for in-plant modifications might be better spent for wastewater treatment. The model treatment technology developed later in this section and the cost analyses of Section VIII are based upon reasonable steps taken in-plant to reduce pollution loadings.

End-of-Line Technology

Wastewater treatment at 11 of 13 operating yeast factories consists of discharge to municipal treatment systems. Three plants (99Y08, 99Y11, and 99Y20) treat high strength wastes, consisting of first and second separation, by means of evaporation to obtain molasses by-products. All of these plants directly discharge third separation beer, evaporator condensate, and other low strength wastes to the municipal system. Plant 99Y08 provides only evaporation before discharging to a municipal system. The remaining two plants (99Y11 and 99Y20) utilize trickling filters and activated sludge, respectively, before discharging to navigable waterways. Table 149 shows the existing treatment practices in the yeast industry.

Several methods of treating soluble carbohydrate yeast wastes have been used in the United States and in Europe. Eldridge (143) reports that, in general, yeast effluents are best stabilized by primary fermentation treatment in anaerobic tanks followed by secondary treatment using percolating filters. A European example of this method is the Slagelse, Denmark, yeast plant where the concentrated wastes, i.e., the yeast wort, are isolated from the dilute wastes (now called the Danish process) and treatment of each wastestream is carried out separately. The concentrated

DRAFT

TABLE 148

SUMMARY OF IN-PLANT CONTROL AND TREATMENT TECHNOLOGY

SUBCATEGORY A 33

Wastewater Source	Inplant Control	Remarks
Storm and Cooling Water	1. Separation from Process Water	1. Significant reduction of hydraulic load to treatment 2. Difficult for older plants
Third Separation Beer	1. Reuse in second Separation	1. Significant reduction of overall water usage
Spent Filter Cake	1. Dry Haul 2. Byproduct Recovery	1. No discharge is technically feasible
Molasses Clarifier Sludge	1. Dry Haul 2. Byproduct Addition	1. No discharge is technically feasible
Floor Wash and Miscellaneous Wastes	1. Improve housekeeping and maintenance practices; use water only when necessary and reuse when possible	1. Significant BOD and suspended solids reduction achievable
Acid and Caustic Wastes	1. Collection and Reuse	1. No discharge is technically feasible.

DRAFT

TABLE 149

SUBCATEGORY A 33

SUMMARY OF END OF LINE TREATMENT AND CONTROL

	Separation Water					Filter Water				Washdown Water			Cooling Water		Misc. Water		
Yeast Plant	Evaporation	Trickling Filters	Activated Sludge	Recycle	Discharge	Trickling Filters	Activated Sludge	Discharge	Precoat Recovery	Trickling Filters	Activated Sludge	Discharge	Recycle	Discharge	Trickling Filters	Activated Sludge	Discharge
99Y01				X	X			X	UK			X		X			X
99Y03				X	X			X	UK			X		X			X
99Y04					X			X	UK			X	UK	UK			X
99Y06				X	X			X	UK			X	X				X
99Y20	X		X		X		X		X		X			X	X	X	
99Y22				UK	X			X	UK			X	X	X			X
99Y07				UK	X			X	X			X	UK	X			X
99Y08	X			UK	X			X	X			X	UK	X			X
99Y09				UK	X			X	X			X	UK	X			X
99Y11	X	X		UK	X					X				X	X		
99Y10				UK	X			X	UK			X		X			X
99Y12				UK	X			X	UK			X		X			X
99Y13				UK	X			X	UK			X	X	X			X

Note: UK = Unknown

wastes are digested anaerobically; the remaining dilute effluents are treated with high rate trickling filters. Figure 247 shows a diagram of this treatment system. A COD reduction of 70 to 80 percent is obtained for a retention time of four days in the digesters. The concentration of sludge in digestion must be maintained because it is the main carrier of methane bacteria. The fermentation gas obtained has a value of 6000 to 6500 Kcal/cu m (26 BTU), or about 0.5 cu m (18 cu ft) collected for each kg of BOD removed, and is used mainly for heating to maintain the 30 to 40°C necessary in the digesters. The amount of digested sludge discharged is about 0.5 percent of the wort, and is used in making vitamin B_{12}. The object of aerating the wort is to remove hydrogen sulphide so that the gas may be burned in boiler furnaces. About one hour of aeration, consuming 3 to 5 cu m of air per cu m of waste is required to oxidize 98 percent of the hydrogen sulphide to elemental sulphur. The recirculation ratio for the trickling filters is at least 1.3. A BOD reduction of 94 percent is attained using both digestion and high-rate trickling filters.

A plant (39Y24) operating in Illinois during the 1940's is reported (44) to have treated an average of 500 cu m/day (.132 MGD) of wastewater with a BOD of 3200 mg/l and volatile solids of approximately 700 mg/l, using two-stage digestion followed by a high-rate trickling filter, final settling, and chlorination of the final effluent after it was mixed with approximately twice its volume of clear condenser water. This treatment system shown in Figure 248, achieved 89 to 98 percent average monthly BOD reduction for wastes from production of about 10.4 kkg/day (11.5 ton/day). The total raw waste was passed through a gas and oil-fired heat exchanger into the floating covered primary tank which has a 66 hr detention time. The overflow from this tank was fed to a fixed-cover secondary tank with a 48 hr detention time. The upper two-thirds of either tank could be recirculated through the heat exchanger, or waste from the secondary tank pumped back to the primary tank. The overflow from the secondary tank was mixed with approximately eight times its volume of clarifier effluent and then pumped to a 19 m (62 ft) diameter, 2.5 m (8 ft) deep trickling filter being dosed at approximately 68,000 cu m/ha/day (10 MGAD) by a multiple-arm rotary distributor with Page-type nozzles. The filter had complete underdrainage, a conical roof with center stack, and a 70 cu m (3000 cu ft) capacity fan to produce down draft ventilation. A commercial deodorant was placed in a flat pan under the fan discharge to eliminate disagreeable odors.

The filter effluent was passed through a weir to a circular final clarifier, 20 m (60 ft) in diameter and 2.5 m (8 ft) deep, with a detention time of 3.75 hours. All clarifier effluent was recirculated to the filter except a volume equal to the daily raw waste, which was mixed with twice the volume of condense, water, chlorinated, and discharged into the storm sewer system. Sludge removed daily from the clarifier was hauled by truck to farm land and used as fertilizer. This system worked well after starting, although it was necessary to reinoculate the digesters with sludge from an outside source periodically to maintain optimum operation.

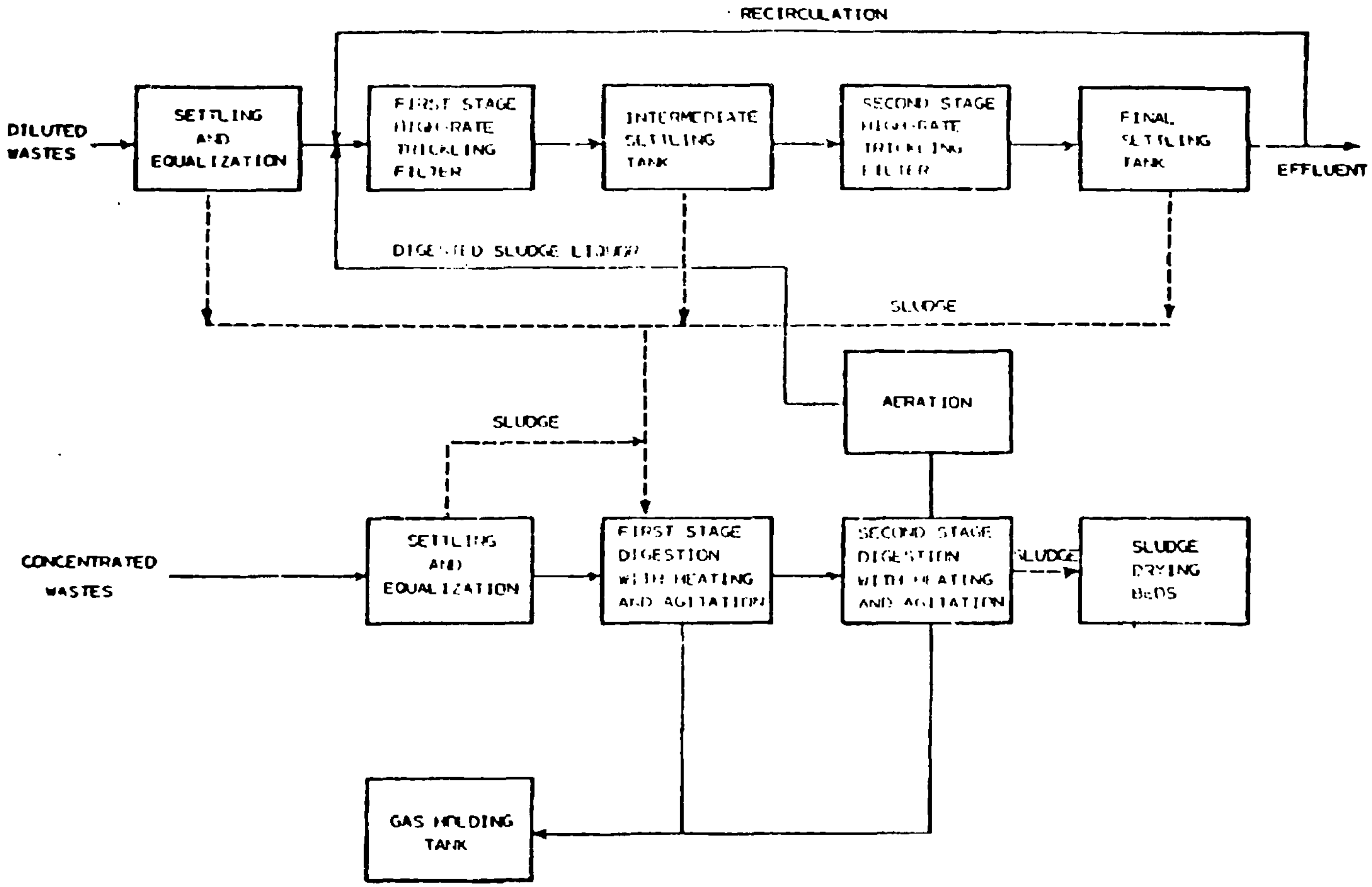


FIGURE 247

SLAGELSE, DENMARK YEAST PLANT TREATMENT SYSTEM.

DRAFT

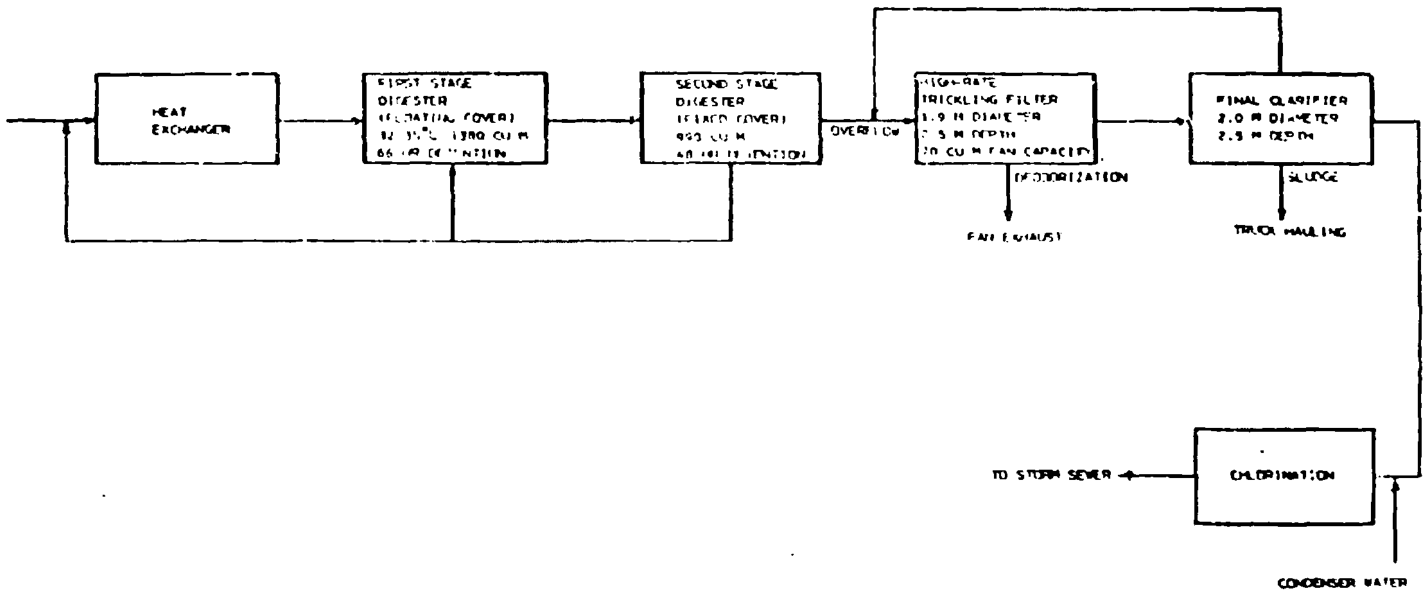


FIGURE 248

PLANT 99Y24

TREATMENT SYSTEM

Another plant (99Y25) operating in Illinois (99Y25) in the 1940's treated yeast wastes with a BOD of 4200 to 7600 mg/l using a system consisting of six fixed-cover digesters operated in three digestion stages of two tanks each. The system produced an overall BOD reduction of 80 to 85 percent and destruction of an average of 50 percent of the volatile solids.

Rudolfs and Trubnick (86) describe in detail a system once used for five years by plant 99Y05. The system (Figure 249) consisted of two equalization tanks, one for concentrated wastes (spent wort) and one for dilute wastes (wash water and cooling water), two steam heated digesters in series, a circular hopper-bottomed settling tank for retention and recycling of digester sludge, two 1.2 m (4.0 ft) deep trickling filters, and a final settling tank for filter sludge. Careful control of loading, acclimatization of the seed sludge, maintenance of proper proportions of seed and substrate, and provisions for adequate contact between the seed and the substrate resulted in peak digester efficiency of 95 percent BOD reduction (with a loading of 1.5 kg/cu m) in the digesters. Maintenance of proper concentration and neutral pH in the trickling filter achieved a BOD reduction as high as 75 percent, and the combined system obtained 80 to 92 percent removal of over 4000 kg/day (9000 lb/day) of BOD. The optimum pH of the influent to the trickling filters was 7.0, and efficiency fell rapidly at lower pH values. Below a pH of 6.0 the trickling filters were clogged by a growth of wild yeasts. Sodium hydroxide was used to maintain suitable pH values.

Buswell (145) has pointed out that while anaerobic treatment provides flexability in loading, the BOD of the effluent rarely has a BOD of less than several hundred mg/l, and that it is usually necessary to finish treatment of the anaerobic treatment effluent by the aerobic filter bed method before discharging the final effluent. Anaerobic digestion was used in Puerto Rico by one plant (99Y14) for a short time, but the treatment system and plant never performed adequately and are not currently operating.

The annual wastage of salts (145) by yeast factories is considerable. As early as 1930 mention was made of the possibility of concentrating the high strength wastes (spent beer) and using the concentrate as fertilizer or for cattle feed. Recovery of molasses by evaporating to dryness is currently practiced by three plants in the United States. One plant (99Y11) is currently starting by-product recovery operations, and little information is available on recovery methods at one other facility (99Y01), although the process was reported to be performing adequately.

At the third plant (99Y20) a 113,000 kg/hr (250,000 lb/hr) evaporation plant has been installed to handle the highly concentrated molasses wastes (first and second separator beers) discharged from the centrifugal separators, and an oxygen activated sludge system is used to heat the remaining combined plant wastes. Figures 250, 251, and 252 present the flow paths of plant wastestreams and treatment system operations. This

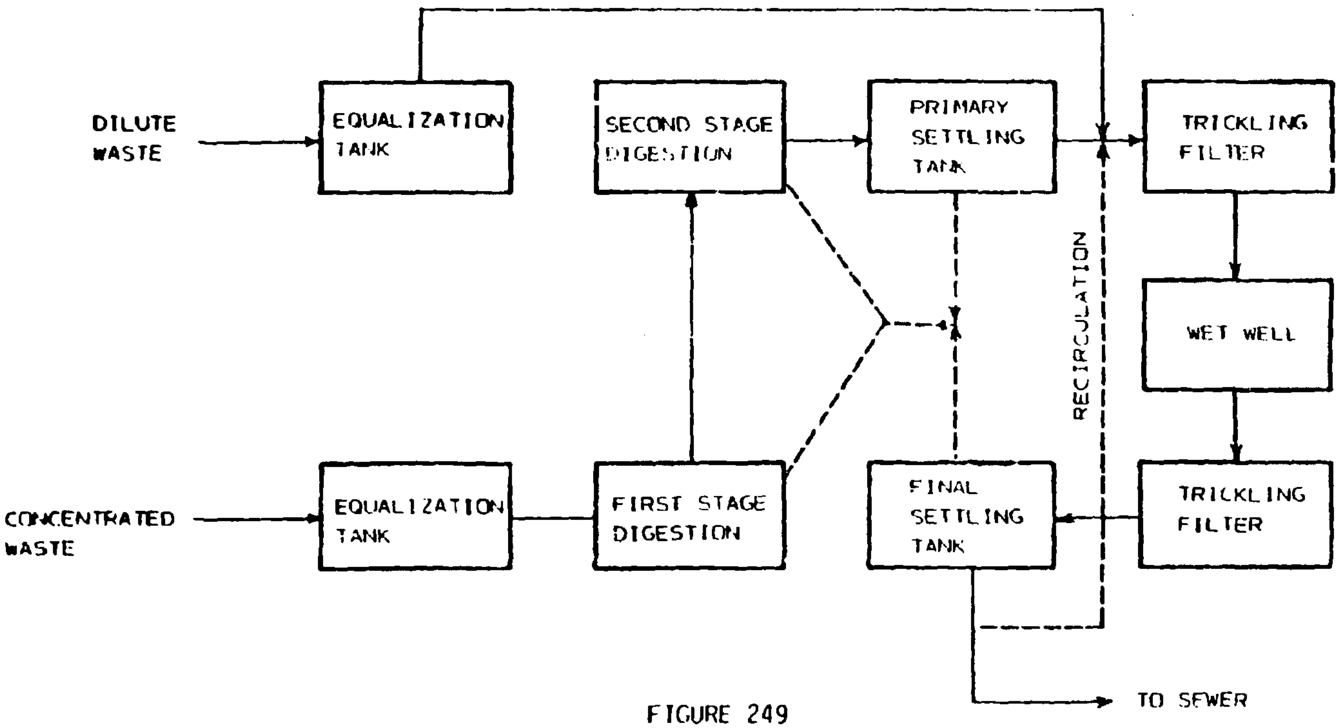


FIGURE 249

TREATMENT AND CONTROL

PLANT 99Y25

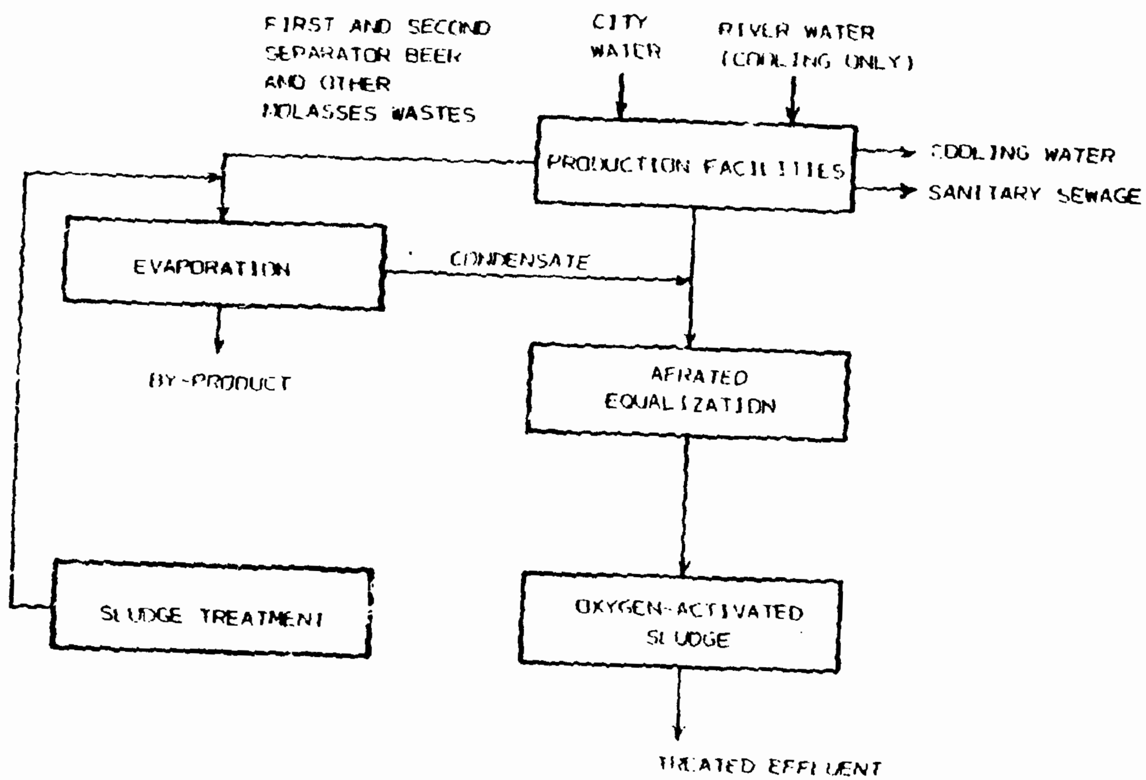


FIGURE 2.6

YEAST PLANT 99Y20

SIMPLIFIED WASTEWATER FLOW DIAGRAM

DRAF

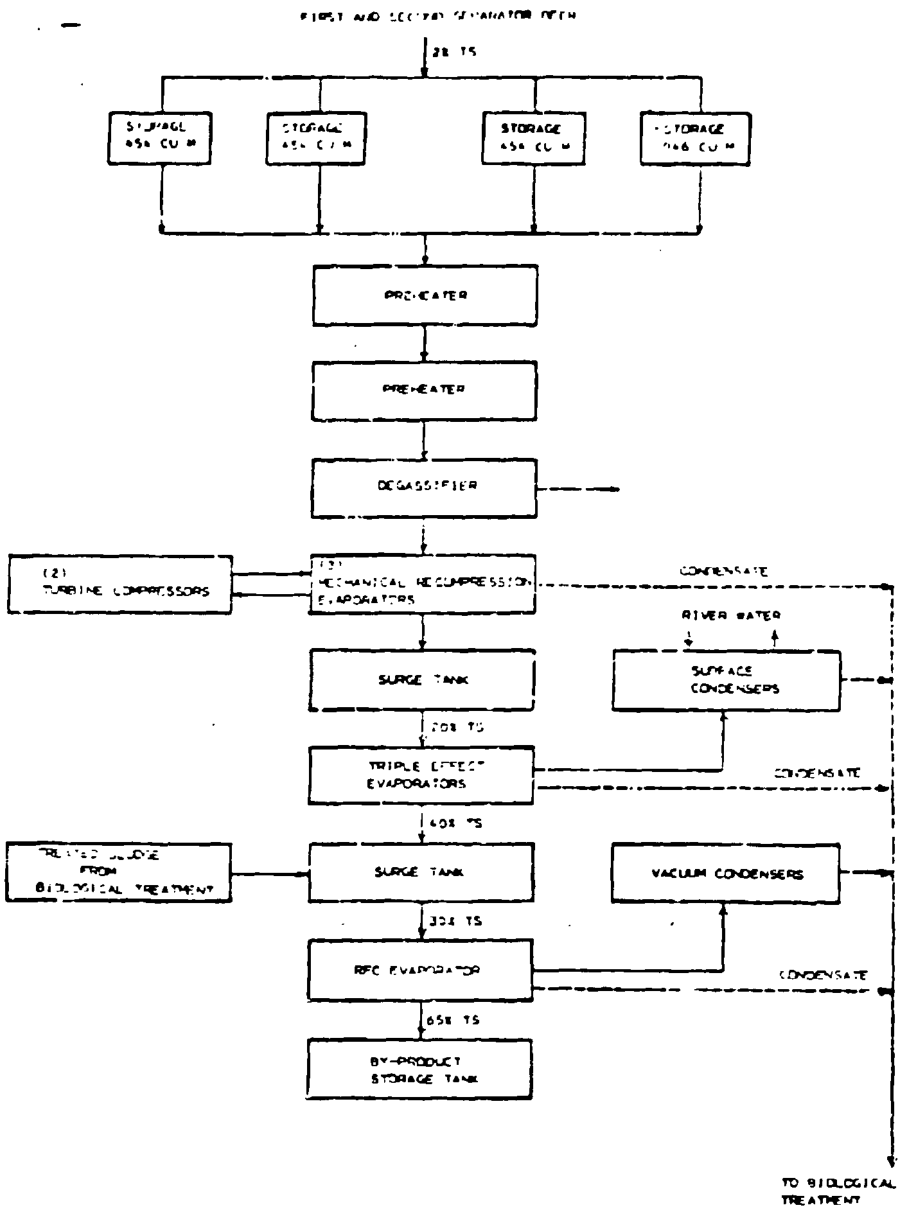


FIGURE 251

YEAST PLANT 99Y20

BY-PRODUCT RECOVERY USING EVAPORATION

DRAFT

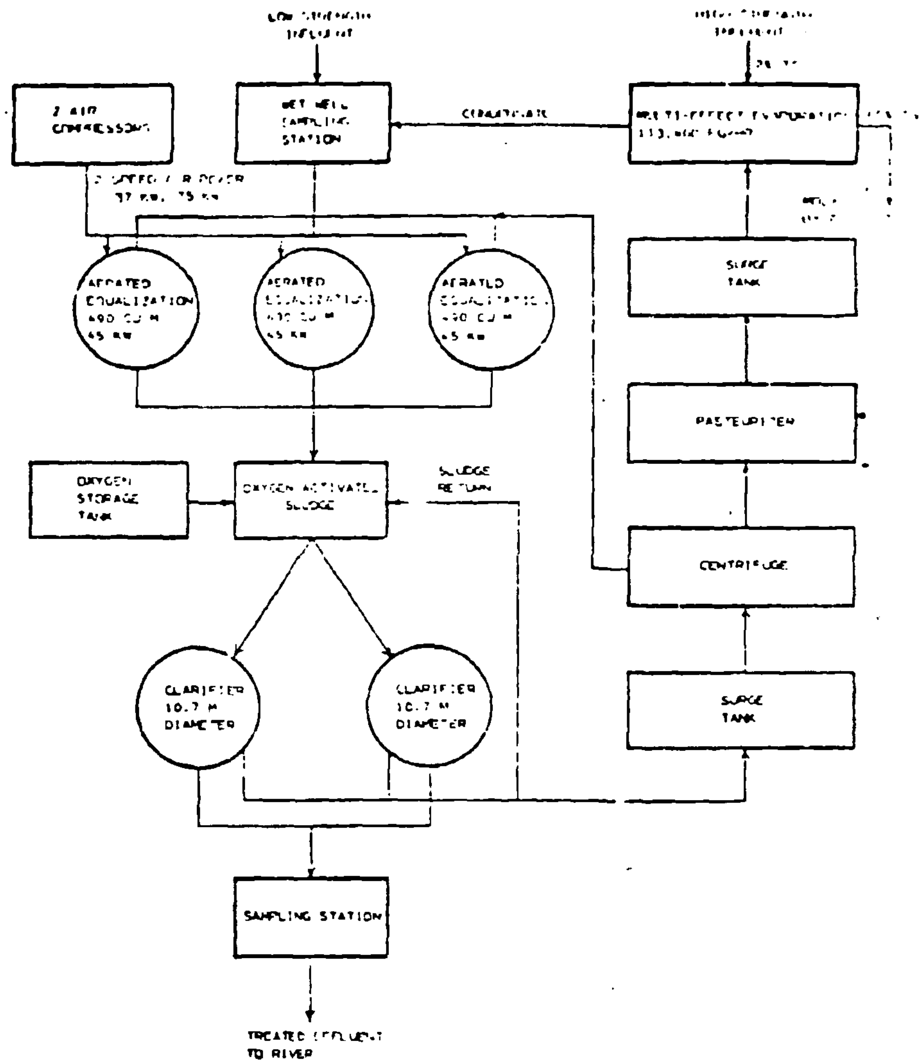


FIGURE 252

YEAST PLANT 99Y20

BIOLOGICAL TREATMENT AND CONTROL

system has treated an average of 85.7 kkg/week (94.5 ton/week) of BOD and 38.1 kkg/week (42.0 ton/week) of total suspended solids with a demonstrated removal of 91.4 percent of the BOD and 77.8 percent of the total suspended solids.

Concentration of the high strength wastes takes place in a multi-effect evaporation plant. First and second separator beers and other molasses wastes are pumped to any one of four surge tanks and then preheated and degasified in packed column type atmospheric flash strippers. The degassed wastes, containing 2 percent total solids are concentrated in three falling film mechanical recompression evaporators in series to 20 percent total solids. The evaporator condensate is sewered to the biological treatment system. A triple effect vacuum evaporator is then used to further concentrate the waste to 40 percent total solids, and the condensate is again sent to the oxygen-activated sludge system. Sludge from biological treatment is mixed with the 40 percent TS material and concentrated to 65 percent in a forced circulation (RFC) evaporator and the condensate from this final stage sent to biological treatment. Finally, the 65 percent total solids material is pumped to storage for future resale as animal feed. The evaporators are reported to remove 90 percent of the BOD and 99 percent of the suspended solids from high strength wastes. Reverse osmosis, ultrafiltration, and other methods (see rum distilling) of concentration were considered but were found to be unfeasible for this plant.

All low strength wastes, including third separator beer, evaporator condensate, and plant washings, are sent to the biological treatment system. The first stage of the system consists of neutralization, nutrient addition using phosphoric acid, and aerated equalization in three 454 cu m (120,000 gal) wood tanks, each provided with a two speed turbine agitator and air from two compressors. From equalization the wastes are pumped into the oxygen-activated sludge system where pure oxygen is used in place of air to achieve the conversion of influent BOD to biological cells and inorganic material. From this reactor the wastes are gravity fed into two 10.7 m (35.0 ft) diameter clarifiers in parallel to remove suspended solids. Clarifier overflow (treated effluent) is then discharged to a navigable waterway. Clarifier sludge is pumped to a surge tank, then concentrated, centrifuged, and pasteurized, and finally pumped from a second surge tank back to the last stage of evaporation. Some sludge is returned to the reactor. This sophisticated system worked well after some modification to eliminate fouling in the evaporators, although the final effluent still exhibits a brown color.

Selection of Control and Treatment Technology

In Section V a model plant was developed for the yeast industry. It is assumed that the model plant provides no treatment of its wastewater prior to discharge, and that cooling water and domestic sewage are separated from process wastewater. The chosen flow assumes that third separation beer is reused as dilution wash water during second separation. The raw wastewater characteristics of the model plant are:

DRAFT

Production	82 kkg (90.4 ton/day)
Flow	2,650 cu m (0.7 MGD)
BOD	6,300 mg/l
SS	1,850 mg/l

The treatment alternatives which include equalization were not judged to require neutralization. Biological treatment requires the addition of both nitrogen and phosphorus. In alternatives including molasses by-product recovery, evaporation is assumed to receive 50 percent of total plant flow (spent bees), 75 percent of the BOD and suspended solids, and removes 90 percent of the BOD and 99 percent of the suspended solids.

Table 150 lists the pollutant loading and calculated removal efficiencies of each of the treatment alternatives selected for this subcategory. Figures 253 and 254 provide simplified flow diagrams for the treatment alternatives in this subcategory.

Alternative A 33-I - This alternative includes no additional control or treatment. The efficiency of BOD and suspended solids removal is zero.

Alternative A 33-II - This alternative consists of a control house, pumping station, nutrient addition, flow equalization with 24 hour detention time, aerated lagoons, and settling ponds. Nutrient addition consists of 1012 kg/day (2231 lb/day) of anhydrous ammonia and 474 kg/day (1044 lb/day) of phosphoric acid. The predicted effluent concentrations are 100 mg/l BOD and 50 mg/l suspended solids. The overall effect of Alternative A 33-II is a BOD reduction of 98.4 percent and a suspended solids reduction of 97.3 percent.

Alternative A 33-III - This alternative adds dual media filtration to the treatment chain in Alternative A 33-II. The predicted effluent concentrations are 50 mg/l BOD and 25 mg/l suspended solids. The overall effect of Alternative A 33-III is a BOD reduction of 99.2 percent and a suspended solids reduction of 98.7 percent.

Alternative A 33-IV - This alternative adds activated carbon to the treatment chain in Alternative A 33-III. The predicted effluent concentrations are 25 mg/l BOD and 13 mg/l suspended solids. The overall effect of Alternative A 33-IV is a BOD reduction of 99.6 percent and a suspended solids reduction of 99.3 percent.

Alternative A 33-V - This alternative consists of a control house, pumping station, flow equalization with 24 hour detention time, primary clarification, nutrient addition, complete mix activated sludge system with fixed surface aerators, sludge thickening producing 2 percent solids, aerobic digestion producing 3.5 percent solids, vacuum filtration producing 15 percent solids, sludge storage, and truck hauling. Nutrient addition consists of 759 kg/day (1674 lb/day) of anhydrous ammonia and 355 kg/day (783 lb/day) of phosphoric acid. The predicted effluent concentrations are 100 mg/l BOD and 50 mg/l suspended solids. The overall

TABLE 150

SUMMARY OF TREATMENT ALTERNATIVES
SUBCATEGORY A33

Treatment Train Alternative	Effluent BOD (kg/kkg)	Effluent SS (kg/kkg)	Percent BOD Reduction	Percent SS Reduction
A33-I A	203.57	59.78	0	0
A33-II BCHIL	3.23	1.62	98.4	97.3
A33-III BCHILN	1.62	0.81	99.2	98.7
A33-IV BCHILNZ	0.81	0.40	99.6	99.3
A33-V BCEHIKQRSYV	3.23	1.62	98.4	97.3
A33-VI BCEHIKQRSYVW	1.62	0.81	99.2	98.7
A33-VII BCEHIKQRSYUNZ	0.81	0.40	99.6	99.3
A33-VIII BCEHIKQRUV	3.23	1.62	98.4	97.3
A33-IX BCEHIKQRUYN	1.62	0.81	99.2	98.7
A33-X BCEHIKQRUYNZ	0.81	0.40	99.6	99.3
A33-XI BCFIHIL	3.23	1.62	98.4	97.3
A33-XII BCFIHILN	1.62	0.81	99.2	98.7
A33-XIII BCFIHILNZ	0.81	0.40	99.6	99.3
A33-XIV BCEFIHIKQRYSV	3.23	1.62	98.4	97.3
A33-XV BCEFIHIKQRYSVN	1.62	0.81	99.2	98.7

TABLE 150 (CONT'D)

Treatment Train Alternative	Effluent BOD (kg/kkg)	Effluent SS (kg/kkg)	Percent BOD Reduction	Percent SS Reduction
A33-XVI BCEFIHIKQRYSVNZ	0.81	0.40	99.6	99.3
A33-XVII BCEFIHIKQRYU	3.23	1.62	98.4	97.3
A33-XVIII BCEFIHIKQRYUN	1.62	0.81	99.2	98.7
A33-XIX BCEFIHIKQRYUNZ	0.81	0.40	99.6	99.3
A33-XX YBU	0	0	100	100

DRAFT

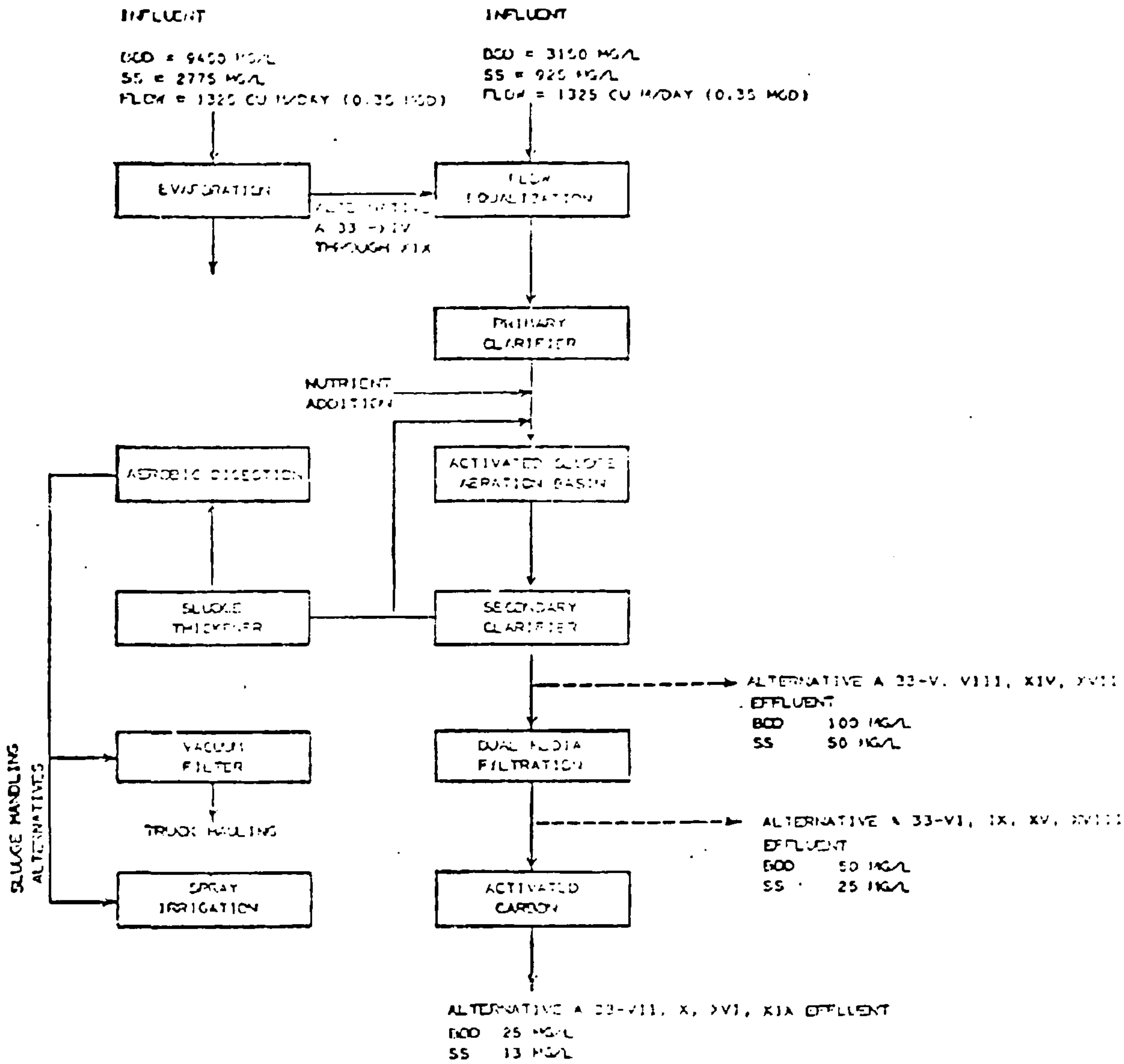


FIGURE 253

SUBCATEGORY A 33

TREATMENT ALTERNATIVES V THROUGH X, XIV THROUGH XIX

DRAFT

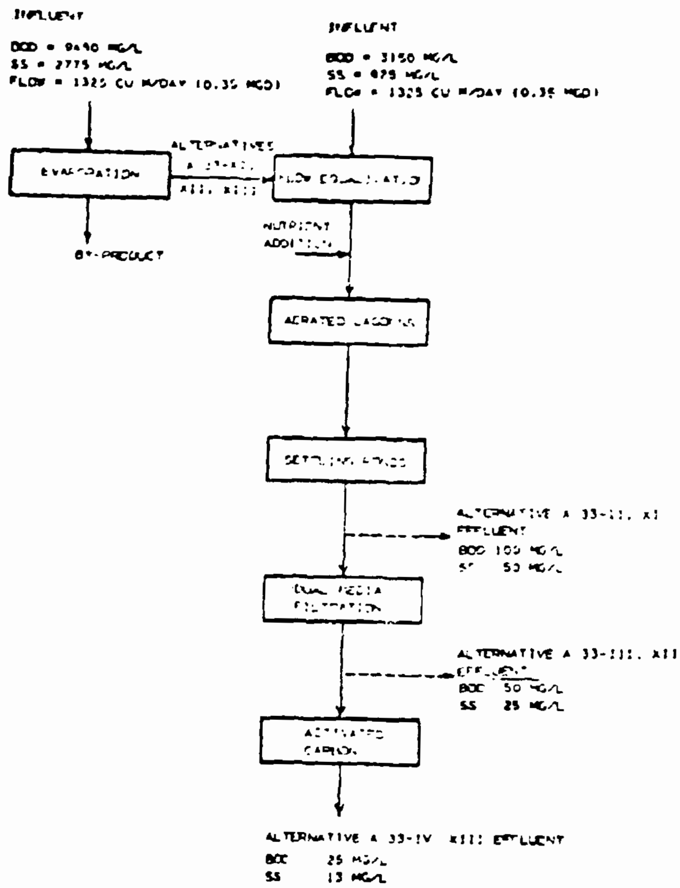


FIGURE 254

SUBCATEGORY A 33

TREATMENT ALTERNATIVES II THROUGH IV, XI THROUGH XIII effect of Alternative A 33-V is a BOD reduction of 98.4 percent and a suspended solids reduction of 97.3 percent.

Alternative A 33-VI - This alternative adds dual media filtration to treatment chain in Alternative A 33-V. The predicted effluent concentrations are 50 mg/l BOD and 25 mg/l suspended solids. The overall effect of Alternative A 33-VI is a BOD reduction of 99.2 percent and a suspended solids reduction of 98.7 percent.

Alternative A 33-VII - This alternative adds activated carbon to the treatment chain in Alternative A 33-VI. The predicted effluent concentrations are 25 mg/l BOD and 13 mg/l suspended solids. The overall effect of Alternative A 33-VII is a BOD reduction of 99.6 percent and a suspended solids reduction of 99.3 percent.

Alternative A 33-VIII - This alternative replaces vacuum filtration and truck hauling in Alternative A 33-V with spray irrigation. The predicted effluent concentrations are 100 mg/l BOD and 50 mg/l suspended solids. The overall effect of Alternative A 33-VIII is a BOD reduction of 98.4 percent and a suspended solids reduction of 97.3 percent.

Alternative A 33-IX - This alternative adds dual media filtration to the treatment chain in Alternative A 33-VIII. The predicted effluent concentrations are 50 mg/l BOD and 25 mg/l suspended solids. The overall effect of Alternative A 33-IX is a BOD reduction of 99.2 percent and a suspended solids reduction of 98.7 percent.

Alternative A 33-X - This alternative adds activated carbon to the treatment chain in Alternative A 33-IX. The predicted effluent concentrations are 25 mg/l BOD and 13 mg/l suspended solids. The overall effect of Alternative A 33-X is a BOD reduction of 99.6 percent and a suspended solids reduction of 99.3 percent.

Alternative A 33-XI - This alternative consists of pumping first and second saturation beer to an evaporation system for molasses by-product recovery, and then treating evaporator condensate and other low strength wastes using the treatment train described in Alternative A 33-II except that nutrient addition consists of 329 kg/day (725 lb/day) of anhydrous ammonia and 154 kg/day (340 lb/day) of phosphoric acid. The predicted effluent concentrations are 100 mg/l BOD and 50 mg/l suspended solids. The overall effect of Alternative A 33-XI is a BOD reduction of 98.4 percent and a suspended solids reduction of 97.3 percent.

Alternative A 33-XII - This alternative adds dual media filtration to Alternative A 33-XI. The predicted effluent concentrations are 50 mg/l BOD and 25 mg/l suspended solids. The overall effect of Alternative A 33-XII is a BOD reduction of 99.2 percent and a suspended solids reduction of 98.7 percent.

Alternative A 33-XIII - This alternative adds activated carbon to the treatment chain in Alternative A 33-XII. The predicted effluent concentrations are 25 mg/l BOD and 13 mg/l suspended solids. The overall effect of Alternative A 33-XIII is a BOD reduction of 99.6 percent and a suspended solids reduction of 99.3 percent.

Alternative A 33-XIV - This alternative consists of evaporation of high strength wastes and treatment of evaporator condensate and other low strength wastes as in Alternative A 33-V except that nutrient addition consists of 247 kg/day (544 lb/day) of anhydrous ammonia and 115 kg/day (254 lb/day) of phosphoric acid. The predicted effluent concentrations are 100 mg/l BOD and 50 mg/l suspended solids. The overall effect of Alternative A 33-XIV is a BOD reduction of 98.4 percent and a suspended solids reduction of 97.3 percent.

Alternative A 33-XV - This alternative consists of adding dual media filtration to the treatment chain in Alternative A 33-XIV. The predicted effluent concentrations are 50 mg/l BOD and 25 mg/l suspended solids. The overall effect of Alternative A 33-XV is a BOD reduction of 99.2 percent and a suspended solids reduction of 98.7 percent.

Alternative A 33-XVI - This alternative adds activated carbon to the treatment chain in Alternative A 33-XV. The predicted effluent concentrations are 25 mg/l BOD and 13 mg/l suspended solids. The overall effect of Alternative A 33-XVI is a BOD reduction of 99.6 percent and a suspended solids reduction of 99.3 percent.

Alternative A 33-XVII - This alternative replaces vacuum filtration and truck hauling in Alternative A 33-XIV with spray irrigation. The predicted effluent concentrations are 100 mg/l BOD and 50 mg/l suspended solids. The overall effect of Alternative A 33-XVII is a BOD reduction of 98.4 percent and a suspended solids reduction of 97.3 percent.

Alternative A 33-XVIII - This alternative adds dual media filtration to the treatment chain in Alternative A 33-XVII. The predicted concentrations are 50 mg/l BOD and 25 mg/l suspended solids. The overall effect of Alternative A 33-XVIII is a BOD reduction of 99.2 percent and a suspended solids reduction of 98.7 percent.

Alternative A 33-XIX - This alternative adds activated carbon to the treatment chain in Alternative A 33-XVIII. The predicted effluent concentrations are 25 mg/l BOD and 13 mg/l suspended solids. The overall effect of Alternative A 33-XIX is a BOD reduction of 99.6 percent and a suspended solids reduction of 99.3 percent.

Alternative A 33-XX - This alternative consists of a holding tank, pumping station, and spray irrigation of the raw effluent. The efficiency of BOD and suspended solids removal is 100 percent.

DRAFT

SUBCATEGORY A 34 - PEANUT BUTTER PLANTS WITH JAR WASHING

In-Plant Technology

In-plant process controls for the reduction of wastewater generation in peanut butter plants primarily consist of non-contact cooling water reuse, reuse of detergent cycle wash water in jar washers, use of steam and specially designated areas for major equipment cleanup, and dry collection of peanut skins, hearts, and fine particles for by-product recovery. Other techniques for the reduction wastewater strength include vacuum collection of process area floor cleanup water and the use of grease traps on all cleanup area floor drains.

Several methods of non-contact water conservation that significantly reduce water usage are practiced by one large plant (99P21). Heat exchangers at several locations on hot water lines used for process pipe heating (to condition oils and product for pumping) are designed as a closed loop system requiring only a small amount of make up water. Condensate is collected and reused for boiler feed water, and a relatively small amount is discharged. Cooling of refrigeration and compressor units is accomplished by two cooling towers recirculating water from chilled water storage tanks. This plant produces 59 to 77 kkg/day (65 to 85 ton/day) and discharges 65 cu m/day (0.017 MGD). In comparison, a much smaller plant (99P20) producing 10.6 kkg/day (11.7 ton/day) and recirculating only a portion of its cooling water, was found to discharge 197 cu m/day (0.052 MGD).

Non-contact water is commonly combined with other plant wastes at plants 99P01, 99P14, and 99P21 which represent the three largest peanut butter producers. While all of the manufacturers surveyed practice varying degrees of water reuse, none were found to completely segregate non-contact water from relatively low volume, high strength wastes (see Section V) such as jar washer effluent or cleanup wastewater. Separation of the above waste streams is a potential in-plant modification that would reduce process wastewater volume by at least 90 percent, and would confine effluents to only water in contact with contaminants. It must be noted, however, that generation of pollutants per unit of production would not decrease, and pollutant concentrations would necessarily increase, especially during cleanup periods (see Table 150). For example, sample analyses of combined jar washer and non-contact water discharge at plant 99P20 show a BOD of 60 mg/l, but jar washer effluent alone has a calculated BOD of 7320 mg/l (see Table 149). Also it is to be expected that segregation of non-contact and process wastewaters would be more difficult at older plants.

Jar washer effluent, which is normally discharged, is the only pollutant source during processing. It is technically feasible to eliminate this waste stream by diverting it to a holding tank. Such action would significantly reduce pollutant generation per unit of production.

DRAFT

Also, improvement on the method of manually scraping peanut butter from jars to be washed would reduce the amount of product left in jars, hence reducing waste generation per unit of production in the jar washer effluent.

Wastewater from floor cleanup is normally batch dumped from buckets or drained from a holding tank inside a vacuum floor scrubber. No steam hoses or water hoses are used in processing areas. Equipment wipedown is performed weekly and scrub buckets dumped at a steam pit where all major equipment cleanup takes place. The steam pit is typically a concrete slab equipped with steam hoses, hot water hoses, and grease traps on all drains. It may also include stainless steel tanks to provide a detergent soak for equipment more difficult to clean. Churn equipment, elevator buckets, drip pans, pipeline sections, and other equipment removed from processing areas is manually cleaned with hot water and steam or detergent after residual product is scraped into drums for oil stock recovery. Rerouting of drain lines after the grease traps to a holding tank would completely eliminate cleanup wastewater discharges and is technically feasible.

End-of-Line Technology

Peanut butter plants do not utilize sophisticated end-of-line treatment systems. All of the plants surveyed have installed grease traps on all floor drains. One multi-product plant (99P13) provides oil skimming of peanut butter wastewater only because these discharges are combined with the effluent from margarine production. All of the plants surveyed discharge jar washer and cleanup effluents, combined with large amounts of non-contact water, to municipal sewer systems.

Selection of Control and Treatment Technology

Based on the model plant developed in Section V, two treatment alternatives that provide no discharge of process wastewater were chosen. It is assumed that the model plant provide grease traps on all floor drains and that non-contact water and domestic sewage are separated from the process wastewater. The wastewater flow from the model plant is 2800 l/day (740 gal/day).

Alternative A 34-I - This alternative provides no additional treatment to the model plant. The removal efficiency of BOD, suspended solids, and oil and grease is zero.

Alternative A 34-II - This alternative consists of a holding tank, pumping station, and spray irrigation of the effluent. This alternative provides 100 percent removal of BOD, suspended solids, and oil and grease.

DRAFT

Alternative A 34-III - This alternative replaces spray irrigation in Alternative A 34-II with truck hauling of the effluent, and also provides 100 percent removal of BOD, suspended solids, and oil and grease.

SUBCATEGORY A 35 - PEANUT BUTTER PLANTS WITHOUT JAR WASHING

The existing and potential in-plant and end-of-line technology for peanut butter plants without jar washing is identical to Subcategory A 34 except that jar washing is not included.

Selection of Control and Treatment Technology

Based on the model plant developed in Section V, two treatment alternatives that provide no discharge of process wastewater were chosen for Subcategory A 35. It is assumed that the model plant provides grease traps on all floor drains and that non-contact water and domestic sewage are separated from the process wastewater. The wastewater flow from the model plant is 757 l/day (200 gal/day).

Alternative A 35-I - This alternative provides no additional treatment to the model plant. The removal efficiency of BOD, suspended solids, and oil and grease is zero.

Alternative A 35-II - This alternative consists of a holding tank, pumping station, and spray irrigation of the effluent. This alternative provides 100 percent removal of BOD, suspended solids, and oil and grease.

Alternative A 35-III - This alternative replaces spray irrigation in Alternative A 35-II with truck hauling of the effluent and also provides 100 percent removal of BOD, suspended solids, and oil and grease.

SUBCATEGORY A 36 - PECTIN

As previously discussed in Section III, there are three known producers of pectin in the United States. During the course of this study all three plants were visited. The information which was obtained regarding the control and treatment practices of the industry is presented below.

In-Plant Technology

Plant 99K01 practices water reuse in the following ways:

1. Barometric condenser cooling water for the pectin evaporator is recycled through a cooling tower. Makeup water is added as needed. This practice decreases the cooling water discharge by approximately 5700 cu m/day (1.5 MGD).

DRAFT

2. The tubular heat exchanger on the alcohol distillation column is cooled by 2800 l/min (750 gpm) of water from a cooling tower. There is a small blowdown of approximately 11 cu m/day (0.0029 MGD) from the system. This practice decreases cooling water discharge by about 4090 cu m/day (1.08 MGD).

3. Cooling water used in a plate exchanger to cool condensed alcohol is subsequently used in a vacuum cooler prior to being stored for further use elsewhere in the plant.

Plant 99K02 reported several areas of water reuse including the following:

1. Peel wash water is reused in the conveyance of peels to grinding and pasteurization, and also as cooling tower makeup water.

2. Nash pump seal water is used to sluice diatomite cake from the pressure filters.

3. A cooling tower is used to minimize cooling water discharge from the plant.

Plant 99K03 also recycles all cooling water through a cooling tower thereby decreasing fresh water requirements by 200 percent. Wherever possible all three plants reclaim acid and alcohol used in the pectin process to minimize the discharge of these substances into the waste stream. Vacuum filter cake, composed mainly of spent peels, is segregated from the waste stream, dried, and utilized as cattle feed at plants 99K01 and 99K02.

End-of-Line Technology

Plant 99K03 is currently discharging its entire process wastewater (including still bottoms and spent peel) to a municipal treatment system with no apparent adverse effect on the system. Plant 99K02 utilizes three methods of ultimate wastewater disposal for specific process waste streams. Alcohol still bottoms and water softener regenerate are segregated and truck hauled to a municipal treatment system. Spent peel is dewatered in a press, dried, and utilized as cattle feed. The press liquor waste stream along with peel wash and reuse water, spent diatomaceous filter cake and sluice water, pectin mother liquor, boiler blowdown, and cleanup water (all of low inorganic content) are distributed into 120 ha (290 acres) of land by check and furrow irrigation.

Plant 99K01 also recovers spent peel for subsequent use as cattle feed. Waste streams low in inorganics (peel wash water, diatomaceous filter cake and sluice water, plant cleanup and miscellaneous waste streams) are used to irrigate corn, barley, and Sudan grass crops. The alcohol still bottoms, caustic evaporator wash water, water softening regenerate, and boiler blowdown are neutralized and subsequently discharged to a municipal industrial outfall line.

Ion exchange has been attempted at plant 99K02 for treatment of some process waste streams with poor results. At present, the plant is considering construction of an oxygen activated sludge system for treatment of its process waste (excluding alcohol still bottoms and water softening regenerate) along with other citrus process wastes generated at the plant.

Selection of Control and Treatment Technology

In Section V a model plant was developed for pectin processing. The raw wastewater characteristics of the plant were assumed to be as follows:

Flow	1530 cu m/day (0.404 MGD)
BOD	4950 mg/l
SS	2100 mg/l
N	260 mg/l
pH	4.6 to 6.0

Table 151 lists the pollutant effluent loading and the estimated operating efficiency of each of the ten treatment alternatives selected for this subcategory as illustrated in Figures 255 and 256. It is assumed that truck hauling of alcohol still bottoms, diatomaceous filter cake and sluice water, and water softening regenerate to landfill is provided for each alternative. It should be noted that biological treatment will not provide reduction of inorganics in the wastewater. Citrus wastes have been shown (146) to be biodegradable in an efficiently operated complete-mix activated sludge system. The organic constituents of the pectin wastewater are similar to those of citrus processors and would therefore also be expected to be biodegradable under similar conditions.

Alternative A 36-I - This alternative provides no additional treatment for the raw waste effluent. The overall reduction of pollutants is zero.

Alternative A 36-II - This alternative consists of a pumping station and a holding tank followed by spray irrigation of the raw waste effluent. This alternative would require 32.4 ha (80.0 acres) of land and provide a 100 percent reduction of pollutants to navigable waters.

Alternative A 36-III - This alternative consists of a pumping station, a flow equalization tank, caustic neutralization, complete-mix activated sludge basins, sludge thickening, aerobic digestion, and vacuum filtration. A flow equalization tank is provided to dampen shock loadings to the activated sludge basins. Neutralization of the waste is accomplished by the daily addition of an estimated 98 kg (220 lb) of sodium hydroxide to the raw wastewater The complete-mix activated sludge system would be expected to provide a BOD and suspended solids reduction of 94.9 and 90.0 percent, respectively. The amount of sludge wasted from the vacuum filters is estimated at 25 cu m/day (0.0066 MGD).

The overall benefit of this alternative is a BOD reduction of 94.9 percent and a suspended solids reduction of 90.0 percent.

Ion exchange has been attempted at plant 99K02 for treatment of some process waste streams with poor results. At present, the plant is considering construction of an oxygen activated sludge system for treatment of its process waste (excluding alcohol still bottoms and water softening regenerate) along with other citrus process wastes generated at the plant.

Selection of Control and Treatment Technology

In Section V a model plant was developed for pectin processing. The raw wastewater characteristics of the plant were assumed to be as follows:

Flow	1530 cu m/day (0.404 MGD)
BOD	4950 mg/l
SS	2100 mg/l
N	260 mg/l
pH	4.6 to 6.0

Table 151 lists the pollutant effluent loading and the estimated operating efficiency of each of the ten treatment alternatives selected for this subcategory as illustrated in Figures 255 and 256. It is assumed that truck hauling of alcohol still bottoms, diatomaceous filter cake and sluice water, and water softening regenerate to landfill is provided for each alternative. It should be noted that biological treatment will not provide reduction of inorganics in the wastewater. Citrus wastes have been shown (146) to be biodegradable in an efficiently operated complete-mix activated sludge system. The organic constituents of the pectin wastewater are similar to those of citrus processors and would therefore also be expected to be biodegradable under similar conditions.

Alternative A 36-I - This alternative provides no additional treatment for the raw waste effluent. The overall reduction of pollutants is zero.

Alternative A 36-II - This alternative consists of a pumping station and a holding tank followed by spray irrigation of the raw waste effluent. This alternative would require 32.4 ha (80.0 acres) of land and provide a 100 percent reduction of pollutants to navigable waters.

Alternative A 36-III - This alternative consists of a pumping station, a flow equalization tank, caustic neutralization, complete-mix activated sludge basins, sludge thickening, aerobic digestion, and vacuum filtration. A flow equalization tank is provided to dampen shock loadings to the activated sludge basins. Neutralization of the waste is accomplished by the daily addition of an estimated 98 kg (220 lb) of sodium hydroxide to the raw wastewater The complete-mix activated sludge system would be expected to provide a BOD and suspended solids reduction of 94.9 and 90.0 percent, respectively. The amount of sludge wasted from the vacuum filters is estimated at 25 cu m/day (0.0066 MGD).

The overall benefit of this alternative is a BOD reduction of 94.9 percent and a suspended solids reduction of 90.0 percent.

TABLE 151

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY A 36 - PECTIN

Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent BOD Removal	Percent SS Removal
A 36-I	4128	1751	0.0	0.0
A 36-II	0.0	0.0	100	100
A 36-III	208.5	175.1	94.9	90
A 36-IV	208.5	175.1	94.9	90
A 36-V	208.5	175.1	94.9	90
A 36-VI	208.5	175.1	94.9	90
A 36-VII	104.3	83.4	97.5	95.2
A 36-VIII	104.3	83.4	97.5	95.2
A 36-IX	104.3	83.4	97.5	95.2
A 36-X	104.3	83.4	97.5	95.2

DRAFT

DRAFT

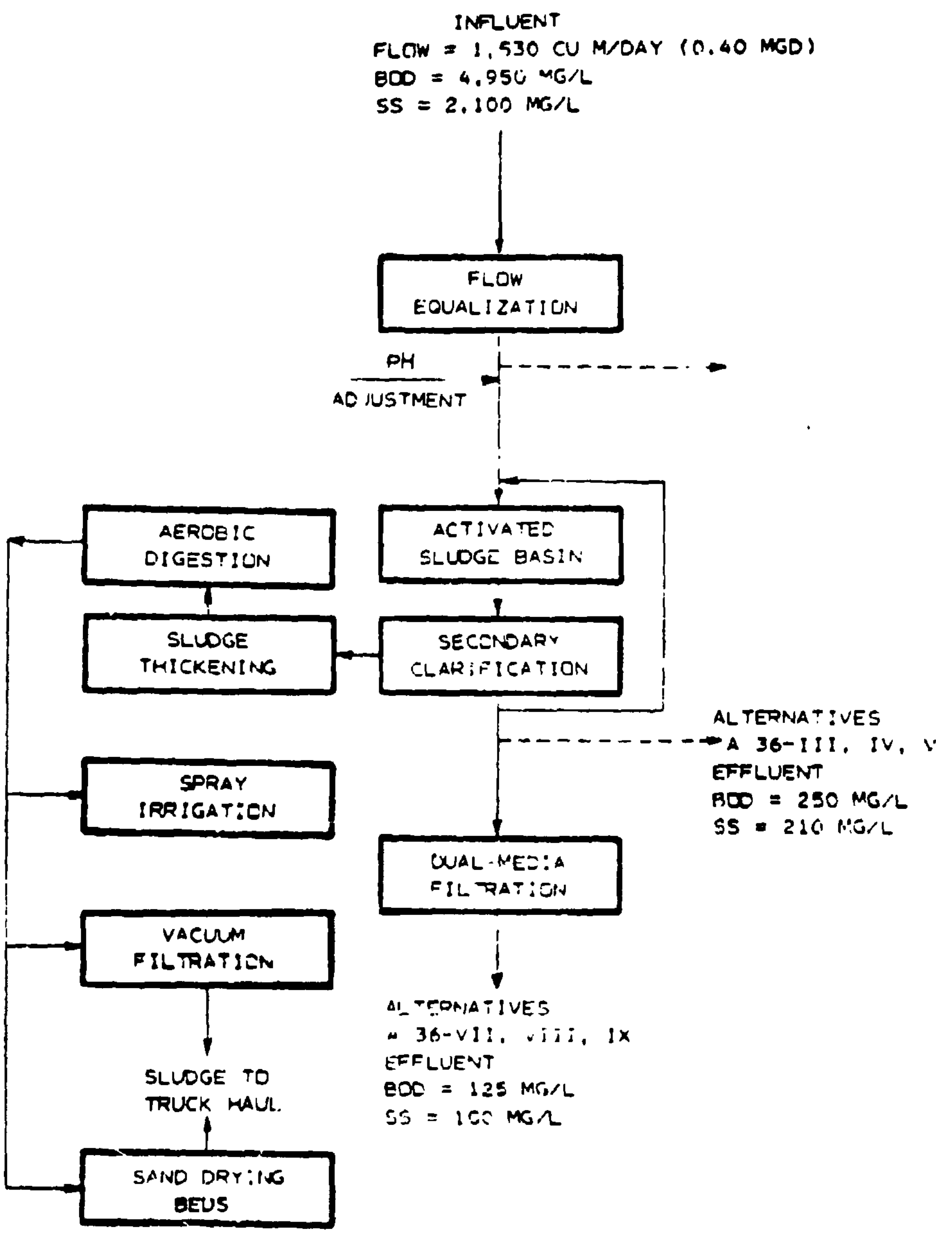


FIGURE 251

SUBCATEGORY A36
TREATMENT ALTERNATIVES III, IV, V, VII, VIII, IX

DRAFT

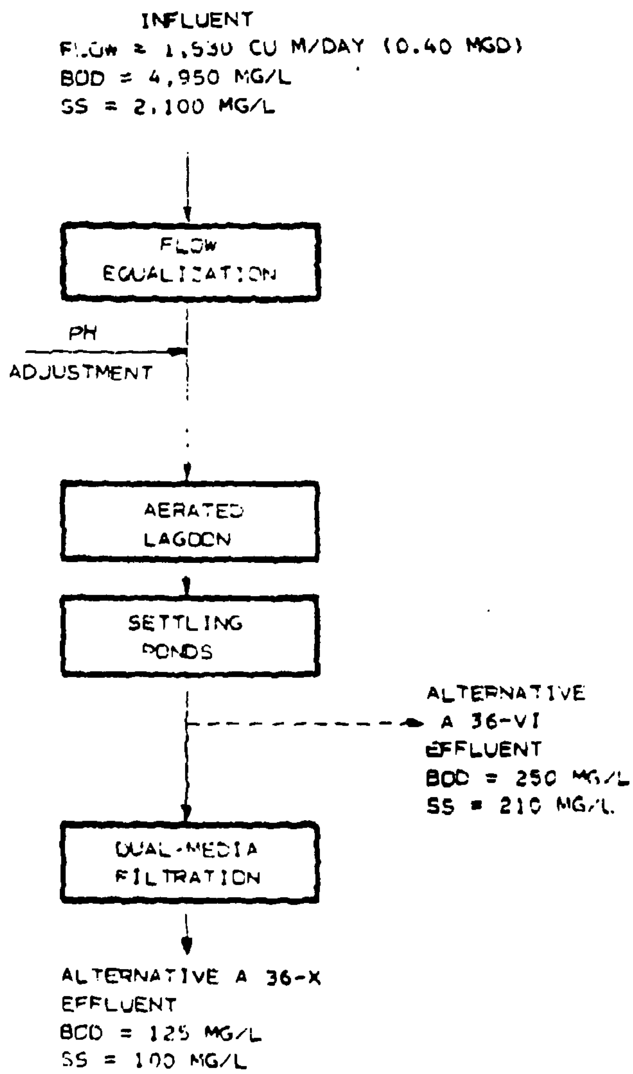


FIGURE 256

SUBCATEGORY A36
TREATMENT ALTERNATIVES VI AND X

Alternative A 36-IV - This alternative consists of the same modules as Alternative A 36-III except vacuum filtration is replaced by sand drying beds, resulting in twice the daily sludge production over that of Alternative A 36-III.

The overall benefit of this alternative is a BOD and suspended solids reduction of 94.9 and 90.0 respectively.

Alternative A 36-V - This alternative consists of the same treatment modules as Alternative A 36-III except vacuum filtration is replaced by spray irrigation of daily sludge produced. This would require a spray field of approximately 2.3 ha (5.7 acres).

The overall benefit of this alternative is a BOD reduction of 94.9 percent and a suspended solids reduction of 90.0 percent.

Alternative A 36-VI - This alternative consists of a pumping station, a flow equalization tank, caustic neutralization and an aerated lagoon.

The overall effect of this alternative is a BOD reduction of 94.9 percent and a suspended solids reduction of 90.0 percent.

Alternative A 36-VII - This alternative is identical to Alternative A 36-III with the addition of dual-media filtration which would provide an estimated additional BOD and suspended solids reduction of 2.6 and 5.2 percent, respectively.

The overall benefit of this alternative is a BOD reduction of 97.5 percent and a suspended solids reduction of 95.2 percent.

Alternative A 36-VIII - This alternative is identical to Alternative A 36-IV with the addition of dual-media filtration. The overall benefit of this alternative is a BOD reduction of 97.5 percent and a suspended solids reduction of 95.2 percent.

Alternative A 36-IX - This alternative consists of the same modules as Alternative A 36-V with the addition of dual-media filtration. The overall benefit of this alternative is a BOD reduction of 97.5 percent and a suspended solids reduction of 95.2 percent.

Alternative A 36-X - This alternative consists of the same treatment modules as Alternative A 36-VI with the addition of dual-media filtration. The overall benefit of this alternative is a BOD reduction of 97.5 percent and a suspended solids reduction of 95.2 percent.

SUBCATEGORY A 37 - PROCESSING OF ALMOND PASTE

There are currently four known processors of almond paste in the United States. All four discharge their process wastewater to municipal facilities. Results of a telephone survey to three plants and one plant visitation indicate that the production of almond paste contributes a relatively insigificant waste load to the total waste load of the four multi-product processing plants. The production of almond paste exists in combination with the production of a large variety of other products such as nut pastes (i.e., pecan, walnut, hazel nut, cashew, and apricot kernals), granulated nuts, and nut toppings. The wastewater characteristics of almond paste processing are currently unavailable for the following reasons: 1) the multi-product plants contacted were unable to furnish historical data on almond paste production alone, with the only available information being that of the final combined products waste load, 2) the actual sampling of the almond paste production line was impractical due to the combination of waste streams from other product lines, and 3) production data was unobtainable.

The industry has made no future plants for the construction of any new almond paste processing plants and, as previously mentioned, discharges its wastewaters to municipal facilities. Therefore, the possibility of a future point source discharge from an installation primarily engaged in the production of almond paste is minimal. Due to a lack of information on the industry's product line, production variability, and wastewater characteristics, the development of effluent guidelines for almond paste processing is not feasible at this time.

SUBCATEGORY B 1 - FROZEN PREPARED DINNERS

Existing and Potential In-Plant Technology

The majority of wastes from the frozen specialties plant originates from clean up of the vats, kettles, friers, mixers, piping, etc., which are used during preparation of the various components of the final product. General plant cleanup, usually a continuous process, is also a major wastewater source. Substantial reduction, therefore, in raw waste load and wastewater treatment cost can be realized by careful in-plant water management:

1. Installation of automatic shut-off valves on water hoses may save up to 60 gallons per minute per hose. Without automatic shut-off valves, employees do not turn off hoses. Cost for a long life valve is approximately $40.

2. Central clean up systems (valved or triggered hoses) should be installed. These commercial systems generate a controlled high pressure supply of hot or warm water containing a detergent. They are reported to clean better with less volume of water used.

3. That portion of very dilute wastewater (such as defrost water) which is not reused or recirculated, should be discharged separately from the process wastewater.

4. Good housekeeping is an important factor in normal pollution control. Spills, spoilage, trash, etc. resulting from sloppy operation may be heavy contributors to liquid waste loads. Improvements will result from educating operating personnel in proper attitudes toward pollution control and providing strategically located waste containers, the basic aim being to avoid loss of product and normal solid waste into the liquid waste stream.

5. The processor should look at his handling of solid waste. A well-operated plant will, insofar as possible, avoid solid waste contact with the liquid waste stream. Where this is not feasible, the solid waste is removed prior to reaching the waste treatment system. Screens of 20 mesh or smaller are usually adequate to remove a large portion of settleable solids. Continuous removal of the screenings is desirable to avoid excessive leaching of solubles by the liquid waste stream from separated solids.

End-of-Line Technology

This subcategory is characterized strong wastes in terms of BOD, SS, and O & G. Nevertheless an existing secondary treatment plant (38*50) is achieving excellent pollutant removals with activated sludge treatment preceded by a series of primary treatment and biological treatment units. Table 152 provides data pertinent to desing of individual treatment units. An analysis of daily reported treatment performance during the months of October and November, 1974, for plant 38*50 shows the effluent quality characteristics shown below. The company reports these results are typical of plant performance since 1972.

BOD, average 9 mg/l, range 1-27 mg/l
SS, average 37 mg/l, range 4-137 mg/l
O&G, average 10 mg/l, range 1-30 mg/l
pH, 7 to 8

Ninety-nine percent plus removals are reflected by the above results based upon average influent characteristics of BOD - 3,500 mg/l, O&G - 3,000 mg/l, and SS - 4,500 mg/l. These results were confirmed by sampling.

This plant was expanded over a ten year period beginning in 1962, and treatment units were added as effluent discharge requirements

TABLE 152

TREATMENT UNIT CHAIN AND MAJOR DESIGN FACTORS FOR EXISTING TREATMENT PLANT TREATING WASTEWATER FROM FROZEN PREPARED DINNERS AND OTHER SPECIALTY FOODS

No.	Treatment unit	Significant design factors
1	Sweco vibrating screens (2), 20 mesh, 48 inch.	300 gpm rated capacity, remove approximately 1,000 lbs/day of screenings.
2	Gravity sedimentation tanks (2), 10 ft x 125 ft x 10 ft deep, 187,000 gal capacity total.	200 gpd/sq ft overflow rate and 9 hr detention at design flow of 0.5 mgd.
3	Dissolved air flotation tanks (2) 200 sq ft surface area each.	1,250 gpd/sq ft overflow.
4	Anaerobic lagoons (3), in series, 1.93 MG capacity each with 100 percent recirculation from final lagoon to first lagoon.	11 day retention at design flow. Thick scum mat on lagoons surface aids odor prevention.
5	Roughing filters (2), first filter is 5,500 cu ft of plastic media, second filter is 11,000 cu yd of rock media.	Hydraulic loading is 30 gpd/cu ft per day, BOD loading is approximately 0.36 lb BOD/cu ft per day.
6	Activated sludge aeration tanks (4) rectangular with mechanical surface aerators, 141,000 gal capacity each.	27 hour retention time, BOD loading is approximately 50 lb BOD/1,000 cu ft, 100 percent sludge recirculation capacity.
7	Final clarifiers (2), first clarifier has 962 sq ft surface area, second clarifier has 1,590 sq ft surface area.	500 gpd/sq ft overflow rate at design flow of 0.5 mgd.

TABLE 152 (Continued)

No.	Treatment unit	Significant design factors
8	Chlorine contact tank.	30 minute detention at design flow.
9	Sludge handling - Primary sludge and waste activated sludge is centrifuged, thickened and disposed to landfill. Grease skimmings are recovered and approximately 4,500 lbs/day are sold.	

grew more stringent. An engineer designing a new plant would not design the new plant in exactly the same manner. Nevertheless, much can be learned from the long term effectiveness of the described treatment plant when it is necessary to treat very strong wastes and produce effluents of extraordinary quality, as is the case here. The key to the success of the treatment system described appears to be to remove SS and O&G, and the combination of biological secondary treatment units in series, i.e., anaerobic lagoon roughing filter, and activated sludge. Each treatment unit acts to remove a percentage of the wastewater pollutants and prepare the waste properly for the following treatment unit. Table 153 presents reported pollutant removal efficiencies through each successive treatment unit described previously in Table 152. The performance of the gravity clarifier and air flotation primary treatment units should be noted. The relatively low percent removals through the anaerobic lagoons is deceptive according to the plant operating staff who report that the anaerobic lagoon biological activity converts the dissolved organic pollutants into forms more readily treated by the subsequent aerobic biological processes. In addition, the anaerobic lagoons act as a flow equalization and buffering unit for the succeeding treatment processes. Company personnel report that prior to construction of the anaerobic lagoons, performance of the trickling filters and activated sludge units was less efficient and more erratic.

Selection of Control and Treatment Technology

A model plant for Subcategory B 1 was developed in Section V. The raw wastewater characteristics were as follows:

Flow	(0.3 MGD)
BOD	2000 mg/l
SS	1500 mg/l
O&G	2000 mg/l
N	45 mg/l (deficient)
P	21 mg/l (sufficient)

The following treatment alternatives have been selected for this subcategory:

Alternative B 1-I - This alternative assumes no additional treatment.

Alternative B 1-II - This alternative provides flow equalization, dissolved air flotation, and vacuum filtration of sludge. The expected BOD removal benefit is 60 percent.

Alternative B 1-III - This alternative provides the addition of complete mix activated sludge with two aeration basins and sludge thickening to Alternative B 1-II. The expected BOD removal benefit is 96 percent.

DRAFT

TABLE 153

REPORTED PERFORMANCE FOR TREATMENT UNITS DESCRIBED IN TABLE

Treatment unit	Percent reduction*		
	BOD	G&O	SS
Gravity sedimentation	39	79	73
Air flotation	15	14	16
Anaerobic lagoon	4	6	7
Trickling filter	15	-	(3)
Activated sludge	26	-	6
Totals	99	99	99

*Typical screened raw waste characteristics are: BOD - 3,500 mg/l, O&G - 3,000 mg/l, and SS - 4,500 mg/l.

Alternative B 1-IV - This alternative adds dual media filtration to Alternative B 1-III. The expected BOD removal benefit is 98 percent.

A summary of the pollutant removals expected is presented in Table 154. A schematic diagram of Alternatives B 1-I through B 1-IV is presented in Figure 257.

SUBCATEGORY B 2 - BREADED AND BATTERED FROZEN PRODUCTS

In-Plant Technology

The existing and potential in-plant technology for Subcategory B 2 is the same as for Subcategory B 1.

End-of-Line Technology

This subcategory is characterized by strong wastes in terms of BOD and SS per unit of production as tabulated in Section V of this document. Design of theoretical treatment chains is difficult in this subcategory because of extremely wide fluctuations in the flow volume generated per unit of production. All plants identified which manufacture breaded and battered frozen products discharge into municipal systems. No secondary treatment or exemplary pretreatment facilities were found to exist in this subcategory. Characteristics of the waste are amenable to secondary treatment and technology transfer of activated sludge is appropriated and well-founded.

Selection of Control and Treatment Alternatives

In Section V, a model plant was developed for breaded and battered frozen products. The plant has a flow of 190 cu m/day (0.05 MGD). The wastewater characteristics are as follows:

BOD	4,000
SS	4,000
O&G	400
N & P	(sufficient)
pH	6 to 9

The following treatment alternatives have been selected for this subcategory:

Alternative B 2-I - No additional treatment.

Alternative B 2-II - This alternative consists of flow equalization, dissolved air flotation, and vacuum sludge filtration. The expected BOD reduction benefit is 60 percent.

Alternative B 2-III - This alternative consists of the addition of activated sludge to Alternative B 2-II. Additional vacuum filtration

TABLE 154

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY B1

FROZEN PREPARED DINNERS

Alt.	Treatment unit	Unit influent Characteristics, mg/l BOD	TSS	O&G	Cumulative percent removal BOD	TSS	O&G
B1-I	None	2,000	1,500	2,000	0	0	0
B1-II	Flow Equal.	2,000	1,500	2,000	0	0	0
	Dis. Air Flot.	2,000	1,500	2,000	60	80	80
B1-III	Act. Sludge	800	300	400	96	94	94
B1-IV	Filtration	80	90	120	98	98	97
Fin. Effl.		40	23	60	98	98	97

DRAFT

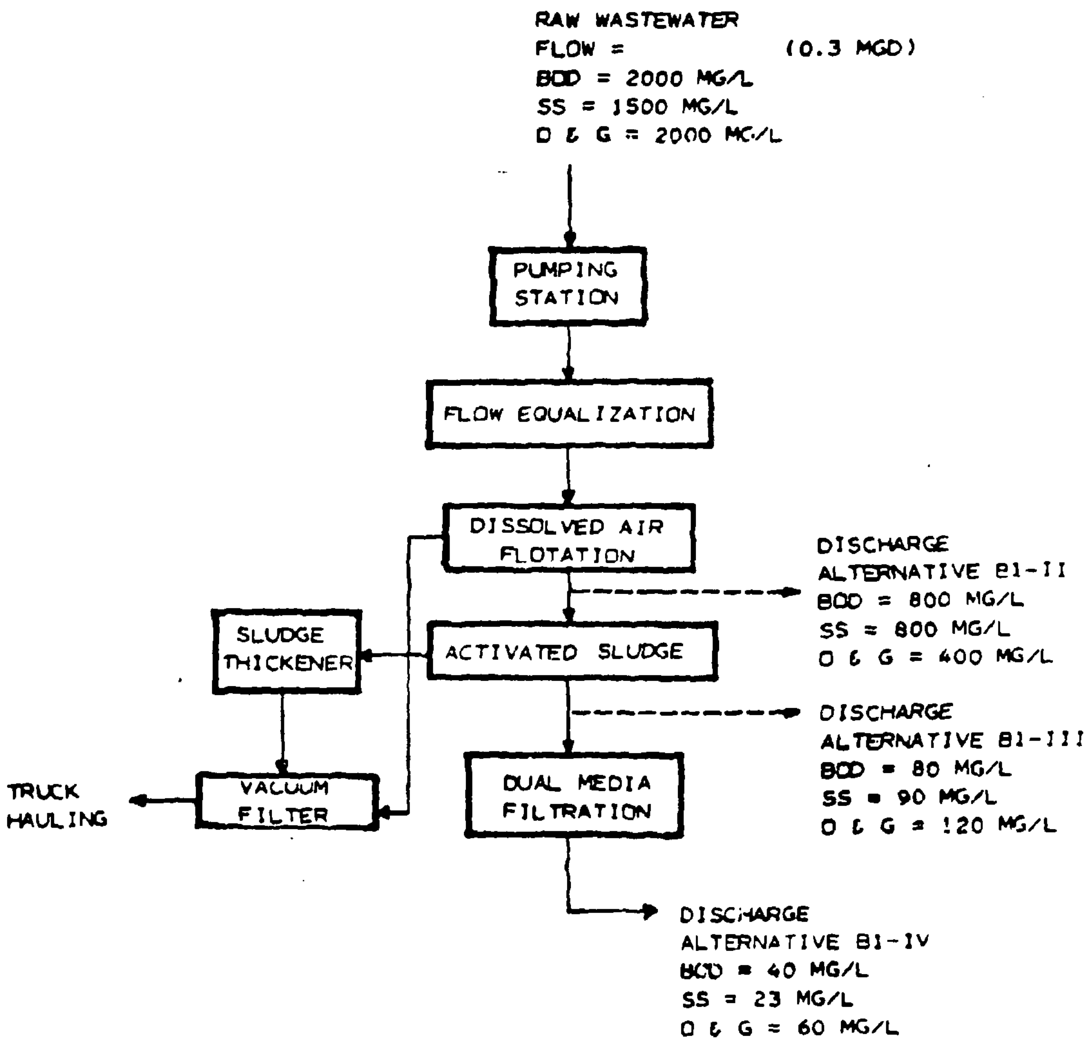


FIGURE 257

CONTROL AND TREATMENT ALTERNATIVES
B_1-I THROUGH B_1-IV

capacity is required for thickened waste activated sludge. The aeration basin required 19 kw (25 hp) aeration. The expected BOD reduction benefit is 96 percent.

Alternative B 2-IV - This alternative provides the addition of dual media filtration to Alternative B 2-III. The expected BOD reduction benefit is 98 percent.

A summary of the pollutant removals expected is presented in Table 155. A schematic diagram of Alternatives B 2-I through B 2-IV is shown in Figure 258.

SUBCATEGORY B 3 - FROZEN BAKERY DESSERTS

In-Plant Technology

The existing and potential inplant technology for Subcategory B 3 is the same as for Subcategory B 1.

End-of-Line Technology

This subcategory is characterized by strong wastes in terms of BOD, SS, and O&G as described in Section V of this document. The rich ingredients (butter, sugar, cream fillings, etc.) are washed from processing equipment and dissolved in the wastewater. No plant was identified which manufactures exclusively frozen bakery desserts and provides secondary treatment prior to direct discharge. However, plant 38*50, described under the prepared dinners subsection of this Section VII, provides excellent "technology transfer" data for this subcategory for two reasons: First, the previously described treatment plant under Prepared Dinners also treats wastewater from preparation of frozen pies; and second, the reported characteristics of the wastes from preparation of frozen bakery desserts are very similar to the characteristics of wastes reported from preparation of prepared dinners.

An extensive pretreatment plant was installed at one of the nations largest manufacturers of frozen bakery desserts, and provides activated sludge treatment prior to discharge into the municipal system of a small community. This pretreatment plant usually achieves better than 90 percent removal of COD, SS and O&G. Table 156 provides data pertinent to design of individual treatment units. An analysis of monthly reported treatment performance from May, 1973 through September, 1974 shows the effluent quality characteristics shown below.

COD, average 632 mg/l, range 325-1, 750 mg/l
SS, average 132 mg/l, range 55-227 mg/l
O&G, average 57 mg/l, range 10-106 mg/l

Average raw waste characteristics through the same period are as follows:

Flow, average 0.125 mgd, range .09-0.18 mgd
COD, average 5,700 mg/l, range 4,500-7,700 mg/l
SS, average 1,550 mg/l, range 800-2,500 mg/l
O&G, average 650 mg/l, range 250-950 mg/l

TABLE 155

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY B2

BREADED AND BATTERED FROZEN PRODUCTS

Alt.	Treatment unit	Unit influent Characteristics, mg/l BOD	TSS	O&G	Cumulative percent removal BOD	TSS	O&G
B2-I	None	4,000	4,000	400	0	0	0
B2-II	Flow Equal.	4,000	4,000	400	0	0	0
	Dis. Air Flot.	4,000	4,000	400	60	80	80
B2-III	Act. Sludge	1,600	800	80	96	96	92
B2-IV	Filtration	160	160	30	98	98	96
Fin. Effl.		80	80	15	98	98	96

DRAFT

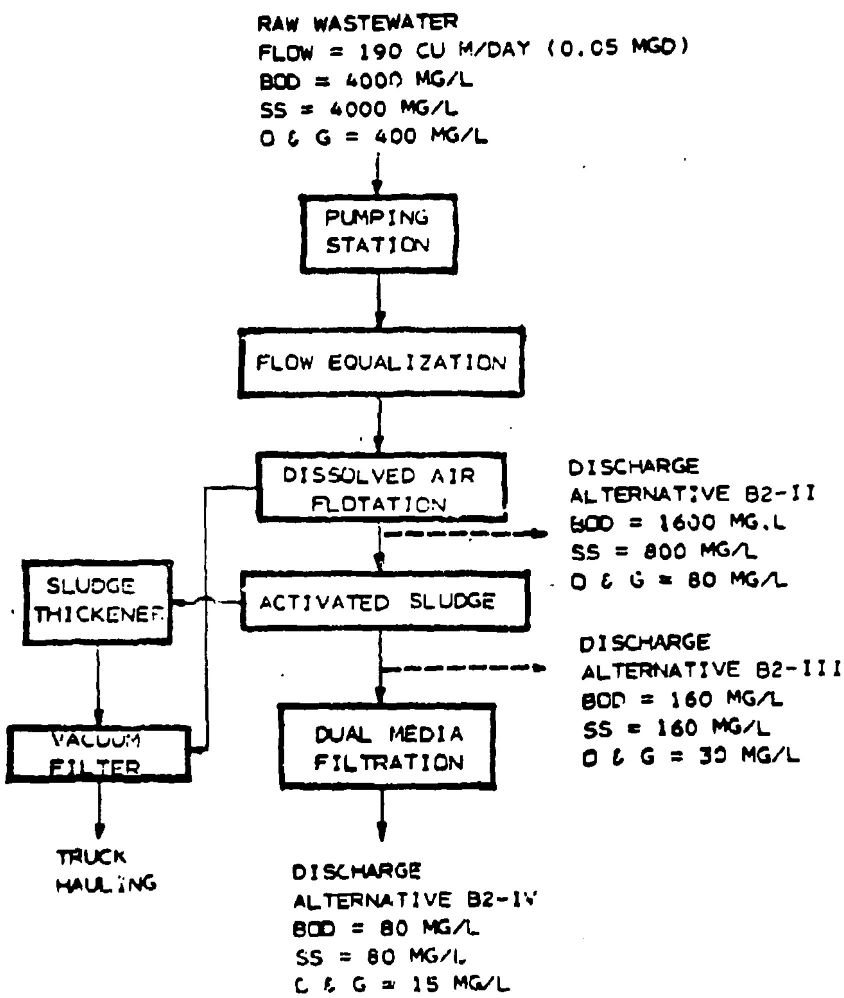


FIGURE 25C

CONTROL AND TREATMENT ALTERNATIVES
B2-I THROUGH B2-IV

DRAFT

TABLE 156

TREATMENT UNIT CHAIN AND MAJOR DESIGN FACTORS FOR EXISTING PRE-TREATMENT PLANT TREATING WASTEWATER FROM FROZEN BAKERY PRODUCTS

No.	Treatment unit	Significant design factors
1	Comminuter	-
2	Chemical flocculation tank(1) with 4,300 gal capacity. Have capability to add lime, ferric chloride, and nutrients.	48 min retention at average flow of 130,000 gpd.
3	Dissolved air flotation tank(1) with 16 ft diameter and 12 ft depth. The air requirement is 2-3 cfm @ 50 psi. Water is pumped from top portion of tank, mixed with air from compressor, and fed to pressurized tank for injection to bottom of flotation unit.	3.8 hr retention at average flow. 650 gpd/ft^2 overflow rate.
4	Aeration tanks(2), each with 213,000 gal capacity. Three 60 HP blowers can supply a maximum of 6,000 cfm. Normal air requirement is 4,000 cfm. One 20 HP mechanical aerator aids the process.	3.3 day retention at average flow. MLVSS concentration ranges from 3,000-6,000 mg/l.
5	Aerated storage tanks(2) of 183,000 gal capacity each, to be used for storage of surge loads or excess aeration capacity for the activated sludge process. After storage, water can be returned to the flotation or activated sludge units.	3 day total retention time at average flow.

TABLE 156 (Continued)

No.	Treatment unit	Significant design factors
6	Final clarification tanks(2), each 14' x 50' x 14 deep. A high percentage of the solids are returned to the activated sludge process.	27 hrs total retention with a 93 gpd/ft^2 overflow rate.
7	Sludge storage pit that accepts waste activated sludge and the solids from the air flotation unit.	

Average percentage reductions therefore are: COD-89 percent, SS-91 percent, and O&G-91 percent. These are excellent removals for a pre-treatment facility.

Performance of the air flotation unit notes particular attention. The company takes separate samples of the air flotation unit effluent (See Table 156 for description of design characteristics). Average air flotation unit effluent characteristics are as follows:

COD, average 3,500 mg/l, range 1,700-5,000 mg/l
SS, average 600 mg/l, range 400-1,000 mg/l
O&G, average 230 mg/l, range 70-600 mg/l

Referring to the noted raw waste characteristics, it can be seen that the air flotation units achieve the following average percentage reductions of this waste: COD-18 percent, SS-61 percent, and O&G-64 percent.

Selection of Control and Treatment Technology

A model plant for frozen bakery desserts was developed in Section V. The raw wastewater characteristics were as follows:

Flow	114 cu m/day (0.3 MGD)
BOD	4000 mg/l
SS	3000 mg/l
O&G	1000 mg/l
N	40 mg/l (deficient)
P	7 mg/l (deficient)
pH	6 to 9

The following treatment alternatives have been selected for this subcategory:

Alternative B 3-I - This alternative assumes no additional treatment.

Alternative B 3-II - This alternative provides flow equalization, dissolved air flotation, and vacuum filtration of sludge. The expected BOD removal benefit is 70 percent.

Alternative B 3-III - This alternative provides complete mix activated sludge with two aeration basins and sludge thickening addition to Alternative B 3-II. Nutrient addition in the amounts of 220 kg/day (490 lb/day) NH_3 and 120 kg/day (260 lb/day) H_3PO_4 is necessary. The expected BOD removal benefit is 97 percent.

Alternative B 3-IV - This alternative adds dual media filtration to Alternative B 3-III. The expected BOD removal benefit is 98 percent.

A summary of the pollutant removals expected is presented in Table 157. A schematic diagram of Alternatives B 3-I through B 3-IV is presented in Figure 259.

TABLE 157

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY B3

FROZEN BAKERY PRODUCTS

Alt.	Treatment unit	Unit influent Characteristics, mg/l BOD	TSS	O&G	Cumulative percent removal BOD	TSS	O&G
B3-I	None	4,000	3,000	1,000	0	0	0
B3-II	Flow Equal.	4,000	3,000	1,000	0	0	0
	Dis. Air Flot.	4,000	3,000	1,000	60	80	80
B3-III	Act. Sludge	1,6C0	600	200	96	94	94
B3-IV	Filtration	160	180	60	98	98	97
Fin. Effl.		80	45	30	98	98	97

DRAFT

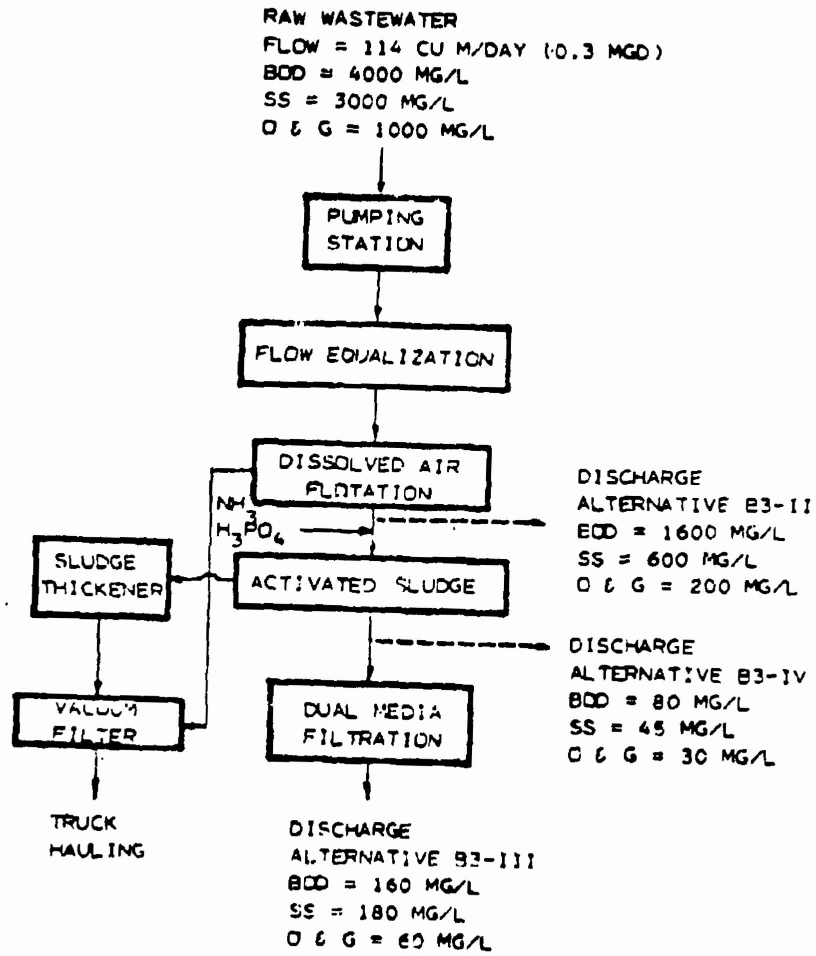


FIGURE 259

CONTROL AND TREATMENT ALTERNATIVES
B3-I THROUGH B3-IV

DRAFT

SUBCATEGORY B 4 - TOMATO-CHEESE-STARCH COMBINATIONS

In-Plant Technology

The existing and potential in-plant technology for Subcategory B 4 is the same as for Subcategory B 1.

End-of-Line Technology

This subcategory is characterized by weak wastes in terms of BOD, SS, and O&G. The principal product is frozen pizza and the manufacturing facilities are careful to waste as little of their expensive ingredients as possible. In addition, the process waste stream is normally substantially diluted by the cooler (freezer) water from the freezing process. No plant was identified which manufactures exclusively frozen tomato-starch-cheese specialties and provides secondary treatment prior to direct discharge or discharge to a municipal sewage syste. Characteristics of the waste in terms of BOD and SS are similar to typical municipal waste (see Section V of this document). Examination of the characteristics of this waste indicate an expected high degree of pollutant removal through conventional biological treatment methods.

Selection of Control and Treatment Technology

A model plant for tomato-starch-cheese products was developed in Section V. The raw wastewater characteristics were as follows:

Flow	378 cu m/day (0.1 MGD)
BOD	700 mg/l
SS	400 mg/l
O&G	200 mg/l
N & P	(sufficient for biological treatment)

The following treatment alternatives have been selected for this subcategory:

Alternative B 4-I - This alternative assumes no additional treatment.

Alternative B 4-II- This alternative provides flow equalization, dissolved air flotation, and vacuum filtration of sludge. The expected BOD removal benefit is 40 percent.

Alternative B 4-III - This alternative provides two complete mix activated sludge systems in parallel and sludge thickening addition to Alternative B 4-II. The expected BOD removal benefit is 90 percent.

A summary of the pollutant removals expected is presented in Table 158. A schematic diagram of Alternatives B 4-I through B 4-III is presented in Figure 260.

TABLE 158

SUMMARY OF TREATMENT TRAIN ALTERNATIVES FOR SUBCATEGORY B4

TOMATO-STARCH-CHEESE COMBINATIONS

Alt.	Treatment unit	Unit influent Characteristics, mg/l			Cumulative percent removal		
		BOD	TSS	O&G	BOD	TSS	O&G
B4-I	None	700	400	200	0	0	0
B4-II	Flow equal.	700	400	200	0	0	0
	Dis. Air Flot.	700	400	200	40	70	70
B4-III	Act. Sludge	420	120	60	94	90	90
Fin. Effl.		40	40	20	94	90	90

DRAFT

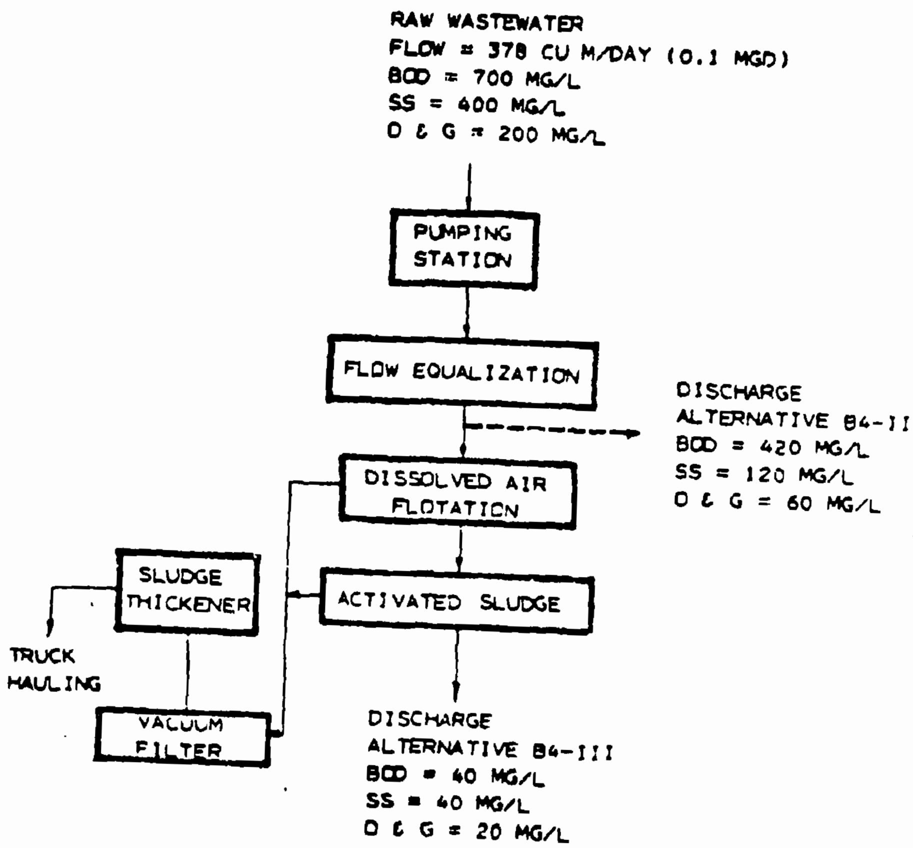


FIGURE 260

CONTROL AND TREATMENT ALTERNATIVES
B4-I THROUGH B4-III

DRAFT

SUBCATEGORY B 9 PAPRIKA AND CHILI PEPPER

In-Plant Technology

Various on-going studies are being done in an effort to increase crop yields, facilitate in-plant processing and maintain existing high quality standards. At the same time, the individual processors are conducting these studies with the intention of minimizing their effluent wasteloads. These efforts encompass field research as well as in-plant controls.

Efforts have been directed towards mechanical harvesting in an effort to reduce field costs. Mechanical harvesting, however, causes more pod splitting, bruising, and breaking, and in some cases is responsible for increased dirt and debris loadings. The various field work being done is being directed toward the elimination of excess dirt and debris and is at the same time achieving a reduction in field damage. These efforts should reduce the organic loads experienced within the processing plants.

The predominant flow volume and waste loads are generated in the washing stages. Dry reels, however, were observed in most installations to reduce the dirt, debris, and "bits" from the field prior to the soak tanks. In most cases, considerable amounts of organics were kept from the waste stream; the debris from the dry reels was collected and removed as dry waste.

The other main source of wastewater originates from normal end-of-shift cleanup, at which time all tanks, conveyors, dicers, etc. are emptied, opened, and thoroughly washed and sanitized. Here again, employee training and good management are of great importance to reduce pollutant generation.

Substantial reduction in both processing raw waste load (flow and pollutant content) and wastewater treatment cost can be realized by careful in-plant water management and reuse.

1. Installation of automatic shut-off valves on water hoses may save up to 60 gallons per minute per hose. Without automatic shut-off valves, employees do not turn off hoses. Cost for a long life valve is approximately $40.

2. Installation of central clean up systems (valved or triggered hoses). These commercial systems generate a controlled high pressure supply of hot or warm water containing a detergent. They are reported to clean better with less volume of water used.

3. Installation of low-volume, high-pressure systems on all water sprays which cannot be eliminated.

4. Elimination of all unnecessary water overflows. Many plants operate water valves wide open regardless of actual need. Examples are make-up water supplies to spray lines and washers. One way to help solve this problem is installation of quick opening ball valves in water lines after globe valves. The globe valve is used by the operator for on-off operation.

5. Maximization of in-plant water recirculation by multiple use of water in the same unit process or reuse in other unit processes.

6. Good housekeeping is an important factor in normal pollution control. Spills, spoilage, trash, etc. resulting from sloppy operation may be a heavy contribution of liquid waste loads. Improvements will result from educating operating personnel in proper attitudes toward pollution control and providing strategically located waste containers, the basic aim being to avoid loss of product and normal solid waste into the liquid waste stream.

7. In addition to implementation of water conservation and reuse, the processor should look at his handling of solid waste. A well-operated plant will insofar as possible avoid solid waste contact with the liquid waste stream. Where this is not feasible, the solid waste is removed prior to reaching the waste treatment system. Screens of 20 mesh or smaller are usually adequate to remove a large portion of settleable solids. Continuous removal of the screenings is desirable to avoid excessive leaching of solubles by the liquid waste stream from separate solids.

8. It is, of course, impossible to predict with exactness the effect of in-plant pollution control such as water use reduction and water reuse.

End-of-Line Technology

As described in Section V of this document this subcategory is characterized by moderately weak wastes slightly stronger than the average domestic municipal waste. All plants identified in this subcategory discharge to municipal systems. No secondary treatment or pretreatment other than screening was identified. To formulate effluent guidelines for the subcategory activated sludge technology transfer must be appropriately adopted. Removal efficiencies compatible with a well operated municipal secondary sewage treatment plant are to be expected.

DRAFT

Selection of Control and Treatment Technology

A model plant for Subcategory B 9 was presented in Section V. It had a flow of 1900 cu m/day (0.5 MGD) with the following characteristics:

BOD	400 mg/l
SS	250 mg/l
pH	6 to 9
N & P	Sufficient

Table 159 lists the treatment alternatives and their expected efficiencies.

Alternative B 9-I - This alternative assumes no control and treatment of the present waste load contribution.

Alternative B 9-II - This alternative includes a pumping station, flow equalization, complete mix activated sludge (two basins and two clarifiers) with a detention time of 17 hr and aeration of (60 hp), sludge thickening, and vacuum filtration. The dewatered sludge is truck hauled to land fill or suitable land disposal site.

Alternative B 9-III - This alternative assumes the addition of dual media filtration to Alternative B 9-II.

SUBCATEGORY C4 - EGG PROCESSING

In-Plant Technology

In-plant procedures designed to reduce the waste load from egg processing plants center on proper training of the employees and efficient management. The principle methods for reducing the waste load, as described by Siderwicz (88), are the following:

1. The condition of the incoming eggs should be checked and poor handling practices reported to the shell egg distributor.

2. Personnel who load eggs into the washer, candle the eggs, and operate the breaking machines must be provided with an easy and efficient method for removing and discarding inedible eggs.

3. Egg washer brushes should be properly adjusted so as to effect good cleaning and eliminate excessive breakage during washing.

4. Breaking machines should be periodically inspected to insure that trays are aligned correctly to catch eggs released from the breaker cups and that water consumption per breaking machine is not in excess of 4 to 6 lpm (1-1.5 gpm).

5. Inclined augers should be used to transfer the egg shells to the hauling vehicle in order to aid in the recovery of adhering egg solids from the broken shells.

TABLE 159

MODEL TREATMENT MODULE CHAIN AND ESTIMATED POLLUTANT REMOVALS
SUBCATEGORY B 9

Alt.	Treatment Unit	Unit Influent Characteristics, mg/l BOD	TSS	O&G	Cumulative Percent Removal BOD	TSS	O&G
B 9-I*	None	400	250	0	0	0	0
B 9-II	Flow Equal.	420	250	0	0	0	0
B 9-III	Act. Sludge	400	250	0	93	-	100
B 9-IV	Filtration	30	30	0	96	94	100
Fin. Effl.		15	15	0	96	94	100

6. Spillage of product from vats should be eliminated through careful monitoring during filling, preferably with the use of electronic probes.

7. Piping should be kept to a minimum and should be sloped to allow the product to drain by gravity after the pumps are turned off.

8. Equipment should be "chased" with water before cleaning to recover as much product as possible, especially if the product is to be dehydrated.

9. Land disposal of egg washer wastewater should be considered as a method of reducing the plants waste load which must be treated.

Many of these procedures have had wide acceptance in the egg processing industry. Siderwicz (82) has reported a 40 percent reduction in BOD loading, after implementation of the in-plant technology discussed above, documents the effectiveness of these types of procedures.

End-of-Line Technology

Hee, et. al., (147) have considered the waste treatment alternatives for egg procesing plants and concluded that aerobic ponds and aerated lagoons are the most acceptable treatment alternatives. Moats and Harris (148) reported a laboratory scale approach which yielded an 80 to 90 percent removal of BOD from egg wastes, initially ranging from 1000 to 2200 mg/l. The method used was acidification to pH 4.7 and heating to 75°C (170°F). However, due to the high energy requirements, this method of treatment has not been installed at any plants. Bulley, et. al.(149) have reported 90 to 95 percent removal of BOD in a laboratory study of a continuous treatment model for egg wastes ranging in concentration from 2780 to 830 mg/l. The treatment model utilized in this study was a two-stage aerated lagoon. Bailey (150) performed pilot plant tests of trickling filter treatment of egg processing wastes. Up to 60 percent BOD removal was reported for wastes ranging in concentration from 1600 to 6000 mg/l.

Cornell University (151) has conducted laboratory studies on several methods of treating egg processing wastewater. The most efficient method of treatment was an anaerobic lagoon followed by an aerated lagoon, with a total detention time of 16 days. This treatment method resulted in 98 percent removal of total COD. Activated sludge gave an average removal of 86 percent of total COD, but excessive foaming indicated that this method of treatment might not be suited for full scale application to egg processing wastewater. Aerated lagoons of 10, 20 and 30 day detention time were reported to result in 60, 70 and 80 percent removal of total COD, respectively.

At the present time, virtually all egg processing plants discharge raw effluent to municipal systems, navigable waters or land application. One plant included in this study has a 0.5 ha (1.2 acre) four-cell diffused aeration lagoon. However, flow from the plant is about 6,000 mld (1,500 gpd), and the lagoon system is providing total retention of the plants wastes. The wastewater from this plant has a BOD concentration of 2100 mg/l and a suspended solids concentration of 750 mg/l. Samples taken during the summer of 1974 (152) from the fourth cell of the lagoon had BOD concentrations averaging 9 mg/l and suspended solids of 7 mg/l.

Another plant included in this study has screening, a settling basin, a holding lagoon and spray irrigation facilties for disposal of their wastes. Two other processing plants have treatment facilities; however neither is being operated currently due to the inability to obtain significant waste reductions. One treatment plant incorporates a trickling filter followed by an activated sludge system. The other employes an aeration tank.

Selection of Control and Treatment Technology

In section V of this document a model plant was developed for the egg processing industry. The raw waste characteristics were assumed to be as follows:

BOD	3700 mg/l or 23 kg/kkg
SS	850 mg/l or 5.4 kg/kkg
N	300 mg/l
P	40 mg/l
pH	6.7 - 9.0
Flow	0.2 mld (0.05 mgd)

Table 160 lists the pollutant effluent loading and the estimated operating efficiency of each of the five treatment trails selected for this subcategory.

Since most egg processing plants are located in rural areas, treatment modules were not selected to minimize land requirements. In addition, Cornell University (151) and one of the plants contacted indicated problems in applying activated sludge treatment to egg processing wastes because of excessive foaming of the wastewater during treatment.

Alternative C 4 - I - This alternative provides no treatment except a catch basin to collect the shells from the waste stream.

Alternative C 4 - II - This alternative consists of a two-cell aerated lagoon and associated settling ponds. The 95 percent removal indicated in Table 160 is based on the study by Culley, et. al., (149) and the 45 day detention time of this treatment train.

TABLE 160

Summary of Treatment Train Alternatives

DRAFT

Treatment Train Alternative	Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent BOD Reduction	Percent SS Reduction
C 4 - I A	23	5.4	0	0
C 4 - II L	1.2	1.1	95	80
C 4 - III LN	0.69	0.33	97	94
C 4 - IV ML	0.45	0.54	98	90
C 4 - V MLN	0.30	0.16	99	97

Alternative C 4 - III - This alternative consists of the treatment module of Alternative C 4 - II with the addition of a dual media filter and associated pumping station. The schematic diagram of Alternative C 4 - III is shown in Figure 261.

Alternative C 4 - IV - This treatment alternative consists of an anaerobic lagoon, a aerated lagoon and associated settling ponds. The laboratory studies (151) of this treatment method indicated anaerobic and aerobic detention times of 10 and 5 days, respectively.

Alternative C 4 - V - This alternative consists of Alternative C 4 - IV with the addition of a dual media filter and associated pumping station. A schematic diagram of Alternative C 4 - V is shown in Figure 262.

SUBCATEGORY C 5 - SHELL EGGS

In-Plant Technology

In-plant procedures designed to reduce the wasteload from egg processing plants center on employee training and management. The principal factors which can contribute to reducing the wasteload are described by Siderwicz (153) for egg processing. The factors which are applicable to shell egg handling plants are as follows:

1. The condition of incoming eggs should be checked and poor handling practices reported to the supplier of the eggs; e.g., the farmer or trucker.

2. Personnel who load eggs onto the washer, candle the eggs, and operate the grading machines must be provided with an easy and efficient method of removing and discarding inedible eggs. Most shell egg plants currently use buckets on the floor to collect inedible eggs. A more efficient method with less chance of spillage should be used.

3. Egg washer brushes should be properly adjusted so as to effect good cleaning and eliminate excessive breaking during washing.

4. Land disposal (burial) of egg washer wastewater should be considered as a method of reducing the plants wasteload which must be treated or discharged to a municipal sewer.

End-of-Line Technology

At the present time most shell egg plants discharge unscreened wastewater to municipal systems or navigable waters. Some plants utilize evaporation/percolation retention ponds. Spray irrigation has been utilized by some plants, but it has been found unacceptable as a result of associated odor problems.

DRAFT

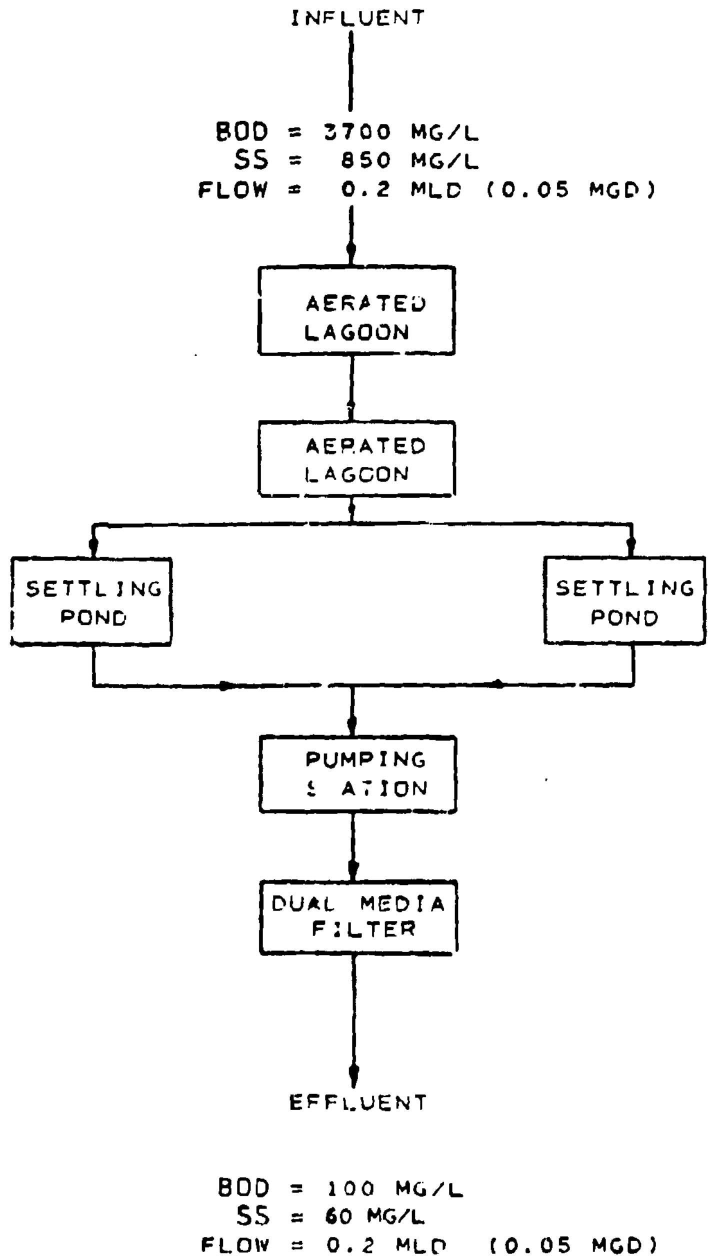


FIGURE 261

CONTROL AND TREATMENT ALTERNATIVE C4 - III

DRAFT

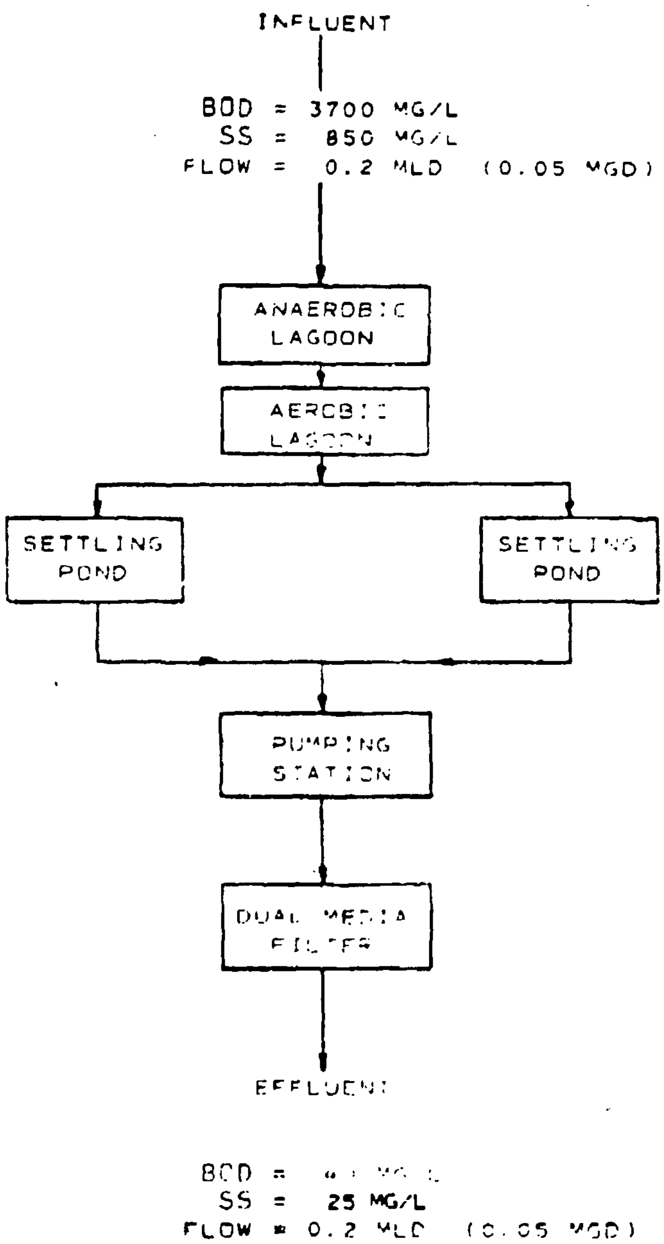


FIGURE 262

CONTROL AND TREATMENT ALTERNATIVE [illegible]

The chemical composition of wastewater from shell egg handling plants is very similar to egg processing wastewater, except that the concentration of pollutants in the egg processing wastewater is higher. A few egg processing plants have treatment facilities, and several studies have been conducted on egg processing wastewater. The information available on egg processing wastewater treatment is discussed in detail in Section V of this document under Subcategory C 4, Egg Processing.

Selection of Control and Treatment Technology

In Section V of this document a model plant was developed for the shell egg industry. The unscreened raw waste characteristics were assumed as follows:

1. Flow - 0.013 mld (3500 gpd)
2. pH - 6.7 to 9.0
3. BOD - 1500 mg/l
4. SS - 500 mg/l
5. Ratio - kg BOD to kkg of product - 1.56
6. Ratio - kg SS to kkg of product - 0.52

The treatment modules in the treatment trains described below were selected on the basis of the literature and treatment plants for Subcategory C 4, Egg Processing.

Table 161 lists the pollutant effluent loading and the estimated operating efficiency of each of the six treatment trains selected for this subcategory.

Alternative C 5 - I - This alternative provides no treatment except a catch basin to collect the shells from the waste stream.

Alternative C 5 - II - This alternative consists of a two-cell aerated lagoon and associated settling ponds. The 95 percent removal indicated in Table 161 is based on the laboratory and full scale studies by Bulley, et. al., (149) and a 45 day detention time.

Alternative C 5 - III - This alternative consists of the treatment module of Alternative C 4- II with the addition of a dual media filter and associated pumping stations. The schematic diagram of Alternative C 5 - III is shown in Figure 263.

TABLE 161

SUMMARY OF TREATMENT TRAIN ALTERNATIVES

Treatment Train Alternative		Effluent BOD kg/kkg	Effluent SS kg/kkg	Percent BOD Reduction	Percent SS Reduction
C 5 - I	A	1.56	0.52	0	0
C 5 - II	L	0.078	0.075	95	85
C 5 - III	LN	0.047	0.021	97	95
C 5 - IV	ML	0.031	0.031	98	90
C 5 - V	MLN	0.016	0.010	99	98

DRAFT

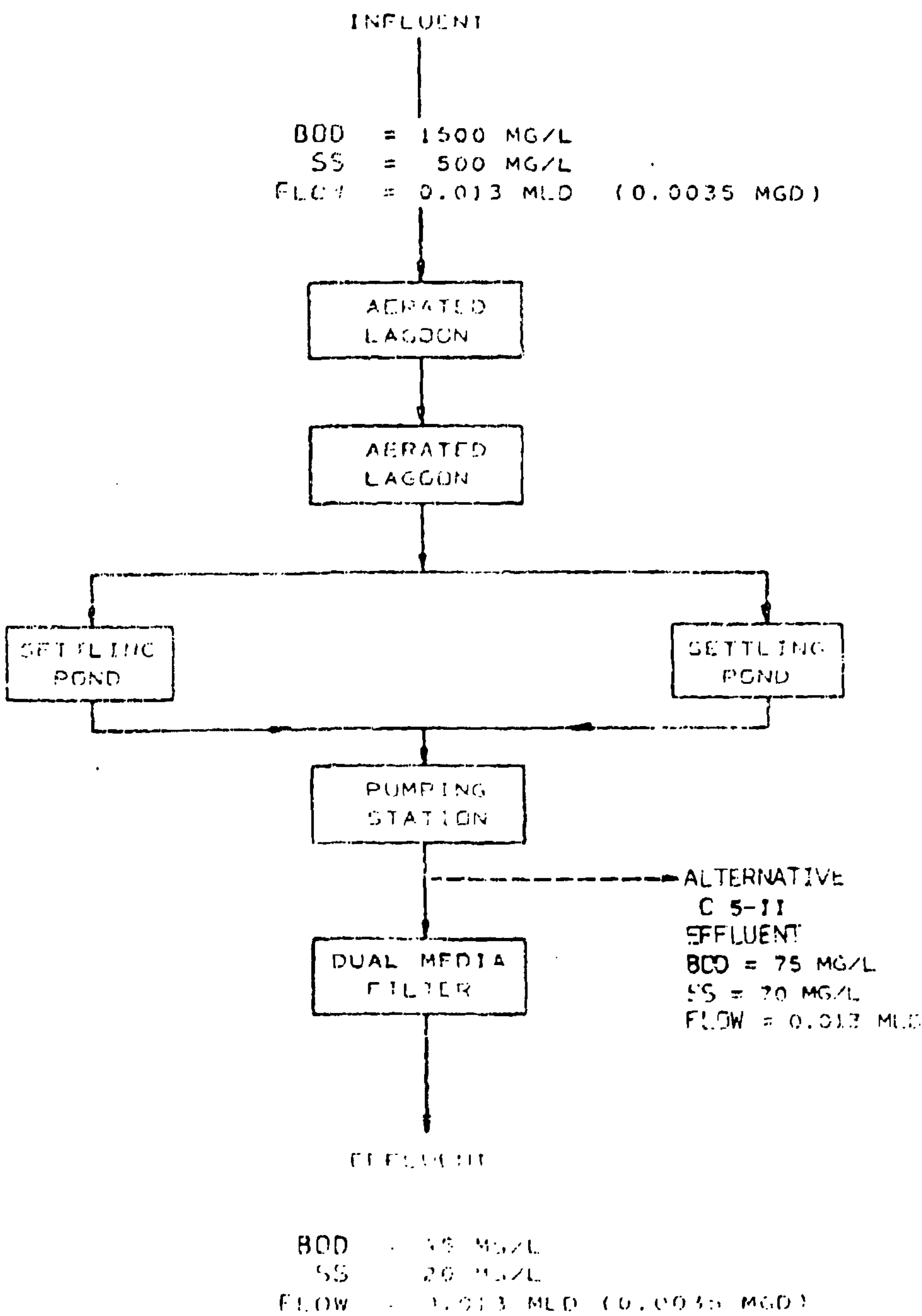


FIGURE 263

CONTROL AND TREATMENT ALTERNATIVES C 5 - II AND III

Alternative C 5 - IV - This treatment alternative consists of an anaerobic lagoon, a aerated lagoon and associated settling ponds. The laboratory studies (154) of this treatment method indicated anaerobic and aerobic detention times of 10 and 6 days, respectively.

Alternative C 5 - V - This alternative consists of Alternative C 4-IV with the addition of a dual media filter and associated pumping station. A schematic diagram of Alternative C 5 - V is shown in Figure 234.

SUBCATEGORY C 6 - MANUFACTURED ICE

In-Plant Technology

In-plant technology and procedures are aimed at reducing the quantity of wastewater discharged from ice manufacturing plants. Some plants reduce their waste stream by incorporating a closed cooling system, with the water used to cool the compressors recirculated through cooling towers. The cooling towers must be blown down periodically. Some plants with once-through water cooling of their compressors route this water to their dip tanks prior to discharge.

In fragmentary ice manufacturing, the water to be frozen may be passed through a cooling tower or other type of heat exchanger to reduce its temperature before it is passed through the ice machine. Excess water flowing through the fragmentary ice making machine and water used during blowdown operations is recycled to this precooler, thus, almost eliminating discharge from fragmentary ice plants.

End-of-Line Technology

No ice manufacturing plant in the country is known to have any form of wastewater treatment facility. Wastewater is normally discharged directly to municipal sewers or to navigable waters. One manufacturer of fragmentary ice dumps excess water into an abandoned water well and distributes it through an infiltration field similar to those used in septic tanks.

The only conceivable treatment to reduce the dissolved solids concentration of the wastewater to the level of the water supply is a demineralization process such as electrodialysis, reverse osmosis, or ion exchange. One ice manufacturer is known to have installed a reverse osmosis unit to treat its incoming water supply, but no plants have installed demineralization equipment to treat wastewater, nor have any pilot or bench tests been run to determine their efficiencies. From a technical standpoint, it is dubious whether the benefits of discharging a partially demineralized wastewater would justify the problems created by generation and disposal of the concentrated brine generated in the treatment facility.

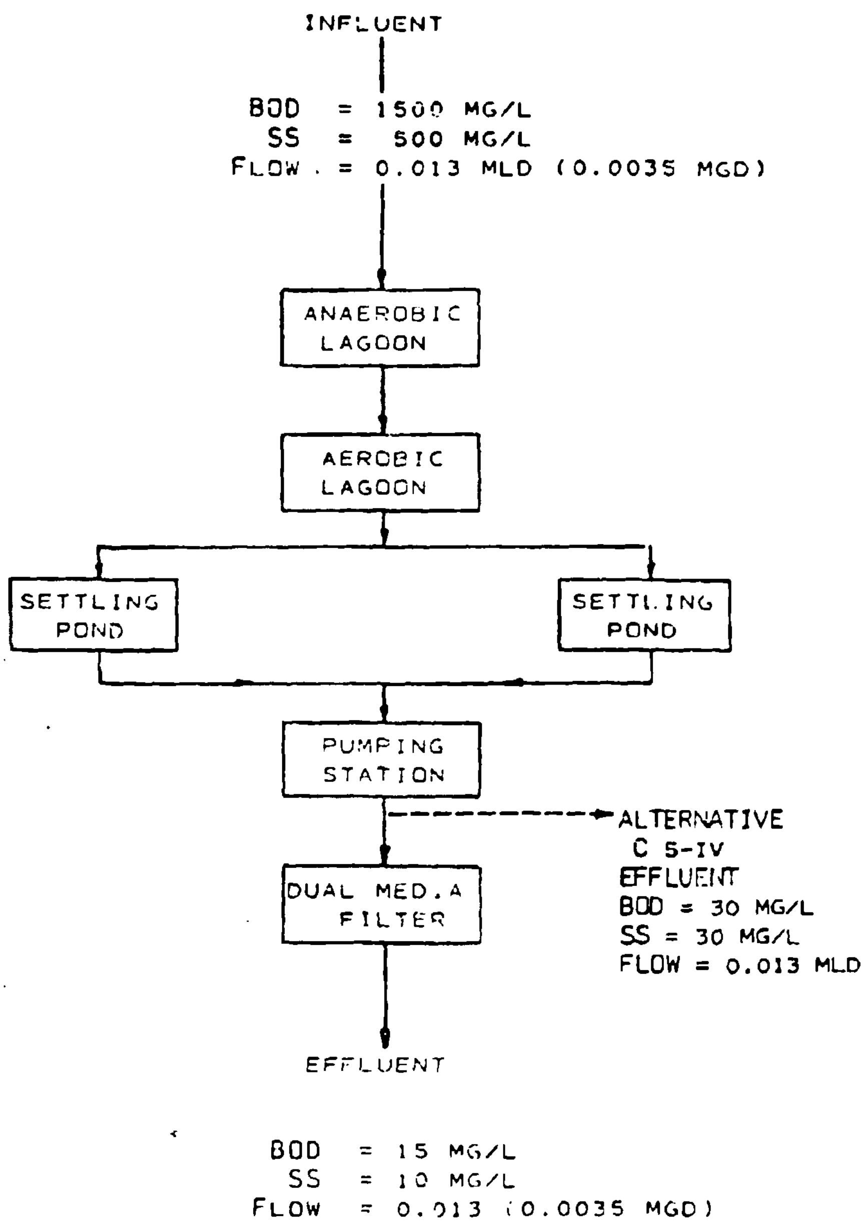


FIGURE 264

CONTROL AND TREATMENT ALTERNATIVES C 5-IV AND V

DRAFT

Selection of Control and Treatment Technology

In Section V, a model plant was developed for ice manufacturing. The characteristics of its wastewater were assumed to be as follows:

1. Flow volume - average - 0.04 mld (11,000 gpd)
   minimum - 0.01 mld (3,000 gpd)
   maximum - 0.19 mld (50,000 gpd)

2. BOD - 1.2 mg/l

3. SS - 5.2 mg/l

4. 0.004 - kg BOD per kkg of product

5. 0.012 - kg SS per kkg of product

Alternative C 6 - I - This alternative provides no additional treatment to the wastewater. Since wastewater from ice manufacturing plants has been shown to be virtually free of pollutants, no treatment of the ice manufacturing waste stream is deemed necessary. The direct discharge of these wastewaters to navigable streams may, in some instances, actually improve the quality of the receiving water. This was found to be the case at one plant.

Subcategory D 4, Vinegar

Existing In-Plant Technology - Two plants of the four summarized on Table 94 in Section V recycled non-contact cooling water from the vinegar generators. Cooling water heat exchange may be either evaporative (cooling tower) or conductive (refrigeration); refrigeration allowing for a completely closed system. Filter washwater from two plants was held for 24 hours to allow for settling out of the filter aid material prior to discharge, thereby realizing a significant reduction in suspended solids. Also, drainage of the last few inches of the vinegar storage tanks into a settling tank and subsequent dry handling of the resulting sediment reduces suspended solid loadings.

Potential In-Plant Technology - One of the first water-saving techniques should be to recycle all non-contact cooling waters. Contact cooling waters, used to cool and clean product containers after pastuerization should be considered for recycling.

Advantageous waste management is demonstrated in such things as adequate training of employees, close plant supervision, good housekeeping, proper maintenance, and salvaging products that can be reused in the process, e.g., filter aids. These improvements will not require large sums of money to implement and may result in economic returns as a result.

DRAFT

End-of-Line Technology - Out of a total of seven plants visited or contacted by the contractor, two had treatment systems resulting in zero discharge. Four of these discharged to municipal systems and one to a local tributary.

Treatment systems employed at the two zero discharge plants were screening, extended aeration and holding ponds, with final discharge to spray irrigation. Plants discharging to municipalities screened the effluent and adjusted pH prior to final discharge. The one plant discharging to a local tributary utilized screening, aerated lagoon and final holding ponds with a retention time of 250 days before discharging. This plant realized a 94 percent reduction in BOD and COD loadings, and 54 percent in suspended solids.

Selection of Control and Treatment Technology

In Section V a model plant was developed for vinegar processing. The raw wastewater characteristics after screening were assumed to be as follows:

BOD	1950 mg/l
SS	660 mg/l
pH	5.2
Flow	91 cu m/day (0.024 MGD)

Table 162 lists the pollutant effluent loading and estimated operating efficiency of each of the treatment trains selected for this subcategory.

Alternative D 4-I - This alternative provides no additional treatment to the screened wastewater.

Alternative D 4-II - This alternative consists of a pumping station, flow equalization basin and acid neutralization.

Alternative D 4-III - This alternative adds to Alternative D 4-II an aerated lagoon system with nitrogen addition.

Alternative D 4-IV - This alternative replaces the aerated lagoon system of Alternative D 4-III with an activated sludge unit. In addition, the treatment train incorporates sludge thickening, aerobic digestion and truck hauling.

Alternative D 4-V - Alternative D 4-V is identical to Alternative D 4-IV except for the addition of sand drying beds for sludge disposal.

Alternative D 4-VI - This alternative adds, to Alternative D 4-V, a dual media pressure filtration system as a final treatment step.

Alternative D 4-VII - This alternative adds a pumping station, pipe line and spray irrigation to the treatment train of Alternative D 4-III.

Alternative D 4-VIII - This alternative adds a pumping station, pipe line and spray irrigation to the treatment train of Alternative D 4-IV.

DRAFT

TABLE 162

SUMMARY OF TREATMENT TRAIN ALTERNATIVES
SUBCATEGORY D4

Treatment Train Alternative	Effluent BOD mg/l	Effluent SS mg/l	Percent BOD Reduction	Percent SS Reduction
I	1950	660	0	0
II	1950	660	0	0
III	98	50	95	92
IV	60	30	97	95
V	60	30	97	95
VI	30	20	98	97
VII	0	0	100	100
VIII	0	0	100	100

SUBCATEGORIES E 1 (MOLASSES, HONEY, AND SYRUPS), E 2 (POPCORN), E 3 (PREPARED GELATIN DESSERTS), E 4 (SPICES), E 5 (DEHYDRATED SOUP), AND E 6 (MACARONI, SPAGHETTI, VERMICELLI, AND NOODLES)

Existing and Potential In-Plant Technology

In general, wastewater volumes and loadings can be reduced by the dry cleaning of equipment as much as possible before cleaning with water. Mixers, vats, hand utensils, etc., should be cleaned as thoroughly as possible by rubber scrappers, cloths, and air hoses. Wastewater volume can be effectively reduced by the use of high pressure spray nozzles instead of open-ended hoses or garden type nozzles. The overall effectiveness of in-plant water conservation and pollutant load reduction depends on a combination of management awareness and employee training.

End-of-Line Technology

Virtually all of the plants in Subcategories E 1 through E 6 presently discharge process wastewater to municipal sewage systems. Those plants which do not have an access to municipal treatment have a choice of a number of low cost disposal alternatives. The low volumes of wastewaters generated make truck hauling practical and feasible--whether to a municipal sewage plant or to land disposal. Those plants that have available land can install retention ponds, land spreading systems, spray or ridge and furrow irrigation, or even small land-related treatment and disposal systems should local conditions permit.

Due to the low volume of these wastes, hauling to nearby treatment facilities or disposal at suitable landfill sites is the preferred handling metnod. All of these production processes result in either no production of process wastewater or very small quantities of wastewater resulting from cleanup operations.

SUBCATEGORIES F 2 (BAKING POWDER), F 3 (CHICORY), AND F 4 (BREAD CRUMBS NOT PRODUCED IN BAKERIES)

As discussed in Sections III and V, the plants associated with these subcategories all employ dry processes which do not generate process wastewater. No control and treatment technology for process wastewater is necessary or appropriate for these industry subcategories.

DRAFT

SECTION VIII

COST, ENERGY AND NON-WATER QUALITY ASPECTS

This section presents an evaluation of the costs, energy requirements, and non-water quality aspects associated with the treatment and control alternatives developed in Section VII in terms of the model processes and plants developed in Section V.

COST AND REDUCTION BENEFITS OF ALTERNATIVE TREATMENT AND CONTROL TECHNOLOGIES

In absence of complete cost information for individual processes, the cost figures developed herein are based on reliable actual cost figures reported for various installations coupled with engineering estimates. An estimate completely applicable to all members of an entire industry is obviously impossible. For instance, it must be realized that land costs vary widely. Construction cost, in terms of both labor and material costs, is another element that is highly variable. The costs presented herein have been developed for the different industry subcategories, rather than the entire industry, thus reducing some of the variability expected in costs. These costs are, nevertheless, intended to serve as a guide only, principally for subsequent economic impact analysis to be conducted by the U.S. Environmental Protection Agency.

Assumptions for Cost Analysis

The following assumptions are common for all of the cost estimates in this section:

1. All costs are reported in August 1972 dollars. All engineering cost estimates were made in December 1974 costs and converted to August 1972 dollars by the Construction Cost Index of the Engineering News Record.

2. Annual interest rate for capital stock is taken to be eight percent.

3. All investment cost is depreciated over a period of 20 years except rolling stock which is depreciated over ten years.

4. Salvage value is taken as zero at the end of the depreciation period.

5. Depreciation is attributed by the straight line method.

6. Total yearly cost = (investment cost/2) (0.08) + yearly depreciation cost + operating cost.

7. Power costs = $0.04/kw-hr.

8. Excavation and fill is estimated at $3.92/cu m ($3.00/cu yd) for December 1974.

9. Personnel costs for operation is $5.00/hr plus 50 percent fringe benefits, administration, and other overhead.

10. All capital construction work is performed by an outside contractor using normal profit margins.

11. When between 10 and 20 aeration units are purchased, a discount of 5.0 percent is obtained. When more than 20 units are purchased, the discount is 7.5 percent.

12. The December 1974 cost of steel is $0.20/kg ($0.45/lb).

13. The December 1974 cost of concrete is $134/cu m ($175/cu yd).

14. The December 1974 cost of contracted truck hauling of dewatered sludge or solid waste is $0.77/cu m ($1.00/cu yd).

15. The December 1974 cost of contracted truck hauling of liquid sludge or wastewater is $5.28/1000 l ($20.00/1000 gal).

The Feasibility and Costs of Municipal Treatment

Although the purpose of the document is to recommend effluent limitations guidelines for point source discharges into navigable waters, discharge to municipal treatment systems is a viable alternative for some installations and is now the case for many existing plants. To avoid redundancy, costs for this alternative are not provided for every subcategory, but are addressed in the following discussion.

The combined treatment of municipal and industrial wastes often offers an attractive alternative for industry, if municipal treatment is available. Many plants within the miscellaneous foods and beverages industry discharge to municipal sewers and, in fact, all plants within some of the subcategories discussed in this document use municipal treatment. Pretreatment for these industrial wastes varies from non-existent to the equivalent of secondary treatment.

Many of those plants which do not presently utilize municipal facilities may not have the feasible option to do so because of location restraints. Others do not use municipal treatment by choice because of municipal treatment cost or because they had already invested heavily in separate treatment facilities before municipal treatment became available.

It is conceivable that some plants currently discharging to municipal treatment will in the future decide to provide separate treatment as municipal charges will inevitably increase. It is even more conceivable that more stringent requirements for pretreatment will be made by municipalities in the future.

Municipal wastewater charges vary widely, as was illustrated in a survey by Maystre and Geyer (155) in 1970. The results of the survey indicated that about 10 percent of small cities, 15 percent of middle size cities, and 20 percent of larger cities had industrial waste charges. All of the 28 cities responding to the inquiry based surcharges on BOD and suspended solids, or their equivalents per unit volume, and on the excess loads of the individual plant relative to some average value stipulated by ordinance. Some cities also considered excess loads of grease and chlorine demand.

Based on the unit costs of treatment applied by the 28 cities, the investigators calculated the surcharge cost per month for two hypothetical industries, both having BOD and suspended solids concentrations of 800 mg/l, but one industry having a flow of 2830 cu m/month (100,000 cu ft/month) and the other a flow of 28,320 cu m/month (one million cu ft/month). The surcharge for the smaller industry ranged from $8/month to $269/month while the surcharge for the larger industry ranged from $78/month to $2690/month.

VEGETABLE OIL PROCESSING AND REFINING

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 1 - Oilseed Crushing, Except Olive Oil, by Direct Solvent Extraction and Prepress Operations

A model plant representative of subcateogry A 1 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 816 kkg (900 ton) of raw oilseed per day.

Alternative A 1-1 - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 816 kkg (900 ton) per day plant is 148 cu m/day (0.039 MG) per day. The BOD waste load is 0.061 kg/kkg (0.122 lb/ton), the suspended solids load is 0.038 kg/kkg (0.076 lb/ton), and the oil and grease load is 0.069 kg/kkg (0.138 lb/ton). The model plant developed is assumed to discharge its process wastewater and noncontact waters separately, and to provide gravity separation and skimming of process waters. Floatable oils and sludges from the gravity separation are pumped to an in-plant oil recovery system.

Costs: 0
Reduction Benefits: None

Alternative A 1-II - This alternative provides a flow equalization basin, complete-mix activated sludge, secondary clarification, a sludge recirculating pump, a sludge thickening tank, and a sludge holding tank.

The resulting BOD waste load is 0.0072 kg/kkg (0.014 lb/ton), the suspended solids load is 0.0090 kg/kkg (0.018 lb/ton) and the oil and grease load is 0.0054 kg/kkg (0.011 lb/ton).

Costs: Total investment cost: $172,650
Total yearly cost: $ 32,580

An itemized breakdown of costs is presented in Table 163. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 88.2 percent
SS: 76.3 percent
O&G: 92.2 percent

Alternative A 1-III - This alternative provides in addition to Alternative A 1-II dual media filtration with a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.0036 kg/kkg (0.0072 lb/ton), the suspended solids load is 0.0045 kg/kkg (0.0090 lb/ton) and the oil and grease load is 0.0027 kg/kkg (0.0054 lb/ton).

Costs: Total investment cost: $189,960
Total yearly cost: $ 37,680

An itemized breakdown of costs is presented in Table 164. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.1 percent
SS: 88.2 percent
O&G: 96.0 percent

A cost efficiency curve is presented in Figure 265.

Alternative A 1-IV - This alternative provides a flow equalization basin, an aerated lagoon system, and a settling pond.

The resulting BOD waste load is 0.0072 kg/kkg (0.014 lb/ton), the suspended solids load is 0.0090 kg/kkg (0.018 lb/ton) and the oil and grease load is 0.0054 kg/kkg (0.011 lb/ton).

Costs: Total investment cost: $154,740
Total yearly cost: $ 38,870

An itemized breakdown of costs is presented in Table 165. It is assumed that land costs $4100 per hectare ($1660 per acre). It is

DRAFT

TABLE 163

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 1-II
(OILSEED SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 88.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
A...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	97510.00
	2. LAND	55640.00
	3. ENGINEERING	9750.00
	4. CONTINGENCY	9750.00
	TOTAL	172650.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	4830.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	2500.00
	TOTAL	19820.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	19820.00
	2. YEARLY INVESTMENT COST RECOVERY	6910.00
	3. DEPRECIATION	5850.00
	TOTAL	32580.00

DRAFT

TABLE 164

ITEMIZED COST SUMMARY FOR ALTERNATIVE A I-III (OILSEED SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	111940.00
2. LAND	55640.00
3. ENGINEERING	11190.00
4. CONTINGENCY	11190.00
TOTAL	189960.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	6990.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	3880.00
TOTAL	23360.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	23360.00
2. YEARLY INVESTMENT COST RECOVERY	7600.00
3. DEPRECIATION	6720.00
TOTAL	37680.00

DRAFT

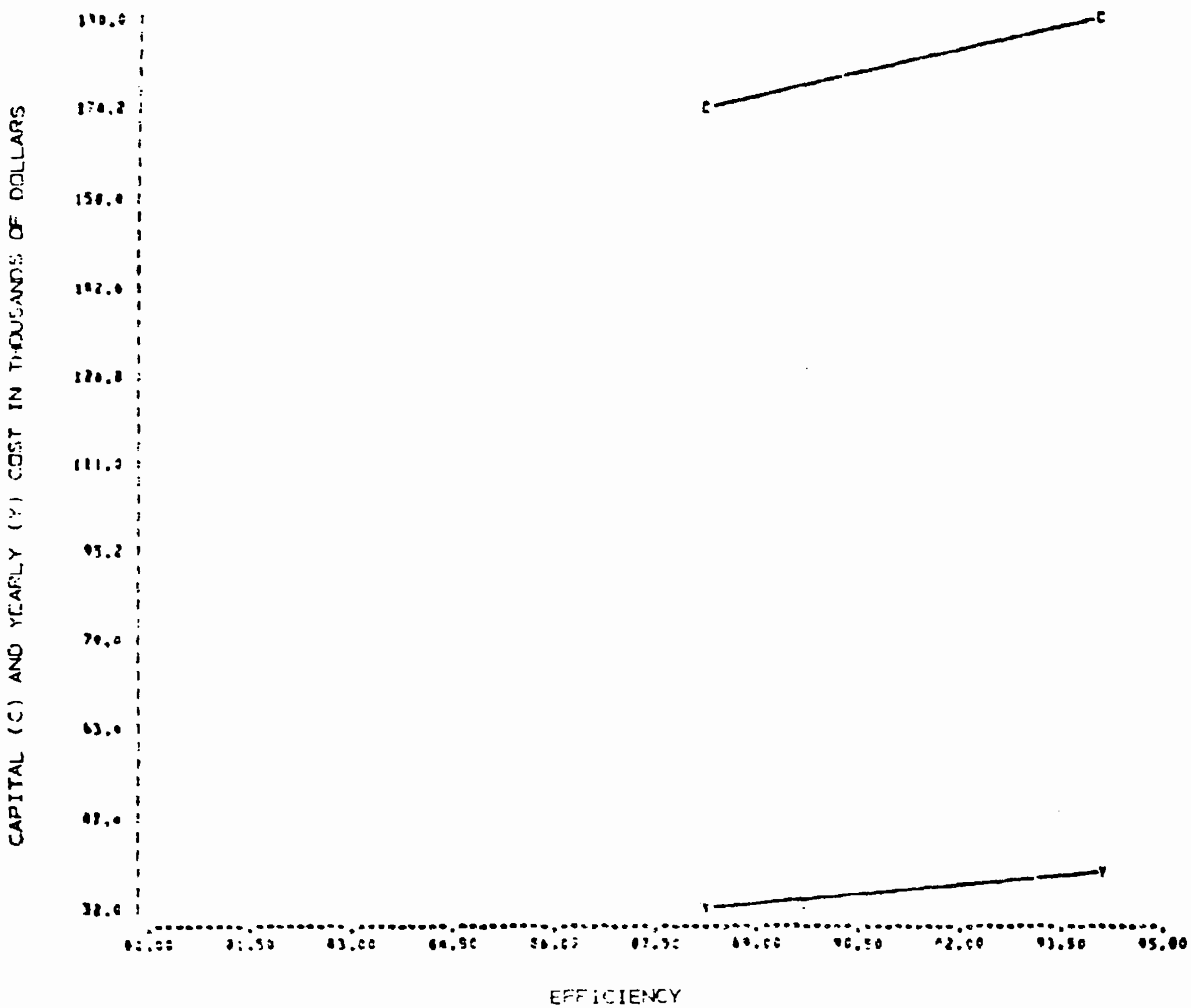


FIGURE 265

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A1, ALTERNATIVE II & III

DRAFT

TABLE 165

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 1-IV
(OILSEED SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 88.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	123110.00
2.	LAND	3330.00
3.	ENGINEERING	12310.00
4.	CONTINGENCY	12310.00
5.	PVC LINER	3680.00
	TOTAL	154740.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	10600.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	1920.00
5.	PVC LINER	100.00
	TOTAL	25110.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	25110.00
2.	YEARLY INVESTMENT COST RECOVERY	6190.00
3.	DEPRECIATION	7570.00
	TOTAL	38870.00

further assumed that one operator is required.

Reduction Benefits: BOD: 88.2 percent
SS: 76.3 percent
O&G: 92.2 percent

Alternative A 1-V - This alternative provides in addition to Alternative A 1-IV dual media filtration with a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.036 kg/kkg (0.0072 lb/ton), the suspended solids load is 0.0045 kg/kkg (0.0090 lb/ton) and the oil and grease load is 0.0027 kg/kkg (0.0054 lb/ton).

Costs: Total investment cost: $172,050
Total yearly cost: $ 43,970

An itemized breakdown of costs is presented in Table 166. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.1 percent
SS: 88.2 percent
O&G: 96.0 percent

A cost efficiency curve is presented in Figure 266.

Alternative A 1-VI - This alternative provides a flow equalization basin, and pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil and grease waste skimmings are pumped to an in-plant oil reclamation system.

The resulting BOD waste load is 0.018 kg/kkg (0.036 lb/ton), the suspended solids load is 0.011 kg/kkg (0.022 lb/ton), and the oil and grease load is 0.021 kg/kkg (0.042 lb/ton).

Costs: Total investment cost: $149,370
Total yearly cost: $ 31,200

An itemized breakdown of costs is presented in Table 167. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 69.8 percent
SS: 70.2 percent
O&G: 70.3 percent

Alternative A 1-VII - This alternative provides in addition to Alternative A 1-VI a complete mix activated sludge unit, secondary clarification, a sludge recirculating pump, a sludge thickening tank, and sludge hauling.

DRAFT

TABLE

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 1-V
(OILSEED SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

P...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
1.	CONSTRUCTION	137540.00
2.	LAND	3330.00
3.	ENGINEERING	13750.00
4.	CONTINGENCY	13750.00
5.	PVC LINER	3680.00
TOTAL		172050.00
YEARLY OPERATING COSTS:		
1.	LABOR	12490.00
2.	POWER	12760.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	3300.00
5.	PVC LINER	100.00
TOTAL		28650.00
TOTAL YEARLY COSTS:		
1.	YEARLY OPERATING COST	28650.00
2.	YEARLY INVESTMENT COST RECOVERY	6880.00
3.	DEPRECIATION	8440.00
TOTAL		43970.00

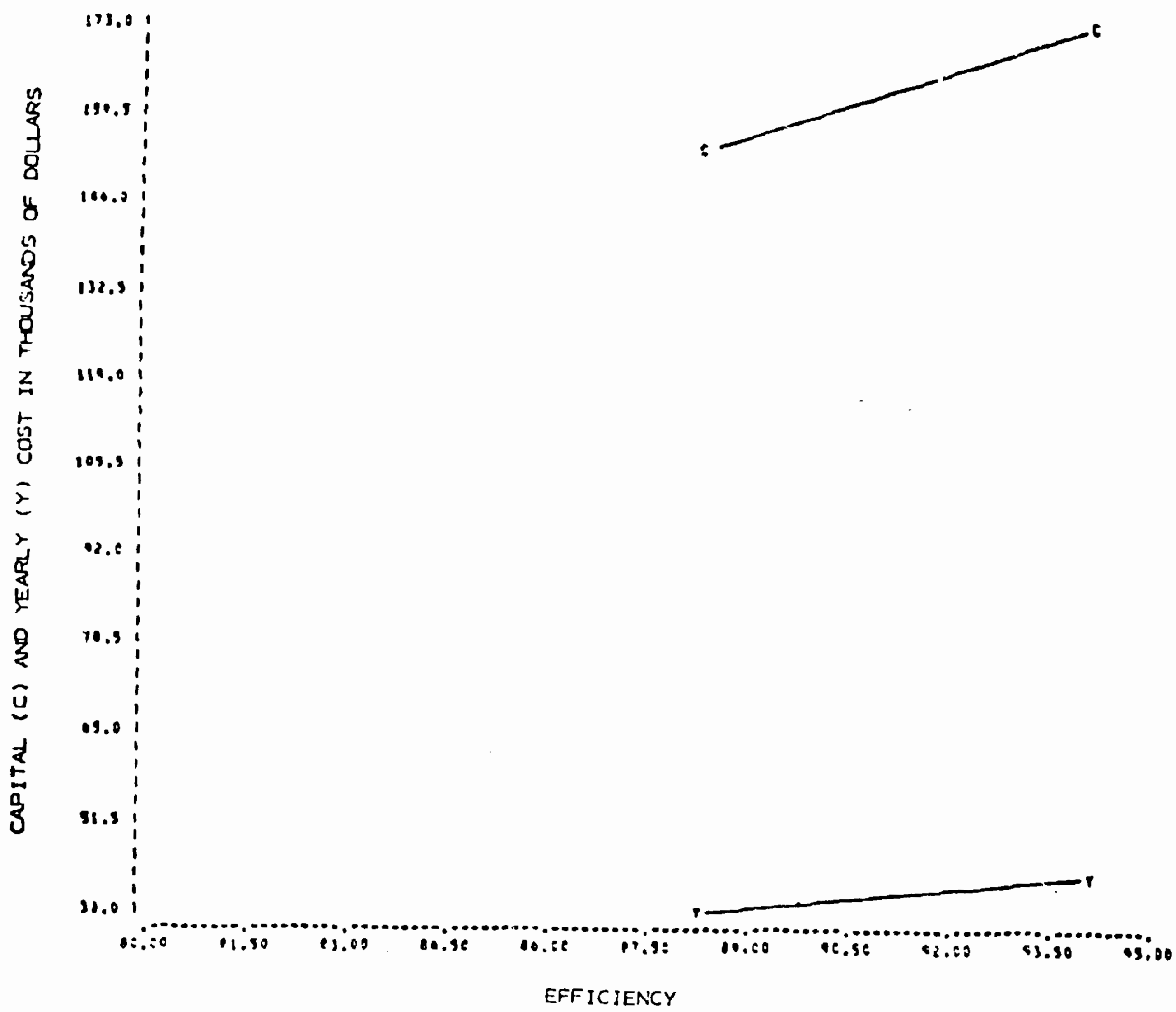


FIGURE 266

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A1, ALTERNATIVES IV & V

DRAFT

TABLE 167

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 1-VI (OILSEED SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- J...AIR FLOTATION

INVESTMENT COSTS:

1. CONSTRUCTION	78110.00
2. LAND	55640.00
3. ENGINEERING	7810.00
4. CONTINGENCY	7810.00
TOTAL	149370.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	2120.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	5930.00
TOTAL	20540.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	20540.00
2. YEARLY INVESTMENT COST RECOVERY	5970.00
3. DEPRECIATION	4690.00
TOTAL	31200.00

The resulting BOD waste load is 0.0036 kg/kkg (.0072 lb/ton), the suspended solids load is 0.0045 kg/kkg (0.0090 lb/ton) and the oil and grease load is 0.0027 kg/kkg (0.0054 lb/ton).

Costs: Total investment cost: $209,480
Total yearly cost: $ 40,690

An itemized breakdown of costs is presented in Table 168. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that one operator is required.

Reduction Benefits. BOD: 94.1 percent
SS: 88.2 percent
O&G: 96.0 percent

A cost efficiency curve is presented in Figure 267.

Alternative A 1-VIII - This alternative provides in addition to Alternative A 1-VI (dissolved air flotation) an aerated lagoon system including a settling pond.

The resulting BOD waste load is 0.0036 kg/kkg (0.0072 lb/ton), the suspended solids load is 0.0045 kg/kkg (0.0090 lb/ton) and the oil and grease load is 0.0027 kg/kkg (0.0054 lb/ton).

Costs: Total investment cost: $188,400
Total yearly cost: $ 43,300

An itemized breakdown of costs is presented in Table 169. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.1 percent
SS: 88.2 percent
O&G: 96.0 percent

A cost efficiency curve is presented in Figure 268.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 2 - Oilseed Crushing, Except Olive Oil, by Mechanical Screw Press Operations

No model plant was developed for this subcategory in Section V as the industry presently discharges less than 4000 liters (1000 gallon) of process wastewater per day to municipal facilities. In Section VII two alternatives were considered as being applicable engineering alternatives for handling these small volumes of waste.

Alternative A 2-I - This alternative provides no additional treatment.

DRAFT

TABLE 160

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 1-VII
(OILSEED SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	127360.00
	2. LAND	56640.00
	3. ENGINEERING	12740.00
	4. CONTINGENCY	12740.00
	TOTAL	209480.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	4850.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	7330.00
	TOTAL	24670.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	24670.00
	2. YEARLY INVESTMENT COST RECOVERY	8380.00
	3. DEPRECIATION	7640.00
	TOTAL	40690.00

DRAFT

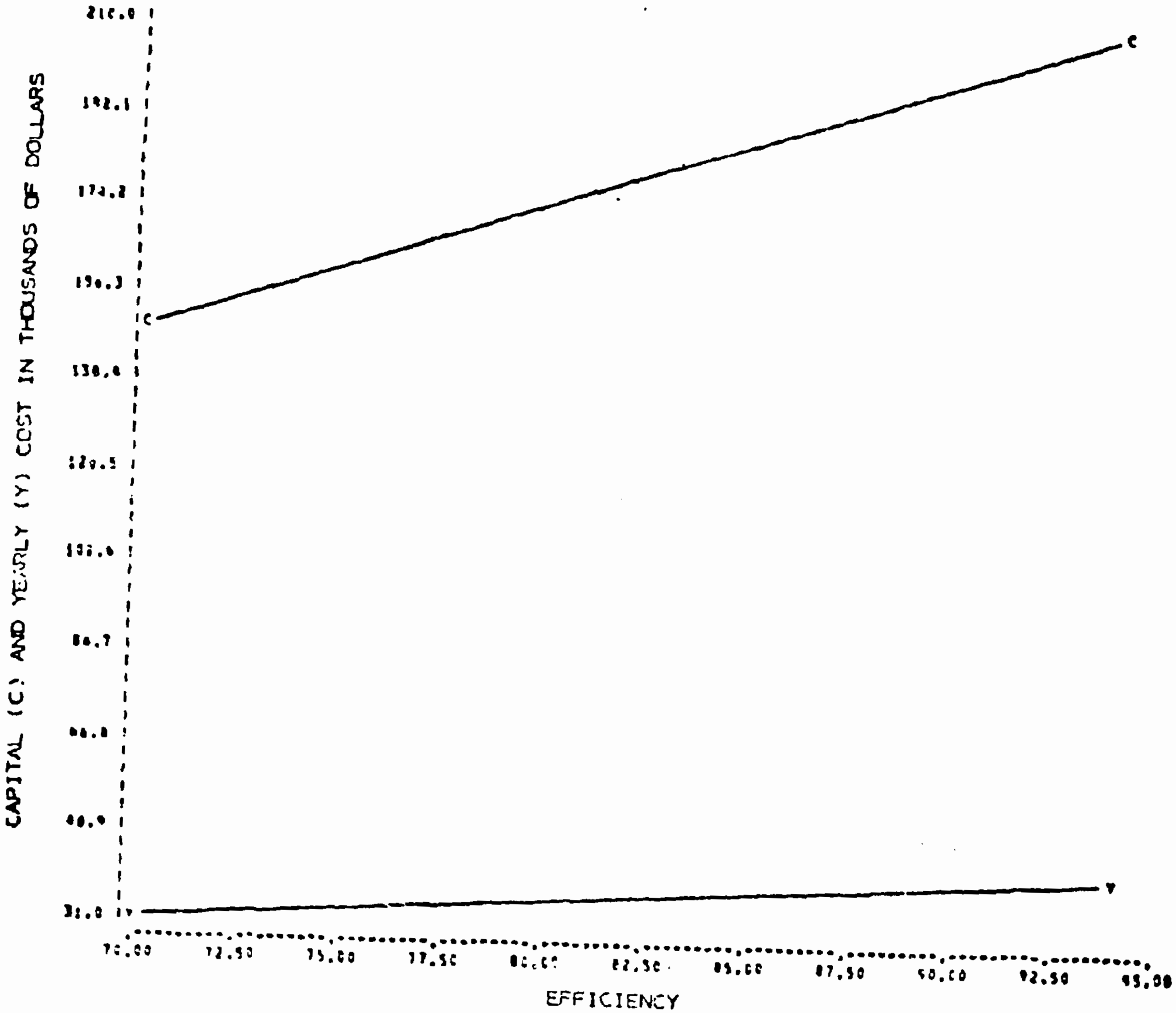


FIGURE 267

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A1, ALTERNATIVES VI & VII

DRAFT

TABLE 169

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 1-VIII
(OILSEED SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	151210.00
2.	LAND	3330.00
3.	ENGINEERING	15120.00
4.	CONTINGENCY	15120.00
5.	PVC LINER	3680.00
	TOTAL	188460.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	6780.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	7130.00
5.	PVC LINER	100.00
	TOTAL	26500.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	26500.00
2.	YEARLY INVESTMENT COST RECOVERY	7500.00
3.	DEPRECIATION	9260.00
	TOTAL	43300.00

DRAFT

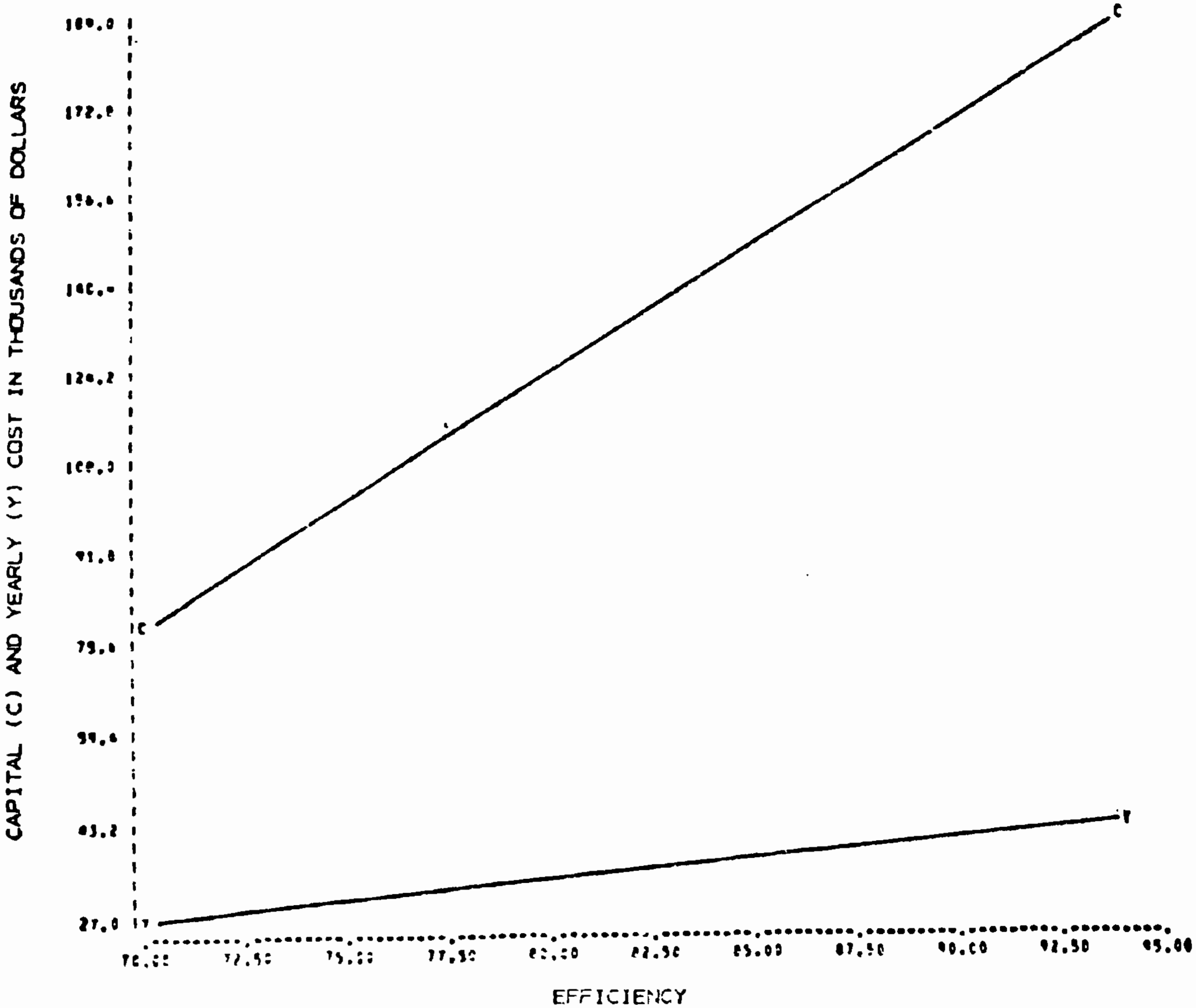


FIGURE 268

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A1, ALTERNATIVE VIII

Costs: 0
Reduction Benefits: None

Alternative A 2-II - This alternative consists of a storage tank and truck hauling of the wastewater to a municipal sewage treatment facility or suitable land disposal site. The resulting waste volume to be trucked averages less than 4000 liter (1000 gallon) per day.

Costs: Total investment cost: $19,450
Total yearly costs: $ 1,510
Reduction Benefits: 100

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 3 - Hydraulic Pressing and Solvent Extraction of Olive Oil

A model plant representative of Subcategory A 3 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which utilizes 21.7 kkg (24 ton) of whole olives and 65.3 kkg (74 ton) of cannery pits and culls per day to produce olive oil. It is estimated that the effluent from the model plant is 10.9 cu m (0.0029 MG) per day. The BOD concentration is 63,000 mg/l, the suspended solids concentration is 14,000 mg/l, and the oil and grease concentration is 3220 mg/l.

Alternative A 3-I - This alternative consists of a pumping station, a holding tank and spray irrigation of the raw waste effluent.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton), and the oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

Costs: Total investment cost: $40,850
Total yearly cost: $ 5,460

An itemized breakdown of costs is presented in Table 170. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 3-II - This alternative consists of four 0.10 ha (0.25 acre) evaporation ponds, lined with PVC fabric to prevent contamination of the fresh water aquifer.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton), and the oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

DRAFT

TABLE 170

ITEMIZED COST SUMMARY FOR ALTERNATIVE A3-I
(OLIVE OIL, HYDRAULIC PRESS AND SOLVENT EXTRACTION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	31020.00
	2. LAND	3630.00
	3. ENGINEERING	3100.00
	4. CONTINGENCY	3100.00
	TOTAL	40850.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	850.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1120.00
	TOTAL	1970.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	1970.00
	2. YEARLY INVESTMENT COST RECOVERY	1630.00
	3. DEPRECIATION	1860.00
	TOTAL	5460.00

Costs: Total investment cost: $60,330
Total yearly cost: $ 6,920

An itemized breakdown of costs is presented in Table 171. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 3-III - This alternative consists of land spreading the raw waste effluent.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton), and the oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

Costs: Total investment cost: $21,720
Total yearly cost: $ 8,330

An itemiz breakdown of costs is presented in Table 172. It is assumed that land osts $4100 per hectare ($1660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 4 - Mechanical Screw Pressing for the Recovery of Olive Oil

A model plant representative of Subcategory A 4 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which utilizes 43.5 kkg (43 ton) of whole olives per day to produce olive oil. It is estimated that the effluent from a 43.5 kkg (48 ton) per day plant is 114 cu m (0.030 MG) per day. The BOD waste load is 78.2 kg/kkg (156 lb/ton), the suspended solids load is 149 kg/kkg (297 lb/ton), and the oil and grease load is 52 kg/kkg (104 lb/ton).

Alternative A 4-I - This alternative consists of a pumping station a holding tank and spray irrigation of the raw waste effluent.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton), and the oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

Costs: Total investment cost: $92,030
Total yearly cost: $10,840

DRAFT

TABLE 171

ITEMIZED COST SUMMARY FOR ALTERNATIVE A3-II

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN A 3-II
DESIGN EFFICIENCY...100 PERCENT BOD REDUCTION

TREATMENT MODULES:
EVAPORATION POND

INVESTMENT COSTS:		
	1. CONSTRUCTION	48,170.00
	2. LAND	2,920.00
	3. ENGINEERING	4,820.00
	4. CONTINGENCY	4.820.00
	TOTAL	60,330.00
YEARLY OPERATING COSTS:		
	1. LABOR	300.00
	2. POWER	0.00
	3. CHEMICALS	0.00
	4. MAINTENANCE & SUPPLIES	340.00
	TOTAL	1,640.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	1,640.00
	2. YEARLY INVESTMENT COST RECOVERY	2,410.00
	3. DEPRECIATION	2,870.00
	TOTAL	6,920.00

DRAFT

TABLE 172

ITEMIZED COST SUMMARY FOR ALTERNATIVE A3-III

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN A3-III
DESIGN EFFICIENCY...100 PERCENT BOD REDUCTION

TREATMENT MODULES:
PUMPING STATION
LAND APPLICATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	16,720.00
	2. LAND	1,660.00
	3. ENGINEERING	1,670.00
	4. CONTINGENCY	1,670.00
	TOTAL	21,720.00
YEARLY OPERATING COSTS:		
	1. LABOR	6,230.00
	2. POWER	100.00
	3. CHEMICALS	0.0
	4. MAINTENANCE & SUPPLIES	130.00
	TOTAL	6,460.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	6,460.00
	2. YEARLY INVESTMENT COST RECOVERY	870.00
	3. DEPRECIATION	1,000.00
	TOTAL	8,330.00

An itemized breakdown of costs is presented in Table 173. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 4-II - This alternative consists of four 0.4 ha (1.0 acre) evaporation ponds lined with PVC fabric to prevent contamination of the fresh water aquifer.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton), and the oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

Costs: Total investment cost: $254,970
Total yearly cost: $ 49,530

An itemized breakdown of costs is presented in Table 174. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 4-III - This alternative consists of land spreading the raw waste effluent.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton), and oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

Costs: Total investment cost: $46,140
Total yearly cost: $11,390

An itemized breakdown of costs is presented in Table 175. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 5 - Processing of Edible Oil by Caustic Refining

A model plant representative of Subcategory A 5 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels

DRAFT

TABLE 173

ITEMIZED COST SUMMARY FOR ALTERNATIVE A4-I (OLIVE OIL, MECHANICAL SCREW PRESS EXTRACTION)

TEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
ESIGN EFFICIENCY...100.0 PERCENT COD REDUCTION

REATMENT MODULES:

Y...HOLDING TANK
U...SPRAY IRRIGATION

NVESTMENT COSTS:		
	1. CONSTRUCTION	66150.00
	2. LAND	12660.00
	3. ENGINEERING	6610.00
	4. CONTINGENCY	6610.00
	TOTAL	92030.00
EARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	980.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	2210.00
	TOTAL	3190.00
OTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	3190.00
	2. YEARLY INVESTMENT COST RECOVERY	3680.00
	3. DEPRECIATION	3970.00
	TOTAL	10840.00

DRAFT

TABLE 174

ITEMIZED COST SUMMARY FOR ALTERNATIVE A4-II

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN A4-II
DESIGN EFFICIENCY...100 PERCENT

TREATMENT MODULES:
EVAPORATION POND

INVESTMENT COSTS:		
	1. CONSTRUCTION	205,010.00
	2. LAND	8,960.00
	3. ENGINEERING	20,500.00
	4. CONTINGENCY	20,500.00
	TOTAL	254,970.00
YEARLY OPERATING COSTS:		
	1. LABOR	1,660.00
	2. POWER	0.00
	3. CHEMICALS	0.00
	4. MAINTENANCE & SUPPLIES	25,370.00
	TOTAL	27,030.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	27,030.00
	2. YEARLY INVESTMENT COST RECOVERY	10,200.00
	3. DEPRECIATION	12,300.00
	TOTAL	49.530.00

DRAFT

TABLE 175

ITEMIZED COST SUMMARY FOR ALTERNATIVE A4-III

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN A4-III
DESIGN EFFICIENCY...100 PERCENT

TREATMENT MODULES:
PUMPING STATION
LAND APPLICATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	32,920.00
	2. LAND	6,640.00
	3. ENGINEERING	3,290.00
	4. CONTINGENCY	3,290.00
	TOTAL	46,140.00
YEARLY OPERATING COSTS:		
	1. LABOR	6,230.00
	2. POWER	830.00
	3. CHEMICALS	0.00
	4. MAINTENANCE & SUPPLIES	500.00
	TOTAL	7,560.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	7,560.00
	2. YEARLY INVESTMENT COST RECOVERY	1,850.00
	3. DEPRECIATION	1,980.00
	TOTAL	11,390.00

of waste reductions for the edible oil model plant which refines 454 kkg (500 ton) of crude edible oil per day.

Alternative A 5-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 314 cu m per day. The BOD waste load is 4.59 kg/kkg (9.18 lb/ton), the suspended solids load is 2.49 kg/kkg (4.98 lb/ton), and the oil and grease load is 2.39 kg/kkg (4.78 lb/ton). The model plant developed for Subcategory A 5 is assumed to have separate discharge of non-contact and process wastewaters, in-plant gravity separation, skimming, pH control, and an oil recovery system for the skimmed oil and water wastes.

Costs: 0
Reduction Benefits: None

Alternative A 5-II - This alternative provides pressurized air floatation utilizing chemical flocculating agents to enhance the formation and floatability of wastes. Oil and grease skimmings are pumped to an in-plant oil recovery system

The resulting BOD waste load is 1.37 kg/kkg (2.74 lb/ton), the suspended solids load is 0.75 kg/kkg (1.50 lb/ton), and the oil and grease load is 0.73 kg/kkg (1.46 lb/tor).

Costs: Total investment cost: $145,530
Total yearly cost: $ 42,500

An itemized breakdown of costs is presented in Table 176. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 70.1 percent
SS: 70.0 percent
O&G: 69.5 percent

Alternative A 5-III - This alternative provides in addition to Alternative A 5-II a complete mix activated sludge unit including a secondary clarifier, sluuge recirculation, sludge thickening, vacuum filtration, and a sludge holding tank.

The resulting BOD waste load is 0.069 kg/kkg (0.14 lb/ton), the suspended solids load is 0.069 kg/kkg (0.14 lb/ton), and the oil and grease load is 0.069 kg/kkg (0.14 lb/ton).

Costs: Total investment cost: $354,770
Total yearly cost: $ 82,560

An itemized breakdown of costs is presented in Table 177. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

DRAFT

TABLE 176

ITEMIZED COST SUMMARY FOR ALTERNATIVE A5-II
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
B1..CONTROL HOUSE
J...AIR FLOTATION

INVESTMENT COSTS:

1.	CONSTRUCTION	71300.00
2.	LAND	59970.00
3.	ENGINEERING	7130.00
4.	CONTINGENCY	7130.00
	TOTAL	145530.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	1490.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	5920.00
	TOTAL	32400.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	32400.00
2.	YEARLY INVESTMENT COST RECOVERY	5820.00
3.	DEPRECIATION	4280.00
	TOTAL	42500.00

DRAFT

TABLE 177

ITEMIZED COST SUMMARY FOR ALTERNATIVE A5-III (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- B1..CONTROL HOUSE
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	245660.00
2. LAND	59970.00
3. ENGINEERING	24570.00
4. CONTINGENCY	24570.00
TOTAL	354770.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	15350.00
3. CHEMICALS	2610.00
4. MAINTENANCE&SUPPLIES	10680.00
TOTAL	53630.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	53630.00
2. YEARLY INVESTMENT COST RECOVERY	14190.00
3. DEPRECIATION	14740.00
TOTAL	82560.00

Reduction Benefits: BOD: 98.5 percent
SS: 97.2 percent
O&G: 97.1 percent

Alternative A 5-IV - This alternative provides in addition to Alternative A 5-III dual media pressure filtration equipped with a pump to generate sufficient head for filter operation.

The resulting BOD waste load is 0.035 kg/kkg (0.070 lb/ton), the suspended solids load is 0.035 kg/kkg (0.070 lb/ton), and the oil and grease load is 0.014 kg/kkg (0.028 lb/ton).

Costs: Total investment cost: $386,850
Total yearly cost: $ 91,380

An itemized breakdown of costs is presented in Table 178. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.5 percent
SS: 99.6 percent
O&G: 99.7 percent

Alternative A 5-V - This alternative provides in addition to Alternative A 5-IV an activated carbon adsorbtion unit before final discharge.

The resulting BOD waste load is 0.021 kg/kkg (0.042 lb/ton), the suspended solids load is 0.017 kg/kkg (0.034 lb/ton), and the oil and grease load is 0.007 kg/kkg (0.014 lb/ton).

Costs: Total investment cost: $459,900
Total yearly cost: $117,120

An itemized breakdown of costs is presented in Table 179. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.5 percent
SS: 99.6 percent
O&G: 99.7 percent

A cost efficiency curve is presented in Figure 269.

Alternative A 5-VI - This alternative provides in addition to Alternative A 5-II (i.e., dissolved air flotation) an aerated lagoon with a settling pond.

The resulting BOD waste load is 0.069 kg/kkg (0.14 lb/ton), the suspended solids load is 0.069 kg/kkg (0.14 lb/ton), and the oil and grease load is 0.069 kg/kkg (0.14 lb/ton).

DRAFT

TABLE 178

ITEMIZED COST SUMMARY FOR ALTERNATIVE A5-IV
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
B1..CONTROL HOUSE
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:		
	1. CONSTRUCTION	272400.00
	2. LAND	59970.00
	3. ENGINEERING	27240.00
	4. CONTINGENCY	27240.00
	TOTAL	386850.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	20450.00
	3. CHEMICALS	2610.00
	4. MAINTENANCE&SUPPLIES	11520.00
	TOTAL	59570.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	59570.00
	2. YEARLY INVESTMENT COST RECOVERY	15470.00
	3. DEPRECIATION	16340.00
	TOTAL	91380.00

DRAFT

TABLE 179

ITEMIZED COST SUMMARY FOR ALTERNATIVE A5-V
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY,.. 99.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
61..CONTROL HOUSE
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	333270.00
2. LAND	59970.00
3. ENGINEERING	33330.00
4. CONTINGENCY	33330.00
TOTAL	459900.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	23520.00
3. CHEMICALS	2610.00
4. MAINTENANCE&SUPPLIES	27600.00
TOTAL	78720.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	78720.00
2. YEARLY INVESTMENT COST RECOVERY	18400.00
3. DEPRECIATION	20000.00
TOTAL	117120.00

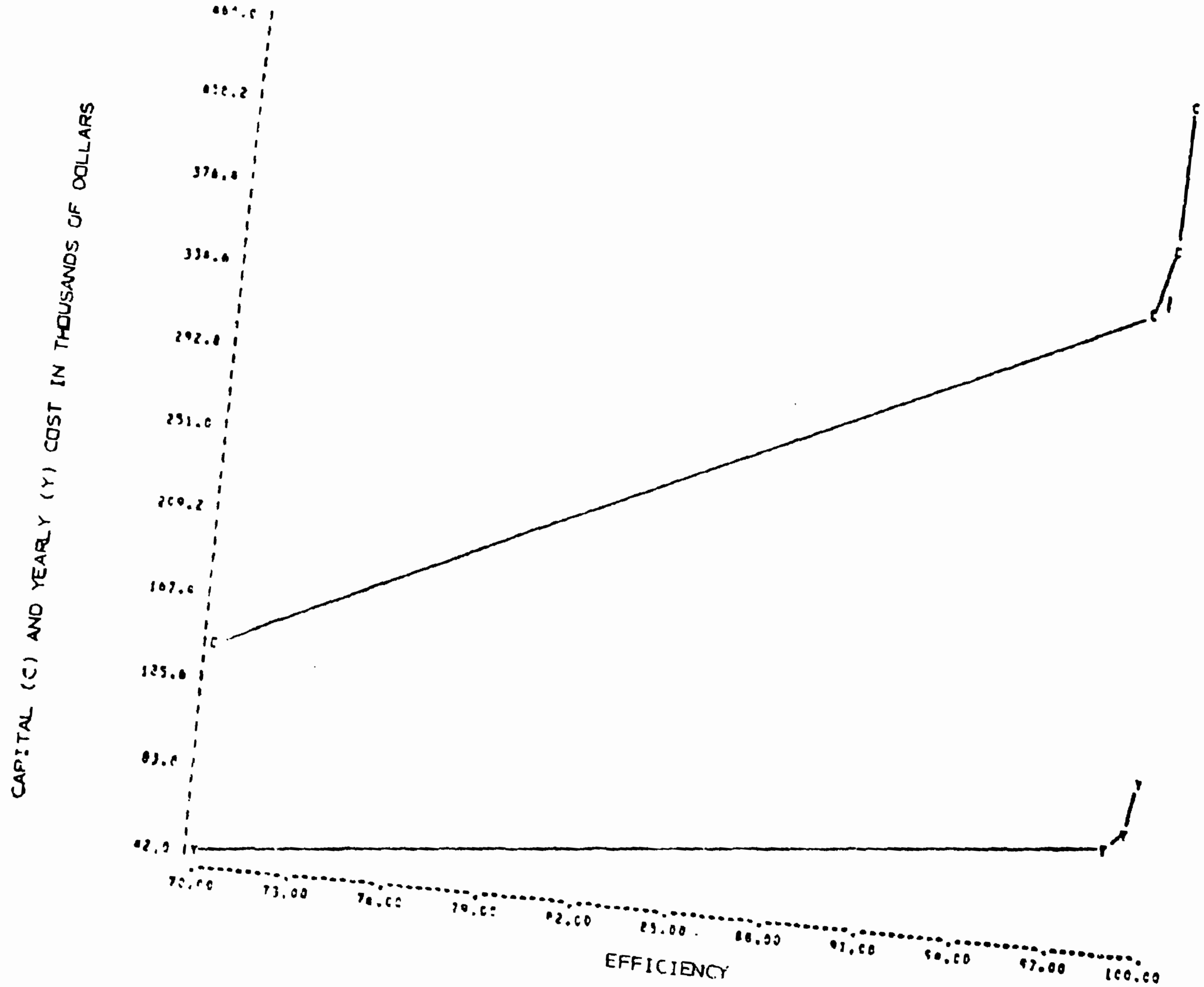


FIGURE 262

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A5. ALTERNATIVES II THRU V

DRAFT

Costs: Total investment cost: $249,080
Total yearly cost: $ 92,170

An itemized breakdown of costs is presented in Table 180. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.5 percent
SS: 97.2 percent
O&G: 97.1 percent

Alternative A 5-VII - This alternative provides in addition to Alternative A 5-VI dual media pressure filtration and a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.035 kg/kkg (0.070 lb/ton), the suspended solids load is 0.035 kg/kkg (0.070 lb/ton), and the oil and grease load is 0.014 kg/kkg (0.028 lb/ton).

Costs: Total investment cost: $281,160
Total yearly cost: $101,010

An itemized breakdown of costs is presented in Table 181. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 99.2 percent
SS: 99.2 percent
O&G: 99.4 percent

Alternative A 5-VIII - This alternative provides in addition to Alternative A 5-VII an activated carbon adsorbtion unit before final discharge.

The resulting BOD waste load is 0.021 kg/kkg (0.042 lb/ton), the suspended solids load is 0.017 kg/kkg (0.034 lb/ton), and the oil and grease load is 0.007 kg/kkg (0.014 lb/ton).

Costs: Total investment cost: $354,210
Total yearly cost: $126,730

An itemized breakdown of costs is presented in Table 182. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 99.5 percent
SS: 99.6 percent
O&G: 99.7 percent

A cost efficiency curve is presented in Figure 270.

DRAFT

TABLE 180

ITEMIZED COST SUMMARY FOR ALTERNATIVE A5-VI (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	200770.00
	2. LAND	4000.00
	3. ENGINEERING	20080.00
	4. CONTINGENCY	20080.00
	5. PVC LINER	4150.00
	TOTAL	249080.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	46890.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	10370.00
	5. PVC LINER	210.00
	TOTAL	69960.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	69960.00
	2. YEARLY INVESTMENT COST RECOVERY	9960.00
	3. DEPRECIATION	12250.00
	TOTAL	92170.00

DRAFT

TABLE 181

ITEMIZED COST SUMMARY FOR ALTERNATIVE A5-VII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	227510.00
2.	LAND	4000.00
3.	ENGINEERING	22750.00
4.	CONTINGENCY	22750.00
5.	PVC LINER	4150.00
TOTAL		281160.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	51990.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	11210.00
5.	PVC LINER	210.00
TOTAL		75900.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	75900.00
2. YEARLY INVESTMENT COST RECOVERY	11250.00
3. DEPRECIATION	13860.00
TOTAL	101010.00

DRAFT

TABLE 182

ITEMIZED COST SUMMARY FOR ALTERNATIVE A5-VIII (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
7...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	288380.00
2.	LAND	4000.00
3.	ENGINEERING	28840.00
4.	CONTINGENCY	28840.00
5.	PVC LINER	4150.00
	TOTAL	354210.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	55060.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	27290.00
5.	PVC LINER	210.00
	TOTAL	95050.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	95050.00
2.	YEARLY INVESTMENT COST RECOVERY	14170.00
3.	DEPRECIATION	17510.00
	TOTAL	126730.00

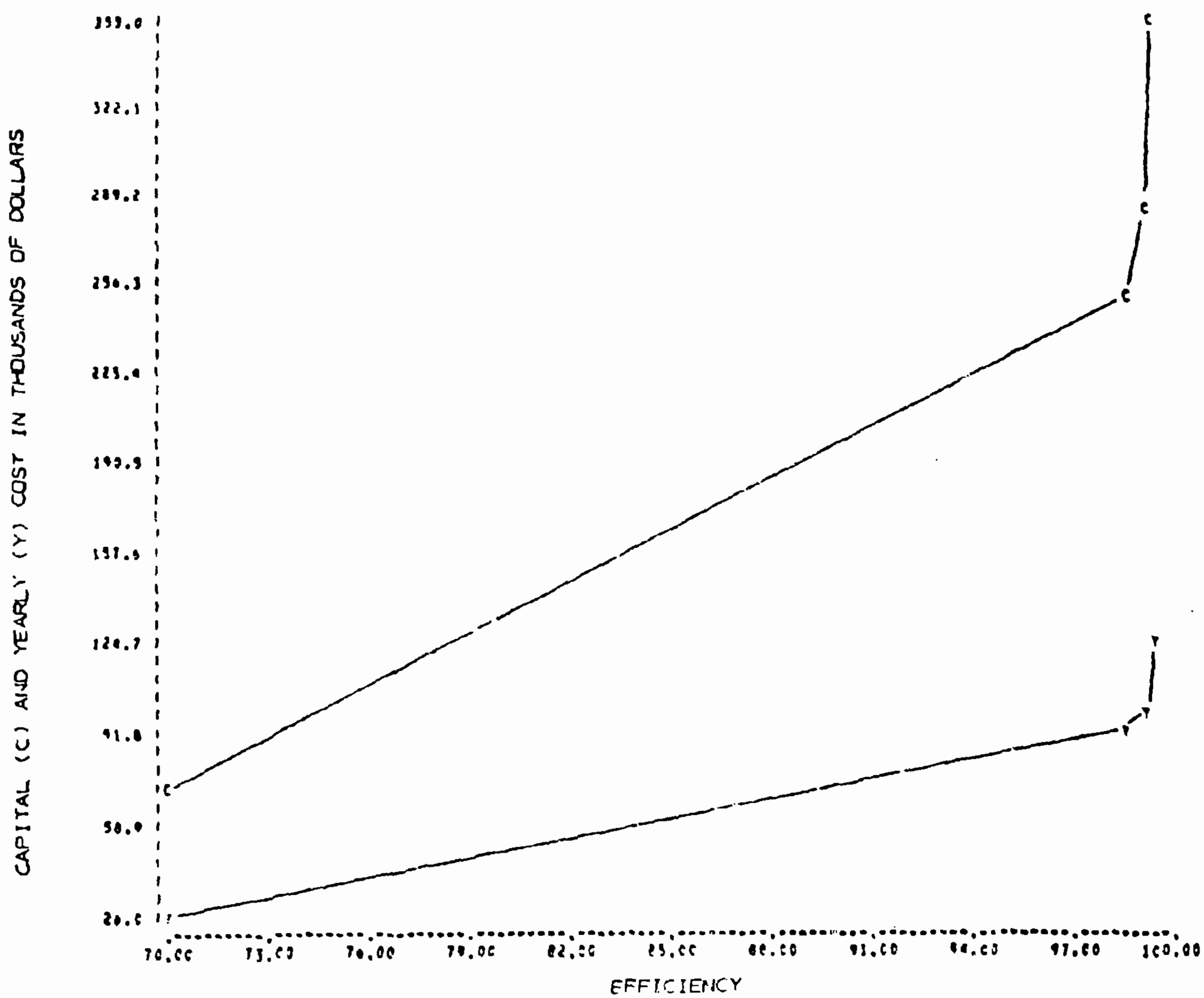


FIGURE 270

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A5, ALTERNATIVES VI THRU VIII

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 6 - Edible Oil Processing by Caustic Refining and Acidulation

A model plant representative of Subcategory A 6 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reduction for the model plant which refines 454 kkg (500 ton) of crude edible oil per day.

Alternative A 6-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 534 cu m (0.141 MG) per day. The BOD waste load is 8.95 kg/kkg (17.90 lb/ton), the suspended solids load is 4.03 kg/kkg (8.06 lb/ton), and the oil and grease load is 3.51 kg/kkg (7.02 lb/ton). The model plant developed for Subcategory A 6 is assumed to have separate discharge of non-contact and process wastewaters, in-plant gravity separation, skimming, pH control, and an oil recovery system for the skimmed oil and water wastes.

Costs:	0
Reduction Beneftis:	None

Alternative A 6-II - This alternative provides for the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

The resulting BOD waste load is 2.68 kg/kkg (5.36 lb/ton), the suspended solids load is 1.21 kg/kkg (2.42 lb/ton), and the oil and grease load is 1.05 kg/kkg (2.10 lb/ton).

Costs:	Total investment cost:	$154,540
	Total yearly cost:	$ 44,140

An itemized breakdown of costs is presented in Table 183. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	70 percent
	SS:	70 percent
	O&G:	70 percent

Alternative A 6-III - This alternative provides for the addition of activated sludge, secondary clarification, sludge recirculation pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every four days. The activated sludge unit also includes a control house and two full-time operators.

DRAFT

TABLE 183

ITEMIZED COST SUMMARY FOR ALTERNATIVE A6-II
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
B1..CONTROL HOUSE
J...AIR FLOTATION

INVESTMENT COSTS:

1.	CONSTRUCTION	76790.00
2.	LAND	62390.00
3.	ENGINEERING	7680.00
4.	CONTINGENCY	7680.00
	TOTAL	154540.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	2140.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	6220.00
	TOTAL	33350.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	33350.00
2.	YEARLY INVESTMENT COST RECOVERY	6180.00
3.	DEPRECIATION	4610.00
	TOTAL	44140.00

The resulting BOD waste load is 0.13 kg/kkg (0.27 lb/ton), the suspended solids load is 0.12 kg/kkg (0.24 lb/ton), and the oil and grease load is 0.10 kg/kkg (0.21 lb/ton).

Costs: Total investment cost: $460,940
Total yearly cost: $105,880

An itemized breakdown of costs is presented in Table 184. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 97.0 percent
O&G: 97.0 percent

Alternative A 6-IV - This alternative provides for the addition of dual media pressure filtration with pump stations to generate sufficient head for the filter operation.

The resulting BOD waste load is 0.067 kg/kkg (0.13 lb/ton), the suspended solids load is 0.061 kg/kkg (0.12 lb/ton), and the oil and grease load is 0.023 kg/kkg (0.046 lb/ton).

Costs: Total investment cost: $497,190
Total yearly cost: $116,050

An itemized breakdown of costs is presented in Table 185. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.3 percent
SS: 98.5 percent
O&G: 99.3 percent

Alternative A 6-V - This alternative provides for the addition of activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.035 kg/kkg (0.070 lb/ton), the suspended solids load is 0.030 kg/kkg (0.060 lb/ton), and the oil and grease load is 0.012 kg/kkg (0.021 lb/ton).

Costs: Total investment cost: $528,340
Total yearly cost: $148,780

An itemized breakdown of costs is presented in Table 186. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent
O&G: 99.6 percent

A cost efficiency curve is presented in Figure 271.

DRAFT

TABLE 184

ITEMIZED COST SUMMARY FOR ALTERNATIVE A6-III (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
B1..CONTROL HOUSE
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	332190.00
	2. LAND	62310.00
	3. ENGINEERING	33220.00
	4. CONTINGENCY	33220.00
	TOTAL	460940.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	26000.00
	3. CHEMICALS	3480.00
	4. MAINTENANCE&SUPPLIES	13040.00
	TOTAL	67510.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	67510.00
	2. YEARLY INVESTMENT COST RECOVERY	18440.00
	3. DEPRECIATION	19930.00
	TOTAL	105880.00

DRAFT

TABLE 185

ITEMIZED COST SUMMARY FOR ALTERNATIVE AG-IV (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
D1..CONTROL HOUSE
J...AIR FLOTATION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	362400.00
	2. LAND	62310.00
	3. ENGINEERING	36240.00
	4. CONTINGENCY	36240.00
	TOTAL	497190.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	32330.00
	3. CHEMICALS	3480.00
	4. MAINTENANCE&SUPPLIES	13620.00
	TOTAL	74420.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	74420.00
	2. YEARLY INVESTMENT COST RECOVERY	19890.00
	3. DEPRECIATION	21740.00
	TOTAL	116050.00

DRAFT

TABLE 186

ITEMIZED COST SUMMARY FOR ALTERNATIVE A6-V
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
B1..CONTROL HOUSE
J...AIR FLOTATION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	465030.00
2.	LAND	62310.00
3.	ENGINEERING	46500.00
4.	CONTINGENCY	46500.00
TOTAL		620340.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	36660.00
3.	CHEMICALS	3480.00
4.	MAINTENANCE&SUPPLIES	30940.00
TOTAL		96070.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	96070.00
2.	YEARLY INVESTMENT COST RECOVERY	24810.00
3.	DEPRECIATION	27900.00
TOTAL		148780.00

DRAFT

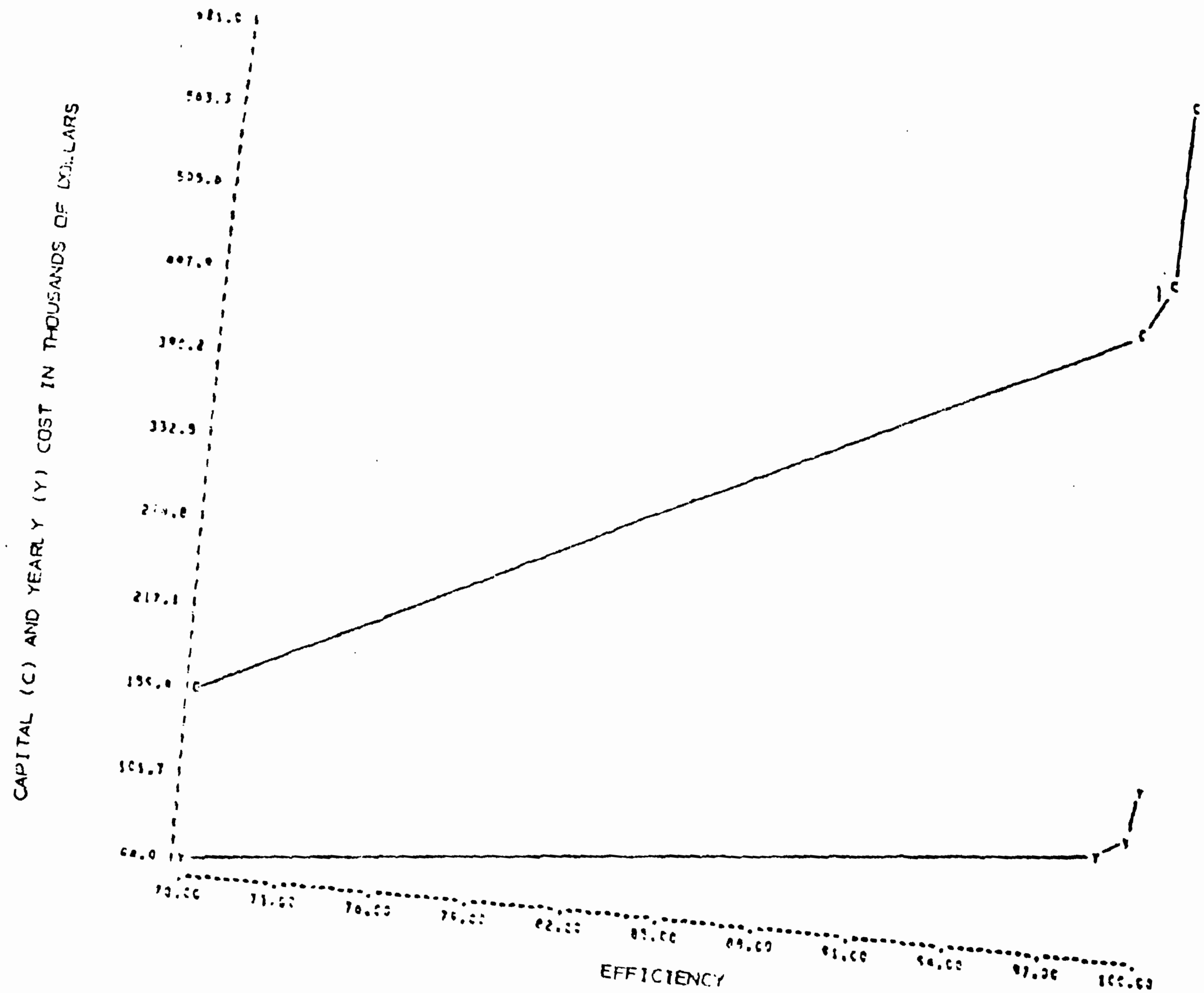


FIGURE 271

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A6, ALTERNATIVES II THRU V

<u>Alternative A 6-VI</u> - This alternative provides in addition to Alternative A 6-II (i.e., dissolved air flotation) an aerated lagoon system including a settling pond.

The resulting BOD waste load is 0.13 kg/kkg (0.27 lb/ton), the suspended solids load is 0.12 kg/kkg (0.24 lb/ton), and the oil and grease load is 0.10 kg/kkg (0.21 lb/ton).

Costs:	Total investment cost:	$374,050
	Total yearly cost:	$152,640

An itemized breakdown of costs is presented in Table 187. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	98.5 percent
	SS:	97.0 percent
	O&G:	97.0 percent

<u>Alternative A 6-VII</u> - This alternative provides in addition to Alternative A 6-VI dual media pressure filtration with a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.067 kg/kkg (0.13 lb/ton), the suspended solids load is 0.061 kg/kkg (0.12 lb/ton), and the oil and grease load is 0.023 kg/kkg (0.046 lb/ton).

Costs:	Total investment cost:	$410,300
	Total yearly cost:	$162,000

An itemized breakdown of costs is presented in Table 188. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	99.0 percent
	SS:	98.5 percent
	O&G:	99.3 percent

<u>Alternative A 6-VIII</u> - This alternative provides in addition to Alternative A 6-VII an activated carbon adsorption unit prior to final discharge.

The resulting BOD waste load is 0.035 kg/kkg (0.070 lb/ton), the suspended solids load is 0.030 kg/kkg (0.060 lb/ton), and the oil and grease load is 0.012 kg/kkg (0.024 lb/ton).

Costs:	Total investment cost:	$533,400
	Total yearly cost:	$195,540

An itemized breakdown of costs is presented in Table 189. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

DRAFT

TABLE 187

ITEMIZED COST SUMMARY FOR ALTERNATIVE A6-VI (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.7 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	300110.00
	2. LAND	5000.00
	3. ENGINEERING	30010.00
	4. CONTINGENCY	30010.00
	5. PVC LINER	8920.00
	TOTAL	374050.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	91590.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	14800.00
	5. PVC LINER	350.00
	TOTAL	119230.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	119230.00
	2. YEARLY INVESTMENT COST RECOVERY	14960.00
	3. DEPRECIATION	18450.00
	TOTAL	152640.00

DRAFT

TABLE 188

ITEMIZED COST SUMMARY FOR ALTERNATIVE A6-VII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	330320.00
2. LAND	5000.00
3. ENGINEERING	33030.00
4. CONTINGENCY	33030.00
5. PVC LINER	8920.00
TOTAL	410300.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	97920.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	15370.00
5. PVC LINER	350.00
TOTAL	126130.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	126130.00
2. YEARLY INVESTMENT COST RECOVERY	16410.00
3. DEPRECIATION	20260.00
TOTAL	162800.00

TABLE 189

ITEMIZED COST SUMMARY FOR ALTERNATIVE A6-VIII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	432960.00
2. LAND	5000.00
3. ENGINEERING	43300.00
4. CONTINGENCY	43300.00
5. PVC LINER	8920.00
TOTAL	533480.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	102250.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	32690.00
5. PVC LINER	350.00
TOTAL	147780.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	147780.00
2. YEARLY INVESTMENT COST RECOVERY	21340.00
3. DEPRECIATION	26420.00
TOTAL	195540.00

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent
O&G: 99.6 percent

A cost efficiency curve is presented in Figure 272.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 7 - Edible Oil Processing by Caustic Refining, Acidulation, Oil Processing, and Deodorization

A model plant representative of Subcategory A 7 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which refines 454 kkg (500 ton) of crude edible oil per day.

Alternative A 7-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 1147 cu m (0.303 MG) per day. The BOD waste load is 16.09 kg/kkg (32.18 lb/ton), the suspended solids load is 7.84 kg/kkg (15.68 lb/ton), and the oil and grease load is 3.93 kg/kkg (7.86 lb/ton). The model plant developed for Subcategory A 7 is assumed to have separate discharge of process and non-contact wastewater, in-plant gravity, separation, skimming, pH control, and an oil recovery system for skimmed oil and water wastes.

Costs: 0
Reduction Benefits: None

Alternative A 7-II - This alternative provides for the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

The resulting BOD waste load is 4.85 kg/kkg (9.70 lb/ton), the suspended solids load is 2.35 kg/kkg (4.70 lb/ton), and the oil and grease load is 1.13 kg/kkg (2.26 lb/ton).

Costs: Total investment cost: $193,640
Total yearly cost: $ 49,530

An itemized breakdown of costs is presented in Table 190. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 69.8 percent
SS: 70.0 percent
O&G: 71.3 percent

DRAFT

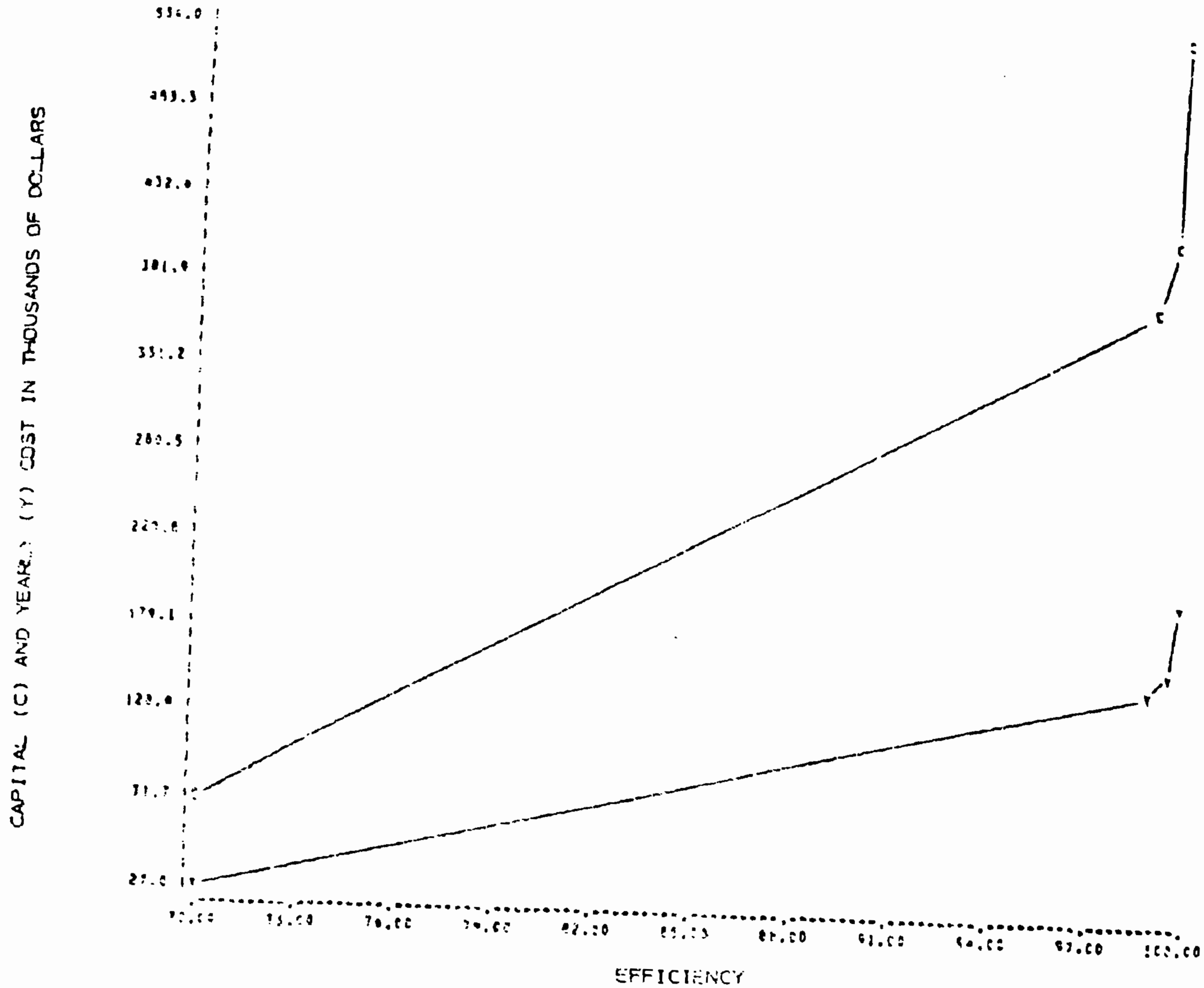


FIGURE 272

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A6, ALTERNATIVES VI THRU VIII

DRAFT

TABLE 190

ITEMIZED COST SUMMARY FOR ALTERNATIVE A7-II
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	100280.00
	2. LAND	73300.00
	3. ENGINEERING	10030.00
	4. CONTINGENCY	10030.00
	TOTAL	193640.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	3840.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	6930.00
	TOTAL	35760.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	35760.00
	2. YEARLY INVESTMENT COST RECOVERY	7750.00
	3. DEPRECIATION	6020.00
	TOTAL	49530.00

Alternative A 7-III - This alternative provides in addition to Alternative A 7-II complete mix activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every ten days. The activated sludge unit also includes a control house and two full-time operators.

The resulting BOD waste load is 0.25 kg/kkg (0.50 lb/ton), the suspended solids load is 0.25 kg/kkg (0.50 lb/ton), and the oil and grease load is 0.25 kg/kkg (0.50 lb/ton).

Costs: Total investment cost: $672,560
Total yearly cost: $151,370

An itemized breakdown of costs is presented in Table 191. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.4 percent
SS: 96.8 percent
O&G: 93.6 percent

Alternative A 7-IV - This alternative provides in addition to Alternative A 7-III dual media pressure filtration with a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.13 kg/kkg (0.25 lb/ton), the suspended solids load is 0.13 kg/kkg (0.25 lb/ton), and the oil and grease load is 0.051 kg/kkg (0.10 lb/ton).

Costs: Total investment cost: $718,630
Total yearly cost: $164,520

An itemized breakdown of costs is presented in Table 192. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.4 percent
O&G: 98.7 percent

Alternative A 7-V - This alternative provides in addition to Alternative A 7-IV activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.076 kg/kkg (0.15 lb/ton), the suspended solids load is 0.063 kg/kkg (0.13 lb/ton), and the oil and grease load is 0.025 kg/kkg (0.050 lb/ton).

Costs: Total investment cost: $1,004,970
Total yearly cost: $ 216,450

DRAFT

TABLE 191

ITEMIZED COST SUMMARY FOR ALTERNATIVE A7-III
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- C...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	499380.00
2. LAND	73300.00
3. ENGINEERING	49940.00
4. CONTINGENCY	49940.00
TOTAL	672560.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	46720.00
3. CHEMICALS	5530.00
4. MAINTENANCE&SUPPLIES	17270.00
TOTAL	94510.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	94510.00
2. YEARLY INVESTMENT COST RECOVERY	26900.00
3. DEPRECIATION	29960.00
TOTAL	151370.00

DRAFT

TABLE 192

ITEMIZED COST SUMMARY FOR ALTERNATIVE A7-IV (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- 6...PUMPING STATION
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- P...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	537770.00
2. LAND	73300.00
3. ENGINEERING	53780.00
4. CONTINGENCY	53780.00
TOTAL	718630.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	55000.00
3. CHEMICALS	5530.00
4. MAINTENANCE&SUPPLIES	17980.00
TOTAL	103500.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	103500.00
2. YEARLY INVESTMENT COST RECOVERY	28750.00
3. DEPRECIATION	32270.00
TOTAL	164520.00

An itemized breakdown of costs is presented in Table 193. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	99.5 percent
	SS:	99.2 percent
	O&G:	99.4 percent

A cost efficiency curve is presented in Figure 273.

Alternative A 7-VI - This alternative provides in addition to Alternative A 7-II an aerated lagoon and settling pond.

The resulting BOD waste load is 0.25 kg/kkg (0.50 lb/ton), the suspended solids load is 0.25 kg/kkg (0.50 lb/ton), and the oil and grease load is 0.25 kg/kkg (0.50 lb/ton).

Costs:	Total investment cost:	$607,720
	Total yearly cost:	$266, 550

An itemized breakdown of costs is presented in Table 194. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	98.4 percent
	SS:	96.8 percent
	O&G:	93.6 percent

Alternative A 7-VII - This alternative provides in addition to Alternative A 7-VI dual media pressure filtration and a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.13 kg/kkg (0.25 lb/ton), the suspended solids load is 0.13 kg/kkg (0.25 lb/ton), and the oil and grease load is 0.051 kg/kkg (0.10 lb/ton).

Costs:	Total investment cost:	$653,790
	Total yearly cost:	$279,680

An itemized breakdown of costs is presented in Table 195. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	99.2 percent
	SS:	98.4 percent
	O&G:	98.7 percent

Alternative A 7-VIII - This alternative provides in addition to Alternative A 7-VII activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.076 kg/kkg (0.15 lb/ton), the suspended solids load is 0.063 kg/kkg (0.13 lb/ton), and the oil and grease load is 0.025 kg/kkg (0.050 lb/ton).

DRAFT

TABLE 193

ITEMIZED COST SUMMARY FOR ALTERNATIVE A7-V (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	776390.00
2. LAND	73300.00
3. ENGINEERING	77640.00
4. CONTINGENCY	77640.00
TOTAL	1004970.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	63540.00
3. CHEMICALS	5530.00
4. MAINTENANCE&SUPPLIES	35610.00
TOTAL	129670.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	129670.00
2. YEARLY INVESTMENT COST RECOVERY	40200.00
3. DEPRECIATION	46580.00
TOTAL	216450.00

DRAFT

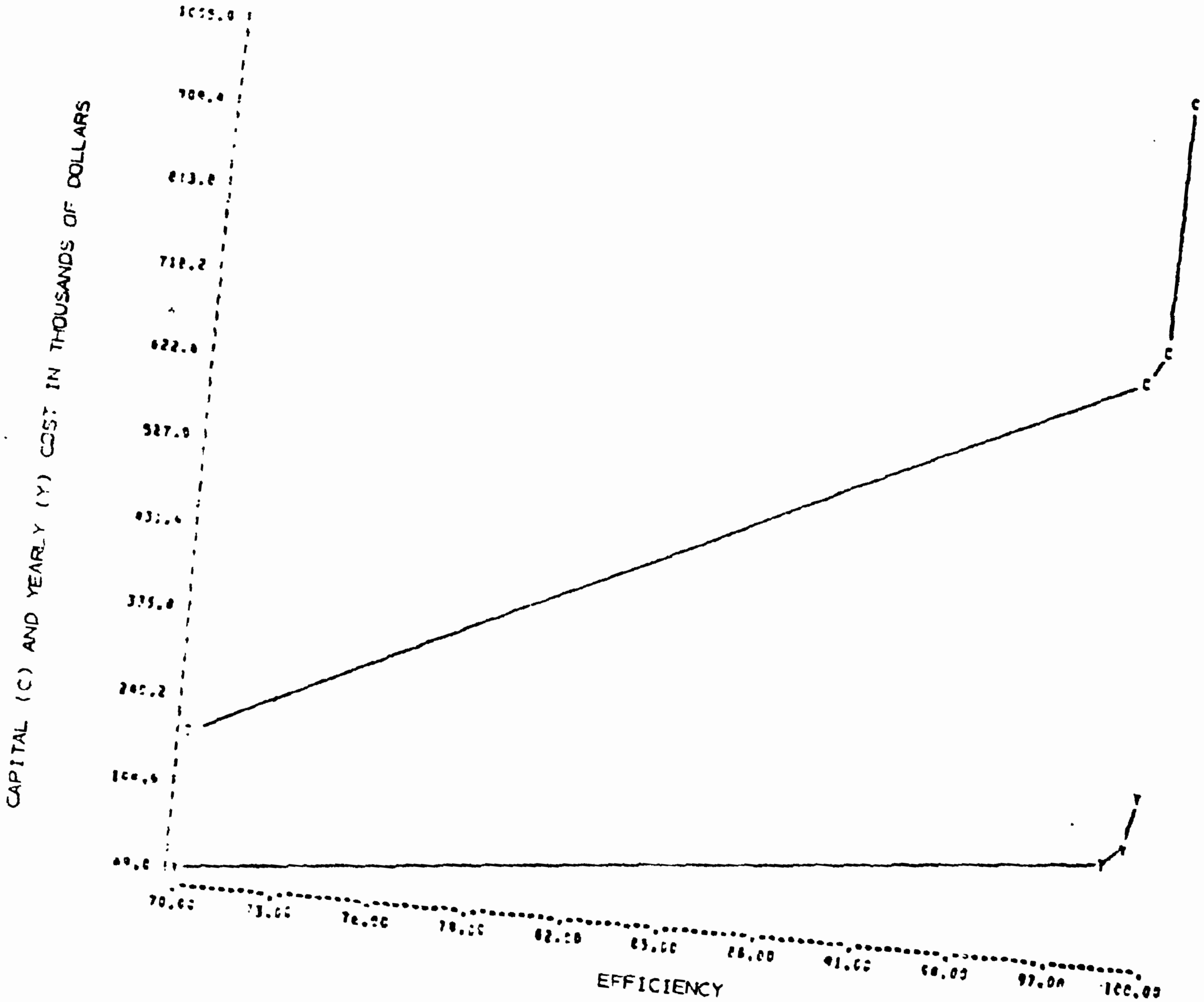


FIGURE 273

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A7, ALTERNATIVES II THRU V

DRAFT

TABLE 194

ITEMIZED COST SUMMARY FOR ALTERNATIVE A7-VI (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:
- P1..CONTROL HOUSE
- H...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	487230.00
2. LAND	6780.00
3. ENGINEERING	48720.00
4. CONTINGENCY	48720.00
5. PVC LINER	16270.00
TOTAL	607720.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	164250.00
3, CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	22210.00
5. PVC LINER	740.00
TOTAL	212190.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	212190.00
2. YEARLY INVESTMENT COST RECOVERY	24310.00
3. DEPRECIATION	30050.00
TOTAL	266550.00

DRAFT

TABLE 195

ITEMIZED COST SUMMARY FOR ALTERNATIVE A7-VII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:
- B1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	525620.00
	2. LAND	6780.00
	3. ENGINEERING	52560.00
	4. CONTINGENCY	52560.00
	5. PVC LINER	16270.00
	TOTAL	653790.00
YEARLY OPERATING COSTS:		
	1. LABOR	24490.00
	2. POWER	172530.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	[illegible]
	5. PVC LINER	740.00
	TOTAL	221180.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	221180.00
	2. YEARLY INVESTMENT COST RECOVERY	26150.00
	3. DEPRECIATION	32350.00
	TOTAL	279680.00

Costs: Total investment cost: $940,130
Total yearly cost: $331,620

An itemized breakdown of costs is presented in Table 196. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD. 99.5 percent
SS: 99.2 percent
O&G: 99.4 percent

A cost efficiency curve is presented in Figure 274.

<u>Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 8 - Edible Oil Processing by Caustic Refining, Oil Processing, and Deodorization</u>

A model plant representative of Subcategory A 8 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which refines 454 kkg (500 ton) of crude edible oil per day.

<u>Alternative A 8-I</u> - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 927 cu m (0.245 MG) per day. The BOD waste load is 11.73 kg/kkg (23.46 lb/ton), the suspended solids load is 6.30 kg/kkg (12.60 lb/ton), and the oil and grease load is 2.81 kg/kkg (5.62 lb/ton). The model plant developed for Subcategory A 8 is assumed to have separate discharge of process and non-contact wastewaters, in-plant gravity separation, skimming, pH control, and an oil recovery system for the skimmed oil and water wastes.

Costs: 0
Reduction Benefits: None

<u>Alternative A 8-II</u> - This alternative provides pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

The resulting BOD waste load is 3.[illegible] kg/kkg (7.66 lb/ton), the suspended solids load is 1.90 kg/kkg (3.8 lb/ton), and the oil and grease load is 0.86 kg/kkg (1.72 lb/ton).

Costs: Total investment cost: $192,460
Total yearly cost: $ 49,060

An itemized breakdown of costs is presented in Table 197. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

DRAFT

TABLE 196

ITEMIZED COST SUMMARY FOR ALTERNATIVE A7-VIII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	764240.00
2.	LAND	6780.00
3.	ENGINEERING	76420.00
4.	CONTINGENCY	76420.00
5.	PVC LINER	16270.00
	TOTAL	940130.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	181070.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	40540.00
5.	PVC LINER	700.00
	TOTAL	247340.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	247340.00
2.	YEARLY INVESTMENT COST RECOVERY	37610.00
3.	DEPRECIATION	46670.00
	TOTAL	331620.00

903

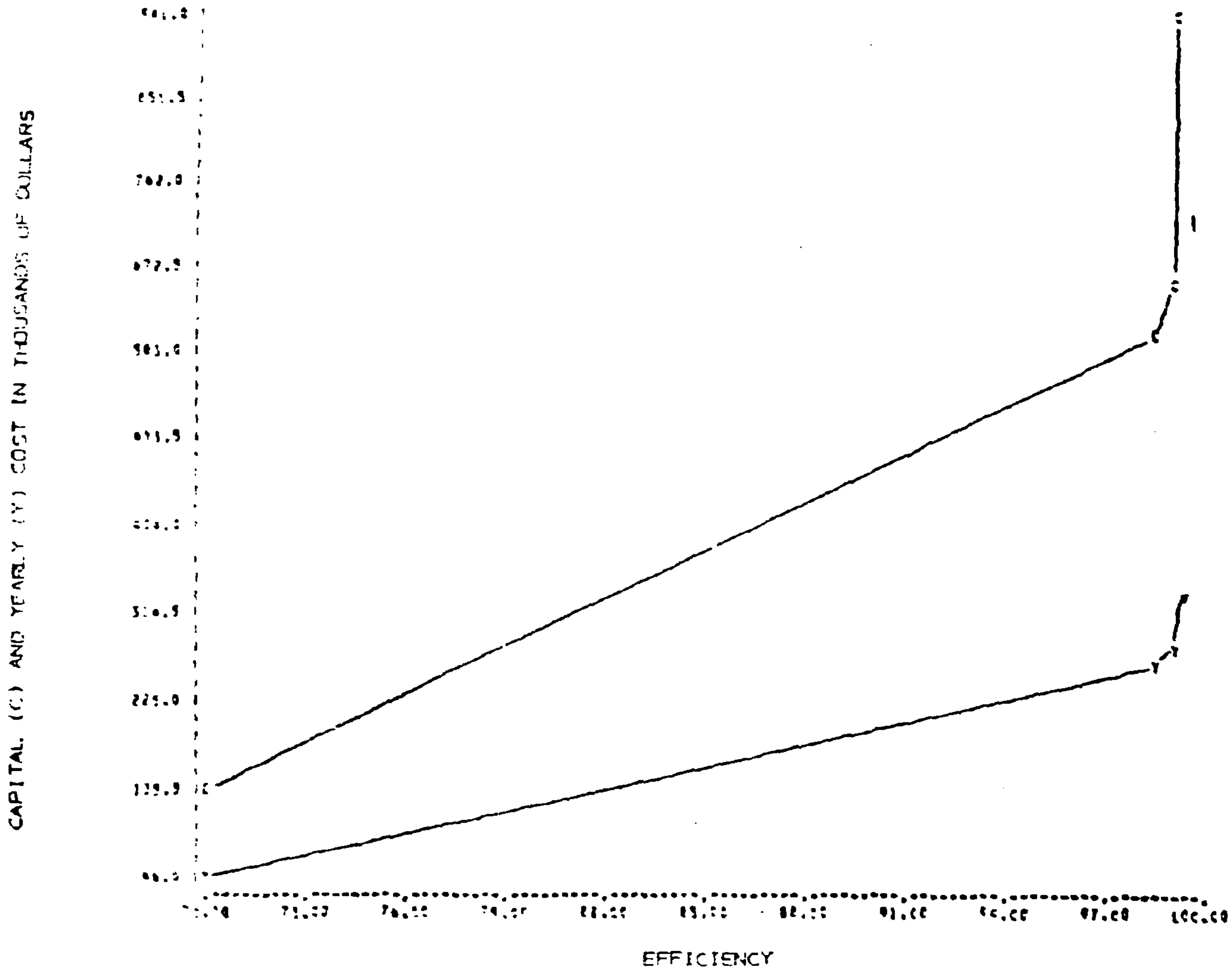


FIGURE 274

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A7 ALTERNATIVES VI THRU VIII

DRAFT

TABLE 197

ITEMIZED COST SUMMARY FOR ALTERNATIVE A8-II
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	102070.00
2. LAND	69970.00
3. ENGINEERING	10210.00
4. CONTINGENCY	10210.00
TOTAL	192460.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	3310.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	6940.00
TOTAL	35240.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	35240.00
2. YEARLY INVESTMENT COST RECOVERY	7700.00
3. DEPRECIATION	6120.00
TOTAL	49060.00

Reduction Benefits:	BOD:	69.9 percent
	SS:	69.8 percent
	O&G:	69.4 percent

Alternative A 8-III - This alternative provides in addition to Alternative A 8-II complete mix activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every seven days. The activated sludge unit also includes a control house and two full-time operators.

The resulting BOD waste load is 0.20 kg/kkg (0.41 lb/ton), the suspended solids load is 0.20 kg/kkg (0.41 lb/ton), and the oil and grease load is 0.10 kg/kkg (0.20 lb/ton).

Costs:	Total investment cost:	$585,720
	Total yearly cost:	$128,180

An itemized breakdown of costs is presented in Table 198. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	98.3 percent
	SS:	96.8 percent
	O&G:	96.4 percent

Alternative A 8-IV - This alternative provides in addition to Alternative A 8-III dual media pressure filtration with a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.10 kg/kkg (0.20 lb/ton), the suspended solids load is 0.10 kg/kkg (0.20 lb/ton), and the oil and grease load is 0.041 kg/kkg (0.082 lb/ton).

Costs:	Total investment cost:	$628,590
	Total yearly cost:	$140,210

An itemized breakdown of costs is presented in Table 199. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	99.1 percent
	SS:	98.4 percent
	O&G:	98.2 percent

Alternative A 8-V - This alternative provides in addition to Alternative A 8-IV activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.051 kg/kkg (0.10 lb/ton), the suspended solids load is 0.051 kg/kkg (0.10 lb/ton), and the oil and grease load is 0.020 kg/kkg (0.040 lb/ton).

DRAFT

TABLE 198

ITEMIZED COST SUMMARY FOR ALTERNATIVE A8-III
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.3 PERCENT BOD REDUCTION

TREATMENT MODULES:
- 21..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- Y...HOLDING TANK
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	429790.00
2. LAND	69970.00
3. ENGINEERING	42980.00
4. CONTINGENCY	42980.00
TOTAL	585720.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	34590.00
3. CHEMICALS	4100.00
4. MAINTENANCE&SUPPLIES	15220.00
TOTAL	78960.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	78960.00
2. YEARLY INVESTMENT COST RECOVERY	23430.00
3. DEPRECIATION	25790.00
TOTAL	128180.00

DRAFT

TABLE 199

ITEMIZED COST SUMMARY FOR ALTERNATIVE A8-IV (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- Y...HOLDING TANK
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	465520.00
2. LAND	69970.00
3. ENGINEERING	46550.00
4. CONTINGENCY	46550.00
TOTAL	628590.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	42110.00
3. CHEMICALS	4100.00
4. MAINTENANCE&SUPPLIES	15940.00
TOTAL	87140.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	87140.00
2. YEARLY INVESTMENT COST RECOVERY	25140.00
3. DEPRECIATION	27930.00
TOTAL	140210.00

Costs: Total investment cost: $856,530
Total yearly cost: $183,240

An itemized breakdown of costs is presented in Table 200. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.3 percent

A cost efficiency curve is presented in Figure 275.

Alternative A 8-VI - This alternative provides in addition to Alternative A 8-II (i.e., dissolved air flotation) an aerated lagoon including a settling pond.

The resulting BOD waste load is 0.20 kg/kkg (0.41 lb/ton), the suspended solids load is 0.20 kg/kkg (0.41 lb/ton), and the oil and grease load is 0.10 kg/kkg (0.20 lb/ton).

Costs: Total investment cost: $488,440
Total yearly cost: $206,100

An itemized breakdown of costs is presented in Table 201. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.3 percent
SS: 96.8 percent
O&G: 96.4 percent

Alternative A 8-VII - This alternative provides in addition to Alternative A 8-VI dual media pressure filtration with a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.10 kg/kkg (0.20 lb/ton), the suspended solids load is 0.10 kg/kkg (0.20 lb/ton), and the oil and grease load is 0.041 kg/kkg (0.082 lb/ton).

Costs: Total investment cost: $531,310
Total yearly cost: $218,140

An itemized breakdown of costs is presented in Table 202. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.1 percent
SS: 98.4 percent
O&G: 98.5 percent

DRAFT

TABLE 200

ITEMIZED COST SUMMARY FOR ALTERNATIVE A8-V (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
Y...HOLDING TANK
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
I...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	655460.00
2. LAND	69970.00
3. ENGINEERING	65550.00
4. CONTINGENCY	65550.00
TOTAL	856530.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	49140.00
3. CHEMICALS	4100.00
4. MAINTENANCE&SUPPLIES	31420.00
TOTAL	109650.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	109650.00
2. YEARLY INVESTMENT COST RECOVERY	34260.00
3. DEPRECIATION	39330.00
TOTAL	183240.00

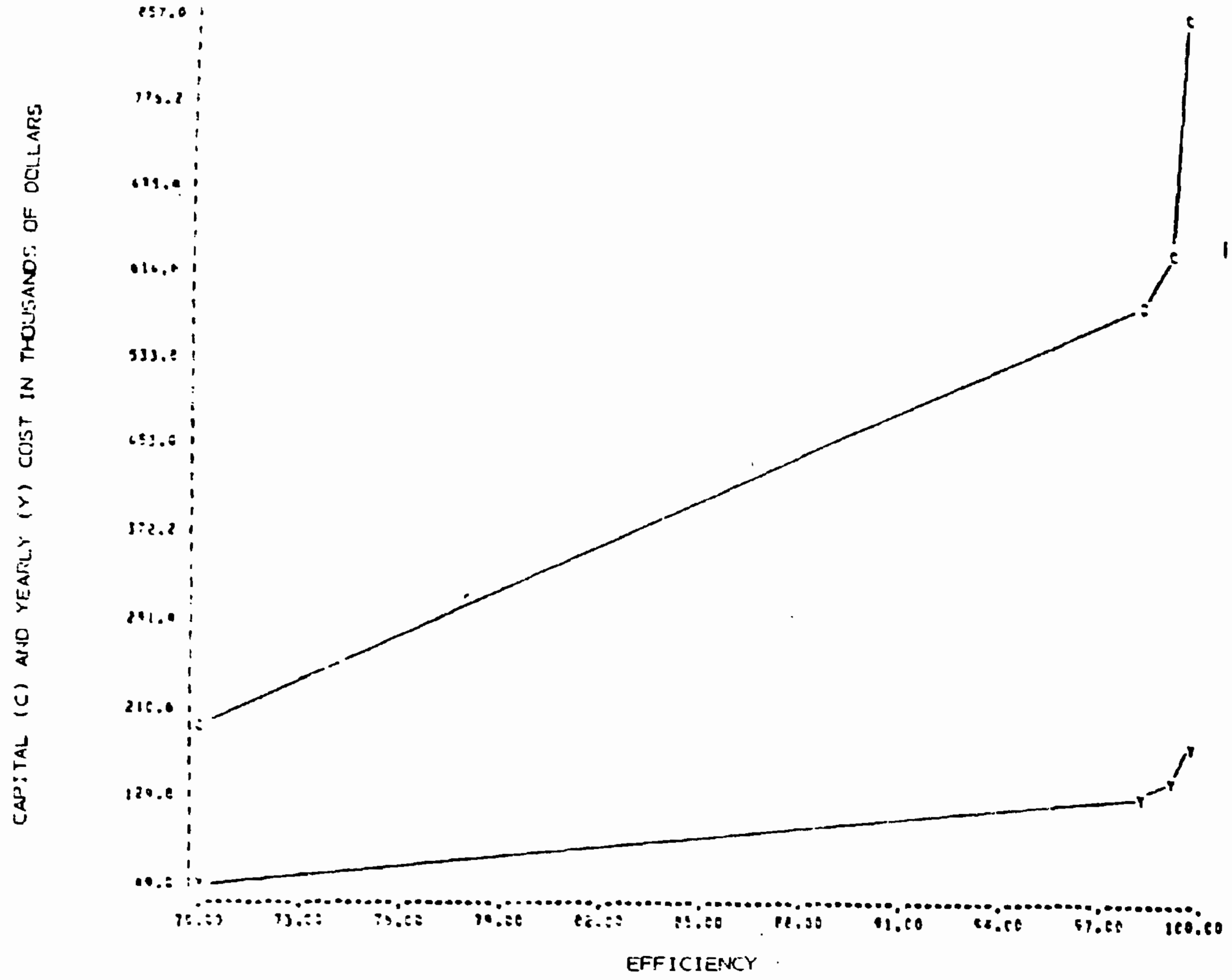


FIGURE 275

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A8, ALTERNATIVES II THRU V

DRAFT

TABLE 201

ITEMIZED COST SUMMARY FOR ALTERNATIVE AB-VI
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON

INVESTMENT COSTS:	
1. CONSTRUCTION	391870.00
2. LAND	6000.00
3. ENGINEERING	39190.00
4. CONTINGENCY	39190.00
5. PVC LINER	12190.00
TOTAL	488440.00
YEARLY OPERATING COSTS:	
1. LABOR	24990.00
2. POWER	119100.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	17750.00
5. PVC LINER	600.00
TOTAL	162440.00
TOTAL YEARLY COSTS:	
1. YEARLY OPERATING COST	162440.00
2. YEARLY INVESTMENT COST RECOVERY	19540.00
3. DEPRECIATION	24120.00
TOTAL	206100.00

DRAFT

TABLE 202

ITEMIZED COST SUMMARY FOR ALTERNATIVE A8-VII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	427600.00
2.	LAND	6000.00
3.	ENGINEERING	42760.00
4.	CONTINGENCY	42760.00
5.	PVC LINER	12190.00
	TOTAL	531310.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	126620.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	18410.00
5.	PVC LINER	600.00
	TOTAL	170620.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	170620.00
2.	YEARLY INVESTMENT COST RECOVERY	21250.00
3.	DEPRECIATION	26270.00
	TOTAL	218140.00

DRAFT

Alternative A 8-VIII - This alternative provides in addition to Alternative A 8-VII activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.051 kg/kkg (0.10 lb/ton), the suspended solids load is 0.051 kg/kkg (0.10 lb/ton), and the oil and grease load is 0.020 kg/kkg (0.040 lb/ton).

Costs:	Total investment cost:	$759,220
	Total yearly cost:	$263,200

An itemized breakdown of costs is presented in Table 203. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	99.6 percent
	SS:	99.2 percent
	O&G:	99.3 percent

A cost efficiency curve is presented in Figure 276.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 9 - Edible Oil Processing by Caustic Refining, Acidulation, Oil Processing, Deodorization, and Shortening and Table Oil Processing

A model plant representative of Subcategory A 9 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which refines 454 kkg (500 ton) of crude edible oil per day.

Alternative A 9-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 1320 cu m (0.349 MG) per day. The BOD waste load is 17.12 kkg (34.24 lb/ton), the suspended solids load is 8.68 kg/kkg (17.36 lb/ton), and the oil and grease load is 4.35 kg/kkg (8.70 lb/ton).

The model plant developed for Subcategory A 9 is assumed to have separate discharge of process and non-contact wastewaters, in-plant gravity separation and skimming, pH control, and an oil recovery system for reclaimation of waste oil and grease skimmings.

Cost:	0
Reduction Benefits:	None

Alternative A 9-II - This alternative provides the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

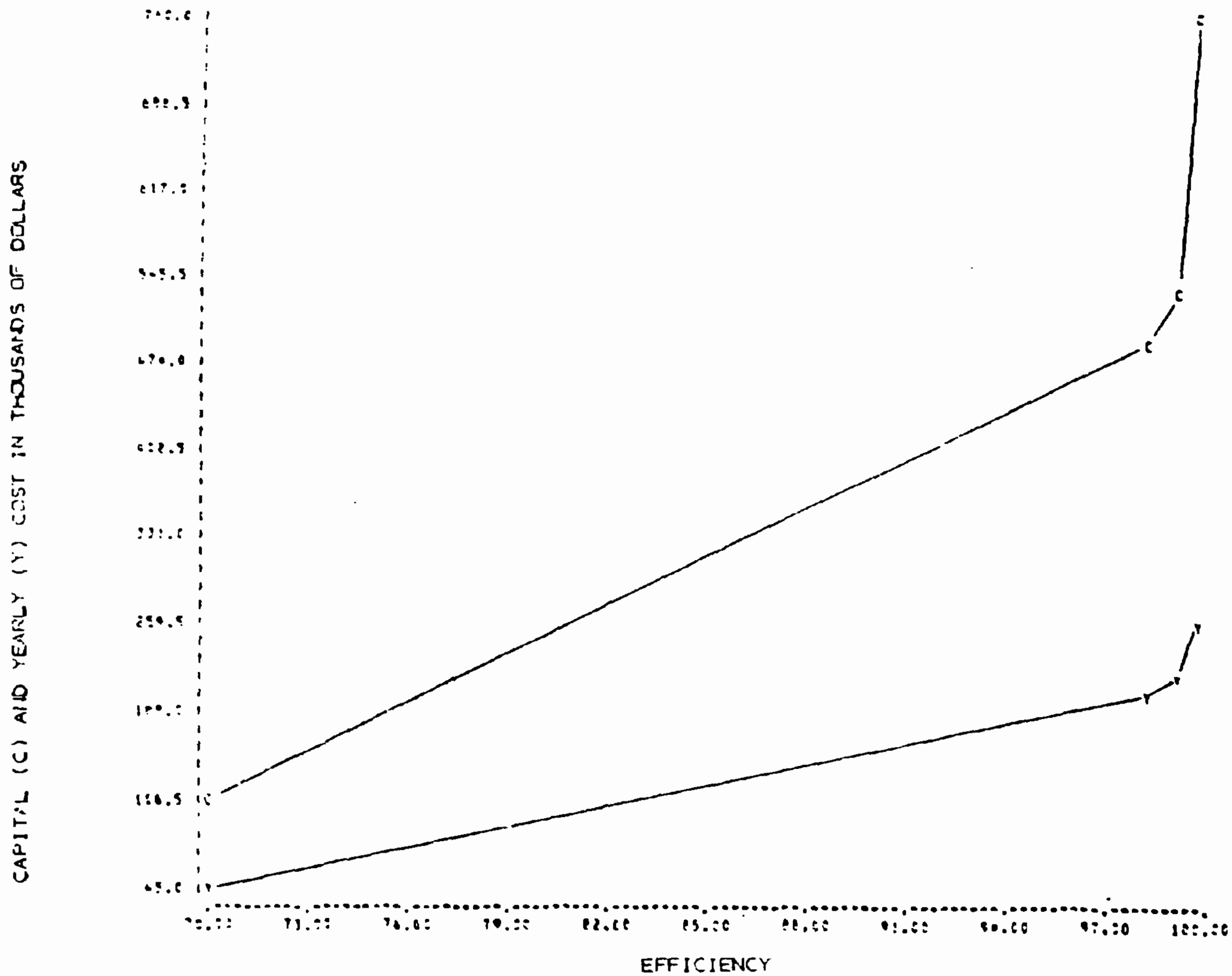


FIGURE 276

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A8, ALTERNATIVES II AND VI THRU VII

DRAFT

TABLE 203

ITEMIZED COST SUMMARY FOR ALTERNATIVE A8-VIII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
P...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:		
	1. CONSTRUCTION	617530.00
	2. LAND	6000.00
	3. ENGINEERING	61750.00
	4. CONTINGENCY	61750.00
	5. PVC LINER	12190.00
	TOTAL	759220.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	133650.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	35930.00
	5. PVC LINER	600.00
	TOTAL	195170.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	195170.00
	2. YEARLY INVESTMENT COST RECOVERY	30370.00
	3. DEPRECIATION	37660.00
	TOTAL	263200.00

The resulting BOD waste load is 5.15 kg/kkg (10.30 lb/ton), the suspended solids load is 2.62 kg/kkg (5.24 lb/ton), and the oil and grease load is 1.31 kg/kkg (2.62 lb/ton).

Costs: Total investment cost: $201,480
Total yearly cost: $ 50,560

An itemized breakdown of costs is presented in Table 204. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 70.0 percent
SS: 70.0 percent
O&G: 70.0 percent

Alternative A 9-III - This alternative provides in addition to Alternative A 9-II complete mix activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every nine days. The activated sludge unit also includes a control house and two full-time operators.

The resulting BOD waste load is 0.26 kg/kkg (0.52 lb/ton), the suspended solids load is 0.26 kg/kkg (0.52 lb/ton), and the oil and grease load is 0.13 kg/kkg (0.26 lb/ton).

Costs: Total investment cost: $694,590
Total yearly cost: $157,600

An itemized breakdown of costs is presented in Table 205. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 97.0 percent
O&G: 97.0 percent

Alternative A 9-IV - This alternative provides with the addition of Alternative A 9-III dual media pressure filtration with a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.13 kg/kkg (0.26 lb/ton), the suspended solids load is 0.13 kg/kkg (0.26 lb/ton), and the oil and grease load is 0.058 kg/kkg (0.12 lb/ton).

Costs: Total investment cost: $743,140
Total yearly cost: $171,620

An itemized breakdown of costs is presented in Table 206. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

TABLE 204

ITEMIZED COST SUMMARY FOR ALTERNATIVE A9-II (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION

INVESTMENT COSTS:

1.	CONSTRUCTION	104050.00
2.	LAND	76630.00
3.	ENGINEERING	10400.00
4.	CONTINGENCY	10400.00
TOTAL		201480.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	4250.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	7020.00
TOTAL		36260.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	36260.00
2. YEARLY INVESTMENT COST RECOVERY	8060.00
3. DEPRECIATION	6240.00
TOTAL	50560.00

DRAFT

TABLE 205

ITEMIZED COST SUMMARY FOR ALTERNATIVE A9-III
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:

1.	CONSTRUCTION	514960.00
2.	LAND	76630.00
3.	ENGINEERING	51500.00
4.	CONTINGENCY	51500.00
TOTAL		694590.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	50340.00
3.	CHEMICALS	5830.00
4.	MAINTENANCE&SUPPLIES	17760.00
TOTAL		98920.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	98920.00
2.	YEARLY INVESTMENT COST RECOVERY	27780.00
3.	DEPRECIATION	30900.00
TOTAL		157600.00

TABLE 206

ITEMIZED COST SUMMARY FOR ALTERNATIVE A9-IV
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	555430.00
2. LAND	76630.00
3. ENGINEERING	55540.00
4. CONTINGENCY	55540.00
TOTAL	743140.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	59230.00
3. CHEMICALS	5830.00
4. MAINTENANCE&SUPPLIES	18510.00
TOTAL	108560.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	108560.00
2. YEARLY INVESTMENT COST RECOVERY	29730.00
3. DEPRECIATION	33330.00
TOTAL	171620.00

Reduction Benefits: BOD: 99.2 percent
SS: 98.5 percent
O&G: 98.6 percent

Alternative A 9-V - This alternative provides with the addition of Alternative A 9-IV activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.073 kg/kkg (0.15 lb/ton), the suspended solids load is 0.073 kg/kkg (0.15 lb/ton), and the oil and grease load is 0.029 kg/kkg (0.058 lb/ton).

Costs: Total investment cost: $1,075,830
Total yearly cost: $ 229,000

An itemized breakdown of costs is presented in Table 207. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.3 percent

A cost efficiency curve is presented in Figure 277.

Alternative A 9-VI - This alternative provides in addition to Alternative A 9-II (i.e., dissolved air flotation) an aerated lagoon system including a settling pond.

The resulting BOD waste load is 0.26 kg/kkg (0.52 lb/ton), the suspended solids load is 0.26 kg/kkg (0.52 lb/ton), and the oil and grease load is 0.13 kg/kkg (0.26 lb/ton).

Costs: Total investment cost: $684,150
Total yearly cost: $305,590

An itemized breakdown of costs is presented in Table 208. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 97.0 percent
O&G: 97.0 percent

Alternative A 9-VII - This alternative provides with the addition of Alternative A 9-VI dual media pressure filtration with a pump station to generate a sufficient head for filter operation.

The resulting BOD waste load is 0.13 kg/kkg (0.26 lb/ton), the suspended solids load is 0.13 kg/kkg (0.26 lb/ton), and the oil and grease load is 0.058 kg/kkg (0.13 lb/ton).

DRAFT

TABLE 207

ITEMIZED COST SUMMARY FOR ALTERNATIVE A9-V
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
F...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	832660.00
2.	LAND	76630.00
3.	ENGINEERING	83270.00
4.	CONTINGENCY	83270.00
TOTAL		1075830.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	68970.00
3.	CHEMICALS	5830.00
4.	MAINTENANCE&SUPPLIES	36220.00
TOTAL		136010.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	136010.00
2.	YEARLY INVESTMENT COST RECOVERY	43030.00
3.	DEPRECIATION	49960.00
TOTAL		229000.00

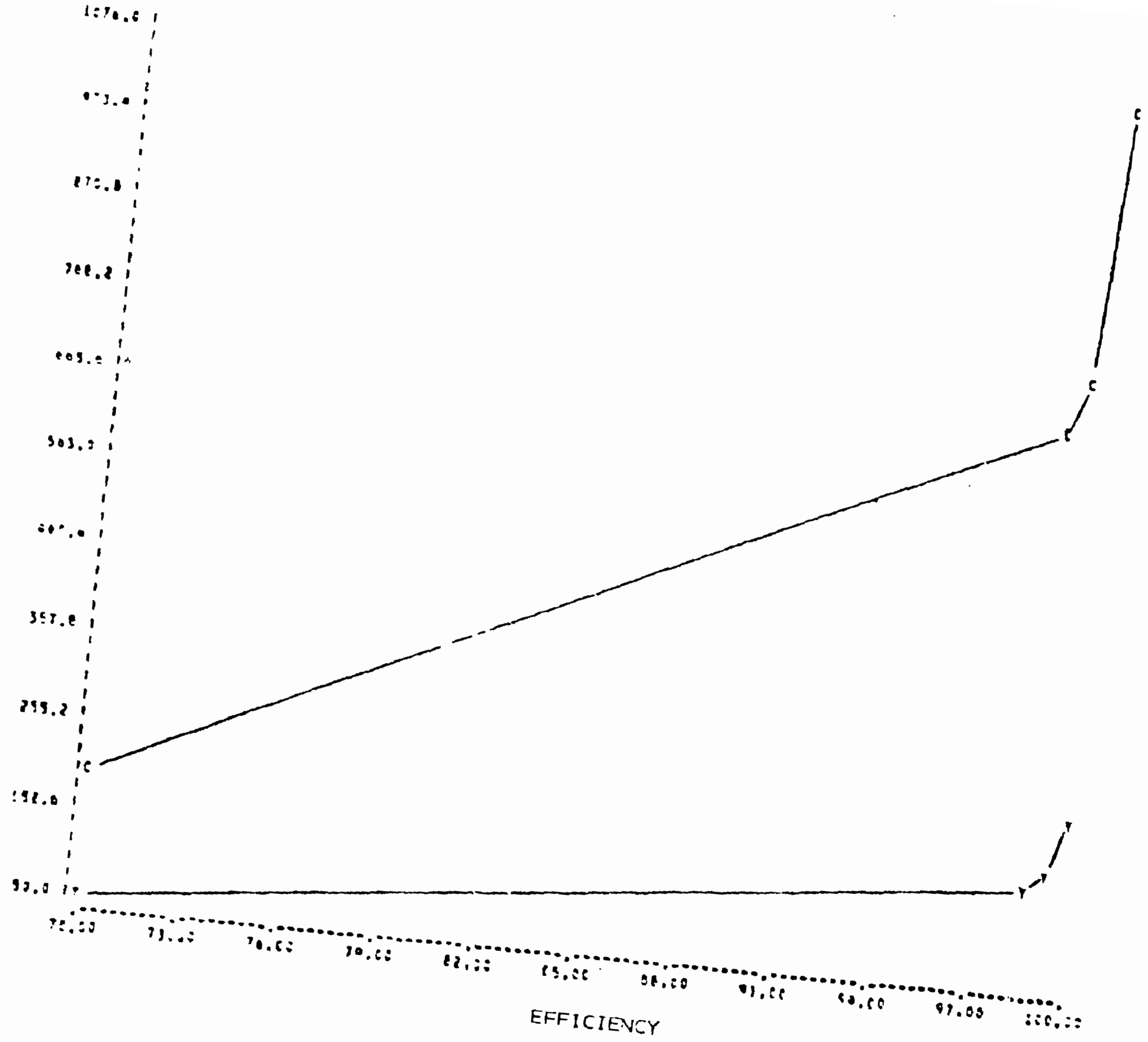


FIGURE 277

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A9, ALTERNATIVES II THROUGH V

DRAFT

TABLE 208

ITEMIZED COST SUMMARY FOR ALTERNATIVE A9-VI
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	547730.00
2. LAND	7830.00
3. ENGINEERING	54770.00
4. CONTINGENCY	54770.00
5. PVC LINER	19050.00
TOTAL	684150.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	193820.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	24730.00
5. PVC LINER	860.00
TOTAL	244400.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	244400.00
2. YEARLY INVESTMENT COST RECOVERY	27370.00
3. DEPRECIATION	33820.00
TOTAL	305590.00

DRAFT

Costs: Total investment cost: $732,710
Total yearly cost: $319,590

An itemized breakdown of costs is presented in Table 209. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.5 percent
O&G: 98.6 percent

Alternative A 9-VIII - This alternative provides in addition to Alternative A 9-VII activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.073 kg/kkg (0.15 lb/ton), the suspended solids load is 0.073 kg/kkg (0.15 lb/ton), and the oil and grease load is 0.029 kg/kkg (0.058 lb/ton).

Costs: Total investment cost: $1,065,380
Total yearly cost: $ 376,990

An itemized breakdown of costs is presented in Table 210. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.3 percent

A cost efficiency curve is presented in Figure 278.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 10, Edible Oil Production by Caustic Refining, Oil Process, Deodorization, and Shortening and Table Oil Production

A model plant representative of Subcategory A 10 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which refines 454 kkg (500 ton) of crude edible oil per day.

Alternative A 10-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 1101 cu m (0.291 MG) per day. The BOD waste load is 12.76 kg/kkg (25.52 lb/ton), the suspended solids load is 7.14 kg/kkg (14.28 lb/ton), and the oil and grease load is 3.23 kg/kkg (6.46 lb/ton).

The model plant developed for Subcategory A 10 is assumed to have separate discharge of process and non-contact wastewaters, in-plant gravity

DRAFT

TABLE 209

ITEMIZED COST SUMMARY FOR ALTERNATIVE A9-VII (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	588190.00
	2. LAND	7630.00
	3. ENGINEERING	58820.00
	4. CONTINGENCY	58820.00
	5. PVC LINER	19050.00
	TOTAL	732710.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	202720.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	25470.00
	5. PVC LINER	860.00
	TOTAL	254040.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	254040.00
	2. YEARLY INVESTMENT COST RECOVERY	29310.00
	3. DEPRECIATION	36240.00
	TOTAL	319590.00

DRAFT

TABLE 210

ITEMIZED COST SUMMARY FOR ALTERNATIVE A9-VIII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	865420.00
2.	LAND	7830.00
3.	ENGINEERING	86540.00
4.	CONTINGENCY	86540.00
5.	PVC LINER	19050.00
TOTAL		1065380.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	212450.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	43190.00
5.	PVC LINER	860.00
TOTAL		281490.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	281490.00
2.	YEARLY INVESTMENT COST RECOVERY	42620.00
3.	DEPRECIATION	52880.00
TOTAL		376990.00

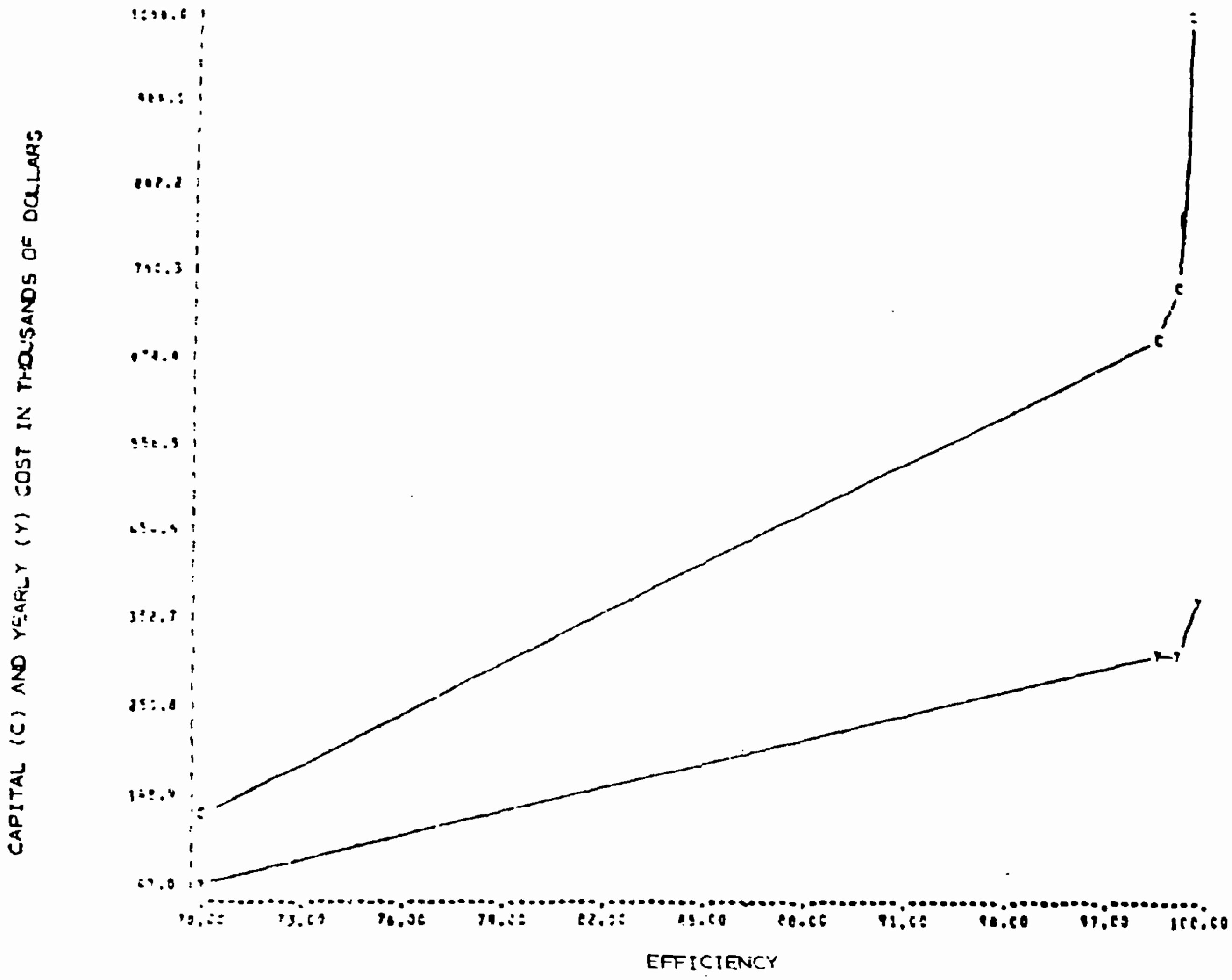


FIGURE 278

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A9, ALT. II AND VI THROUGH VIII separation and skimming, pH control, and an oil recovery system for reclamation of waste oil and grease skimmings.

Costs: 0
Reduction Benefits: None

Alternative A 10-II - This alternative provides for the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclaimation system for dewatering, and recovery of inedible oils.

The resulting BOD waste load is 3.82 kg/kkg (7.64 lb/ton), the suspended solids load is 2.18 kg/kkg (4.36 lb/ton), and the oil and grease load is 0.95 kg/kkg (1.89 lb/ton).

Costs: Total investment cost: $191,780
Total yearly cost: $ 49,200

An itemized breakdown of costs is presented in Table 211. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 70.0 percent
SS: 69.5 percent
O&G: 70.0 percent

Alternative A 10-III - This alternative provides in addition to Alternative A 10-II, complete mix activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every six days. The activated sludge unit also includes a control house and two full-time operators.

The resulting BOD waste load is 0.19 kg/kkg (0.39 lb/ton), the suspended solids load is 0.22 kg/kkg (0.44 lb/ton), and the oil and grease load is 0.097 kg/kkg (0.19 lb/ton).

Costs: Total investment cost: $600,850
Total yearly cost: $133,730

An itemized breakdown of costs is presented in Table 212. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 96.9 percent
O&G: 97.0 percent

Alternative A 10-IV - This alternative provides in addition to Alternative A 10-III dual media pressurized filtration with a pump station to generate sufficient head for filter operation.

DRAFT

TABLE 211

ITEMIZED COST SUMMARY FOR ALTERNATIVE A10-II (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION

INVESTMENT COSTS:

1. CONSTRUCTION	98740.00
2. LAND	73300.00
3. ENGINEERING	9870.00
4. CONTINGENCY	9870.00
TOTAL	191780.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	3730.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	6890.00
TOTAL	35610.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	35610.00
2. YEARLY INVESTMENT COST RECOVERY	7670.00
3. DEPRECIATION	5920.00
TOTAL	49200.00

DRAFT

TABLE 212

ITEMIZED COST SUMMARY FOR ALTERNATIVE A10-III
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- E1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	439630.00
2. LAND	73300.00
3. ENGINEERING	43960.00
4. CONTINGENCY	43960.00
TOTAL	600850.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	38380.00
3. CHEMICALS	4340.00
4. MAINTENANCE&SUPPLIES	15610.00
TOTAL	83320.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	83320.00
2. YEARLY INVESTMENT COST RECOVERY	24030.00
3. DEPRECIATION	26380.00
TOTAL	133730.00

The resulting BOD waste load is 0.097 kg/kkg (0.19 lb/ton), the suspended solids load is 0.11 kg/kkg (0.22 lb/ton), and the oil and grease load is 0.048 kg/kkg (0.096 lb/ton).

Costs: Total investment cost: $646,270
Total yearly cost: $146,640

An itemized breakdown of costs is presented in Table 213. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.5 percent
O&G: 98.5 percent

Alternative A 10-V - This alternative provides in addition to Alternative A 10-IV activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.048 kg/kkg (0.096 lb/ton), the suspended solids load is 0.056 kg/kkg (0.11 lb/ton), and the oil and grease load is 0.024 kg/kkg (0.048 lb/ton).

Costs: Total investment cost: $919,530
Total yearly cost: $199,530

An itemized breakdown of costs is presented in Table 214. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.2 percent

A cost efficiency curve is presented in Figure 279.

Alternative A 10-VI - This alternative provides in addition to Alternative A 10-II (i.e., dissolved air flotation) an aerated lagoon and a settling pond

The resulting BOD waste load is 0.19 kg/kkg (0.39 lb/ton), the suspended solids load is 0.22 kg/kkg (0.44 lb/ton), and the oil and grease load is 0.097 kg/kkg (0.19 lb/ton).

Costs: Total investment cost: $600,480
Total yearly cost: $262,740

An itemized breakdown of costs is presented in Table 215. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

DRAFT

TABLE 213

ITEMIZED COST SUMMARY FOR ALTERNATIVE A10-IV (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	477470.00
2.	LAND	73300.00
3.	ENGINEERING	47750.00
4.	CONTINGENCY	47750.00
	TOTAL	646270.00

YEARLY OPERATING COSTS:

1.	LABOR	24090.00
2.	POWER	46500.00
3.	CHEMICALS	4340.00
4.	MAINTENANCE&SUPPLIES	16310.00
	TOTAL	92140.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	92140.00
2.	YEARLY INVESTMENT COST RECOVERY	25850.00
3.	DEPRECIATION	28650.00
	TOTAL	146640.00

DRAFT

TABLE 214

ITEMIZED COST SUMMARY FOR ALTERNATIVE A10-V
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
C...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	705190.00
2.	LAND	73300.00
3.	ENGINEERING	70520.00
4.	CONTINGENCY	70520.00
TOTAL		919530.00

YEARLY OPERATING COSTS:

1.	LABOR	27490.00
2.	POWER	54700.00
3.	CHEMICALS	4340.00
4.	MAINTENANCE&SUPPLIES	33910.00
TOTAL		120440.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	120440.00
2.	YEARLY INVESTMENT COST RECOVERY	36780.00
3.	DEPRECIATION	42310.00
TOTAL		199530.00

934

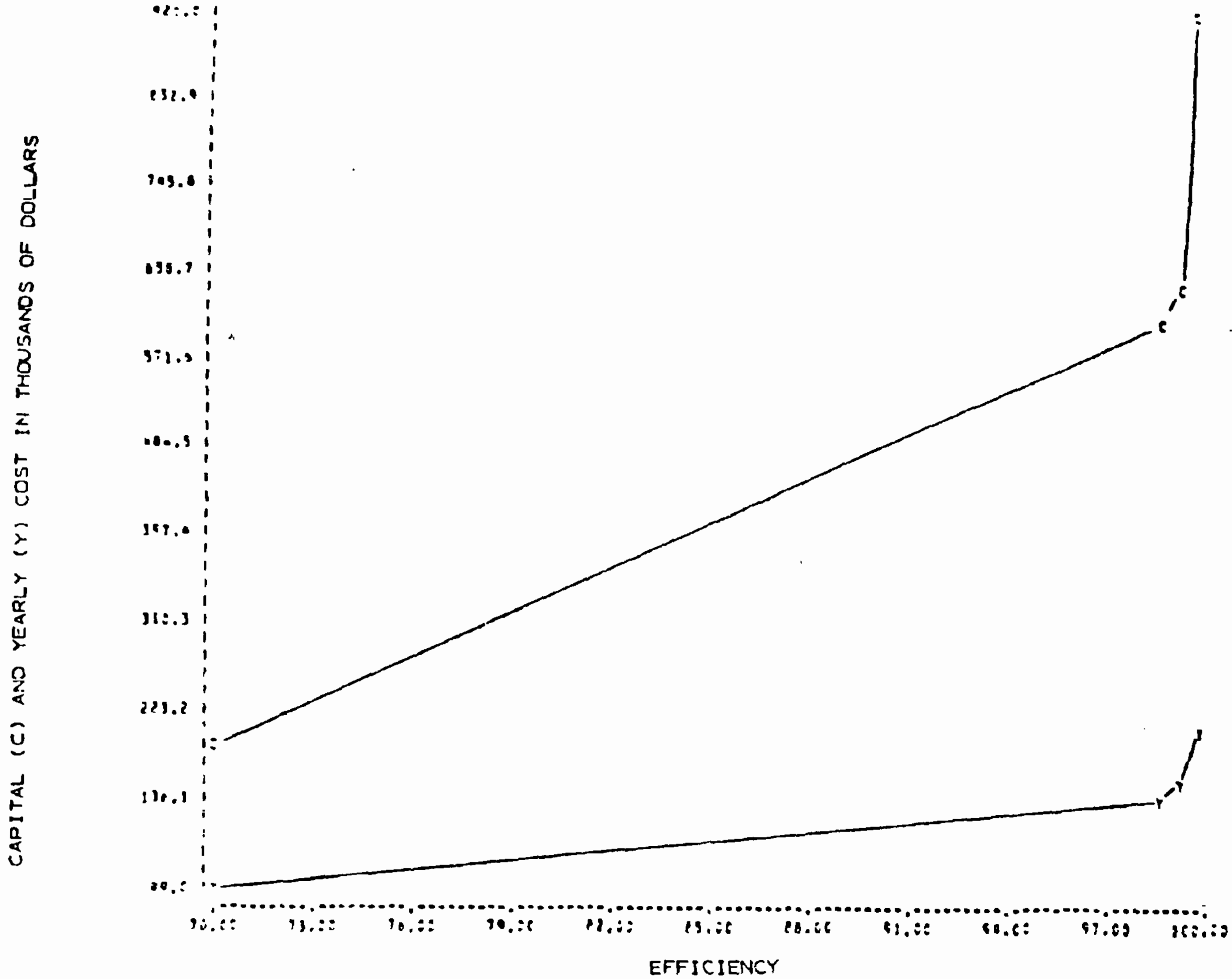


FIGURE 279

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A10, ALT. II THROUGH V

DRAFT

TABLE 215

ITEMIZED COST SUMMARY FOR ALTERNATIVE A10-VI (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- P...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	481230.00
2. LAND	7000.00
3. ENGINEERING	48120.00
4. CONTINGENCY	48120.00
5. PVC LINER	16010.00
TOTAL	600480.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	161970.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	21380.00
5. PVC LINER	710.00
TOTAL	209050.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	209050.00
2. YEARLY INVESTMENT COST RECOVERY	24020.00
3. DEPRECIATION	29670.00
TOTAL	262740.00

DRAFT

Reduction Benefits: BOD: 98.5 percent
SS: 96.9 percent
O&G: 97.0 percent

Alternative A 10-VII - This alternative provides in addition to Alternative A 10-VI dual media pressurized filtration with a pump station to generate a sufficient head for filter operation.

The resulting BOD waste load is 0.097 kg/kkg (0.19 lb/ton), the suspended solids load is 0.11 kg/kkg (0.22 lb/ton), and the oil and grease load is 0.048 kg/kkg (0.096 lb/ton).

Costs: Total investment cost: $645,910
Total yearly cost: $275,650

An itemized breakdown of costs is presented in Table 216. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.5 percent
O&G: 98.5 percent

Alternative A 10-VIII - This alternative provides in addition to Alternative A 10-VII activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.048 kg/kkg (0.096 lb/ton), the suspended solids load is 0.056 kg/kkg (0.11 lb/ton), and the oil and grease load is 0.024 kg/kkg (0.048 lb/ton).

Costs: Total investment cost: $919,160
Total yearly cost: $326,050

An itemized breakdown of costs is presented in Table 217. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.2 percent

A cost efficiency curve is presented in Figure 280.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 11, Edible Oil Processing by Caustic Refining, Acidulation, Oil Processing, and Deodorization, and the Production of Shortening, Table Oils, and Margarine

A model plant representative of Subcategory A 11 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various

DRAFT

TABLE 216

ITEMIZED COST SUMMARY FOR ALTERNATIVE A10-VII (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	519080.00
2.	LAND	7000.00
3.	ENGINEERING	51910.00
4.	CONTINGENCY	51910.00
5.	PVC LINER	16010.00
TOTAL		645910.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	170090.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	22070.00
5.	PVC LINER	710.00
TOTAL		217860.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	217860.00
2.	YEARLY INVESTMENT COST RECOVERY	25840.00
3.	DEPRECIATION	31950.00
TOTAL		275650.00

DRAFT

TABLE 217

ITEMIZED COST SUMMARY FOR ALTERNATIVE A10-VIII (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J. .AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	746790.00
2.	LAND	7000.00
3.	ENGINEERING	74680.00
4.	CONTINGENCY	74680.00
5.	PVC LINER	16010.00
	TOTAL	919160.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	178290.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	39680.00
5.	PVC LINER	710.00
	TOTAL	243670.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	243670.00
2.	YEARLY INVESTMENT COST RECOVERY	36770.00
3.	DEPRECIATION	45510.00
	TOTAL	326050.00

DRAFT

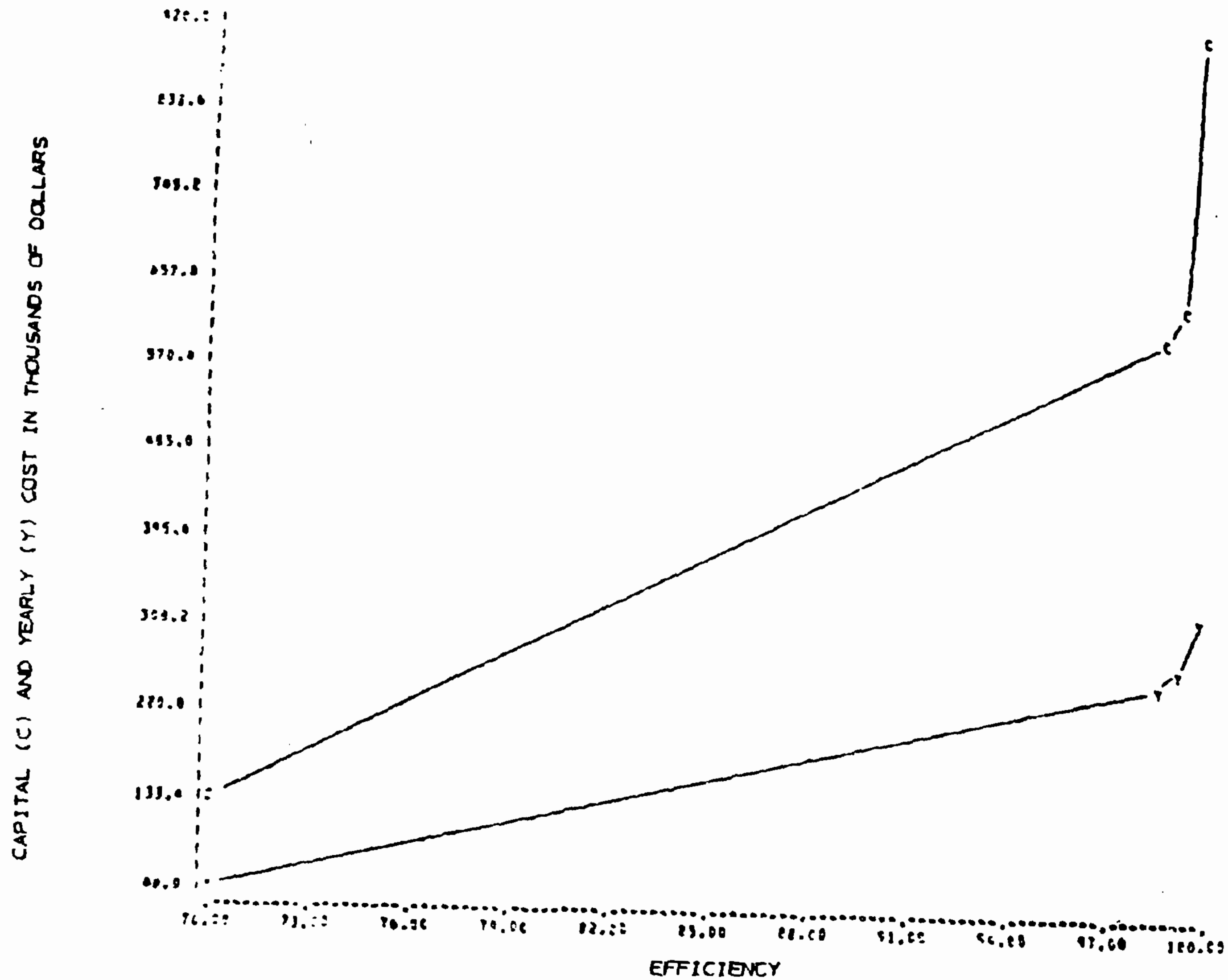


FIGURE 280

levels of waste reductions for the model plant which refines 454 kkg (500 ton) of crude edible oil per day.

Alternative A 11-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 1574 cu m (0.416 MG) per day. The BOD waste load is 20.57 kg/kkg (41.14 lb/ton), the suspended solids load is 10.98 kg/kkg (21.96 lb/ton), and the oil and grease load is 9.95 kg/kkg (19.90 lb/ton).

The model plant developed for Subcategory A 11 is assumed to have separate discharge of process and non-contact wastewaters, in-plant gravity separation and skimming, pH control, and an oil recovery system for reclamation of waste oil and grease skimmings.

Cost:	0
Reduction Benefits:	None

Alternative A 11-II - This alternative provides for the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

The resulting BOD waste load is 6.14 kg/kkg (12.28 lb/ton), the suspended solids load is 3.33 kg/kkg (6.66 lb/ton), and the oil and grease load is 2.92 kg/kkg (5.84 lb/ton).

Costs:	Total investment cost:	$215,730
	Total yearly cost:	$ 52,410

An itemized breakdown of costs is presented in Table 218. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	70.1 percent
	SS:	69.7 percent
	O&G:	70.6 percent

Alternative A 11-III - This alternative provides in addition to Alternative A 11-II complete mix activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every eight days. The activated sludge unit also includes a control house and two full-time operators.

The resulting BOD waste load is 0.31 kg/kkg (0.62 lb/ton), the suspended solids load is 0.35 kg/kkg (0.70 lb/ton), and the oil and grease load is 0.30 kg/kkg (0.60 lb/ton).

DRAFT

TABLE 218

ITEMIZED COST SUMMARY FOR ALTERNATIVE A11-II
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
P...PUMPING STATION
J...AIR FLOTATION

INVESTMENT COSTS:

1.	CONSTRUCTION	113140.00
2.	LAND	79970.00
3.	ENGINEERING	11310.00
4.	CONTINGENCY	11310.00
	TOTAL	215730.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	4840.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	7160.00
	TOTAL	36990.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	36990.00
2.	YEARLY INVESTMENT COST RECOVERY	8630.00
3.	DEPRECIATION	6790.00
	TOTAL	52410.00

Costs: Total investment cost: $761,790
Total yearly cost: $175,830

An itemized breakdown of costs is presented in Table 219. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 97.2 percent
O&G: 97.0 percent

Alternative A 11-IV - This alternative provides in addition to Alternative A 11-III dual media pressure filtration with a pump station to generate a sufficient head for filter operation.

The resulting BOD waste load is 0.16 kg/kkg (0.31 lb/ton), the suspended solids load is 0.17 kg/kkg (0.35 lb/ton), and the oil and grease load is 0.069 kg/kkg (0.14 lb/ton).

Costs: Total investment cost: $813,980
Total yearly cost: $191,110

An itemized breakdown of costs is presented in Table 220. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.4 percent
O&G: 99.3 percent

Alternative A 11-V - This alternative provides in addition to Alternative A 11-IV activated carbon adsorption before final discharge.

The resulting BOD waste load is 0.076 kg/kkg (0.15 lb/ton), the suspended solids load is 0.087 kg/kkg (0.17 lb/ton), and the oil and grease load is 0.035 kg/kkg (0.070 lb/ton).

Costs: Total investment cost: $1,214,140
Total yearly cost: $ 256,440

An itemized breakdown of costs is presented in Table 221. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.6 percent

A cost efficiency curve is presented in Figure 281.

DRAFT

TABLE 219

ITEMIZED COST SUMMARY FOR ALTERNATIVE AII-III (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- R...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:	
1. CONSTRUCTION	568180.00
2. LAND	79970.00
3. ENGINEERING	56820.00
4. CONTINGENCY	56820.00
TOTAL	761790.00
YEARLY OPERATING COSTS:	
1. LABOR	24990.00
2. POWER	59940.00
3. CHEMICALS	6980.00
4. MAINTENANCE&SUPPLIES	19360.00
TOTAL	111270.00
TOTAL YEARLY COSTS:	
1. YEARLY OPERATING COST	111270.00
2. YEARLY INVESTMENT COST RECOVERY	30470.00
3. DEPRECIATION	34090.00
TOTAL	175830.00

DRAFT

TABLE 220

ITEMIZED COST SUMMARY FOR ALTERNATIVE A11-IV
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	611670.00
	2. LAND	79970.00
	3. ENGINEERING	61170.00
	4. CONTINGENCY	61170.00
	TOTAL	813980.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	69730.00
	3. CHEMICALS	6980.00
	4. MAINTENANCE&SUPPLIES	20150.00
	TOTAL	121850.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	121850.00
	2. YEARLY INVESTMENT COST RECOVERY	32560.00
	3. DEPRECIATION	36700.00
	TOTAL	191110.00

DRAFT

TABLE 221

ITEMIZED COST SUMMARY FOR ALTERNATIVE A11-V (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN
2...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	945150.00
2. LAND	79970.00
3. ENGINEERING	94510.00
4. CONTINGENCY	94510.00
TOTAL	1214140.00

YEARLY OPERATING COSTS:

1. LABOR	24000.00
2. POWER	81200.00
3. CHEMICALS	6980.00
4. MAINTENANCE&SUPPLIES	37990.00
TOTAL	151160.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	151160.00
2. YEARLY INVESTMENT COST RECOVERY	48570.00
3. DEPRECIATION	56710.00
TOTAL	256440.00

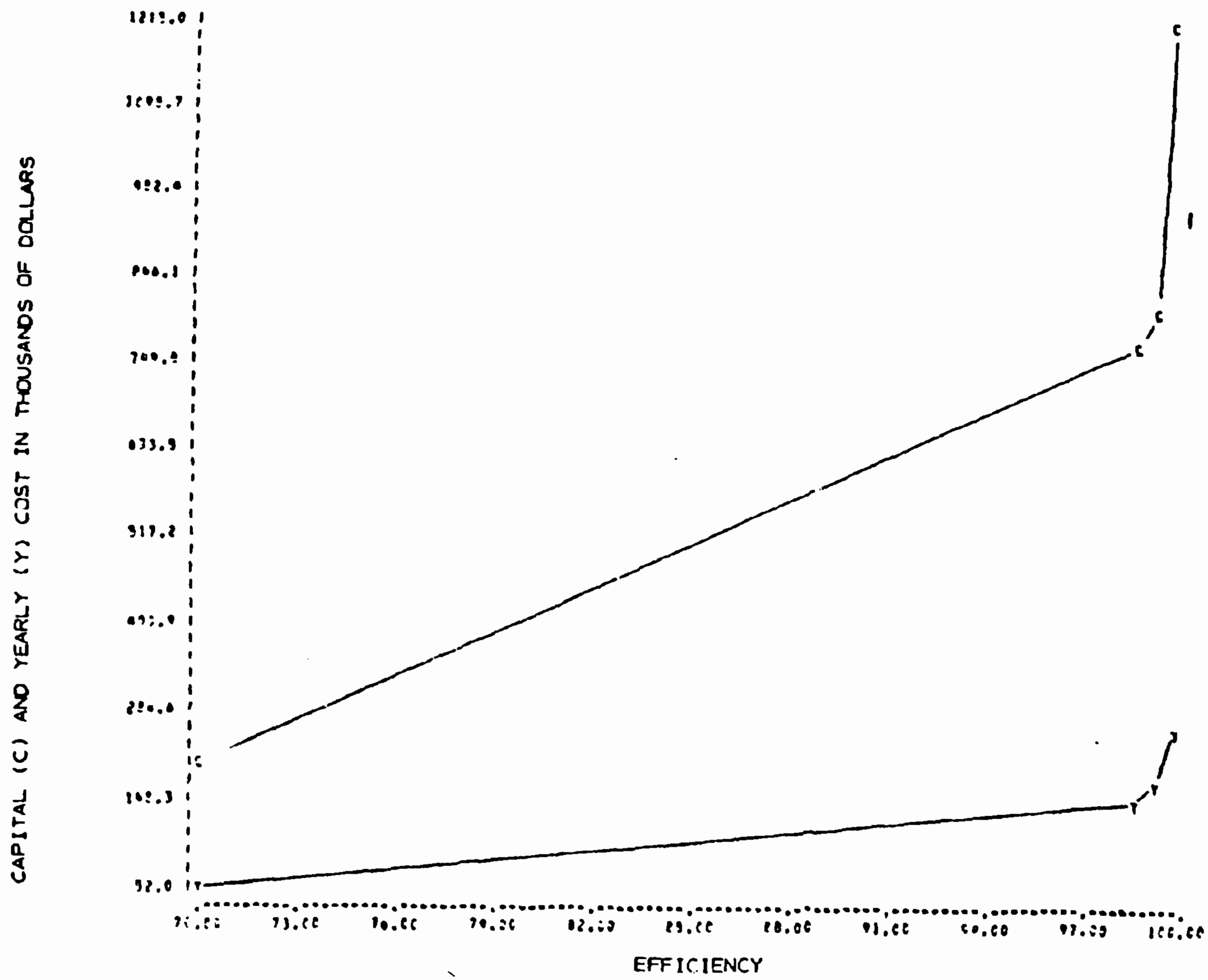


FIGURE 281

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A11, ALTERNATIVES I, THROUGH V

Alternative A 11-VI - This alternative provides in addition to Alternative A 11-TI (i.e., dissolved air flotation) an aerated lagoon system including a settling pond.

The resulting BOD waste load is 0.31 kg/kkg (0.62 lb/ton), the suspended solids load is 0.35 kg/kkg (0.70 lb/ton), and the oil and grease load is 0.30 kg/kkg (0.60 lb/ton).

Costs:	Total inbestment cost:	$768,500
	Total yearly cost:	$353,770

An itemized breakdown of costs is presented in Table 222. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	98.5 percent
	SS:	97.2 percent
	O&G:	97.0 percent

Alternative A 11-VII - This alternative provides in addition to Alternative A 11-VI dual media pressure filtration with a pump station to generate a sufficient head for filter operation.

The resulting BOD waste load is 0.16 kg/kkg (0.31 lb/ton), the suspended solids load is 0.17 kg/kkg (0.35 lb/ton), and the oil and grease load is 0.069 kg/kkg (0.14 lb/ton).

Costs:	Total investment cost:	$820,670
	Total yearly cost:	$369,050

An itemized breakdown of costs is presented in Table 223. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	99.2 percent
	SS:	98.4 percent
	O&G:	99.3 percent

Alternative A 11-VIII - This alternative provides in addition to Alternative A 11-VII activated carbon adsorption prior to final discharge to navigable waters.

The resulting BOD waste load is 0.076 kg/kkg (0.15 lb/ton), the suspended solids load is 0.087 kg/kkg (0.17 lb/ton), and the oil and grease load is 0.035 kg/kkg (0.070 lb/ton).

Costs:	Total investment cost:	$1,220,850
	Total yearly cost:	$ 434,380

DRAFT

TABLE 222

ITEMIZED COST SUMMARY FOR ALTERNATIVE A11-VI
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
- B1..CONTROL HOUSE
- G...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	614660.00
2.	LAND	8660.00
3.	ENGINEERING	61470.00
4.	CONTINGENCY	61470.00
5.	PVC LINER	22240.00
	TOTAL	768500.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	230770.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	28260.00
5.	PVC LINER	1020.00
	TOTAL	285040.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	285040.00
2.	YEARLY INVESTMENT COST RECOVERY	30740.00
3.	DEPRECIATION	37990.00
	TOTAL	353770.00

DRAFT

TABLE 223

ITEMIZED COST SUMMARY FOR ALTERNATIVE A11-VII (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- F1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON
- H...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1.	CONSTRUCTION	658150.00
2.	LAND	8660.00
3.	ENGINEERING	65810.00
4.	CONTINGENCY	65810.00
5.	PVC LINER	22240.00
TOTAL		820670.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	240550.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	29060.00
5.	PVC LINER	1020.00
TOTAL		295620.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	295620.00
2.	YEARLY INVESTMENT COST RECOVERY	32830.00
3.	DEPRECIATION	40600.00
TOTAL		369050.00

An itemized breakdown of costs is presented in Table 224. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.6 percent

A cost efficiency curve is presented in Figure 282.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 12, Edible Oil Processing by Caustic Refining, Oil Processing, and Deodorization, and the Production of Shortening, Table Oils, and Margarine

A model plant representative of Subcategory A 12 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which refines 454 kkg (500 ton) of edible oil per day.

Alternative A 12-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 454 kkg per day plant is 1355 cu m (0.358 MG) per day. The BOD waste load is 16.20 kg/kkg (32.40 lb/ton), the suspended solids load is 9.44 kg/kkg (18.88 lb/ton), and the oil and grease load is 8.83 kg/kkg (17.66 lb/ton).

The model plant developed for Subcategory A 12 is assumed to have separate discharge of process and non-contact wastewaters, in-plant gravity separation and skimming, pH control, and an oil recovery system for reclamation of waste oil and grease skimmings.

Costs: 0
Reduction Benefits: None

Alternative A 12-II - This alternative provides for the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid waste skimmings are pumped to an in-plant oil reclamation system for dewatering, and recovery of inedible oils.

The resulting BOD waste load is 4.84 kg/kkg (9.68 lb/ton), the suspended solids load is 2.87 kg/kkg (5.74 lb/ton), and the oil and grease load is 2.69 kg/kkg (5.38 lb/ton).

Costs: Total investment cost: $202,970
Total yearly cost: $ 50,800

DRAFT

TABLE 224

ITEMIZED COST SUMMARY FOR ALTERNATIVE A11-VIII (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	991630.00
2. LAND	8660.00
3. ENGINEERING	99160.00
4. CONTINGENCY	99160.00
5. PVC LINER	22240.00
TOTAL	1220850.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	252020.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	46910.00
5. PVC LINER	1020.00
TOTAL	324940.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	324940.00
2. YEARLY INVESTMENT COST RECOVERY	48830.00
3. DEPRECIATION	60610.00
TOTAL	434380.00

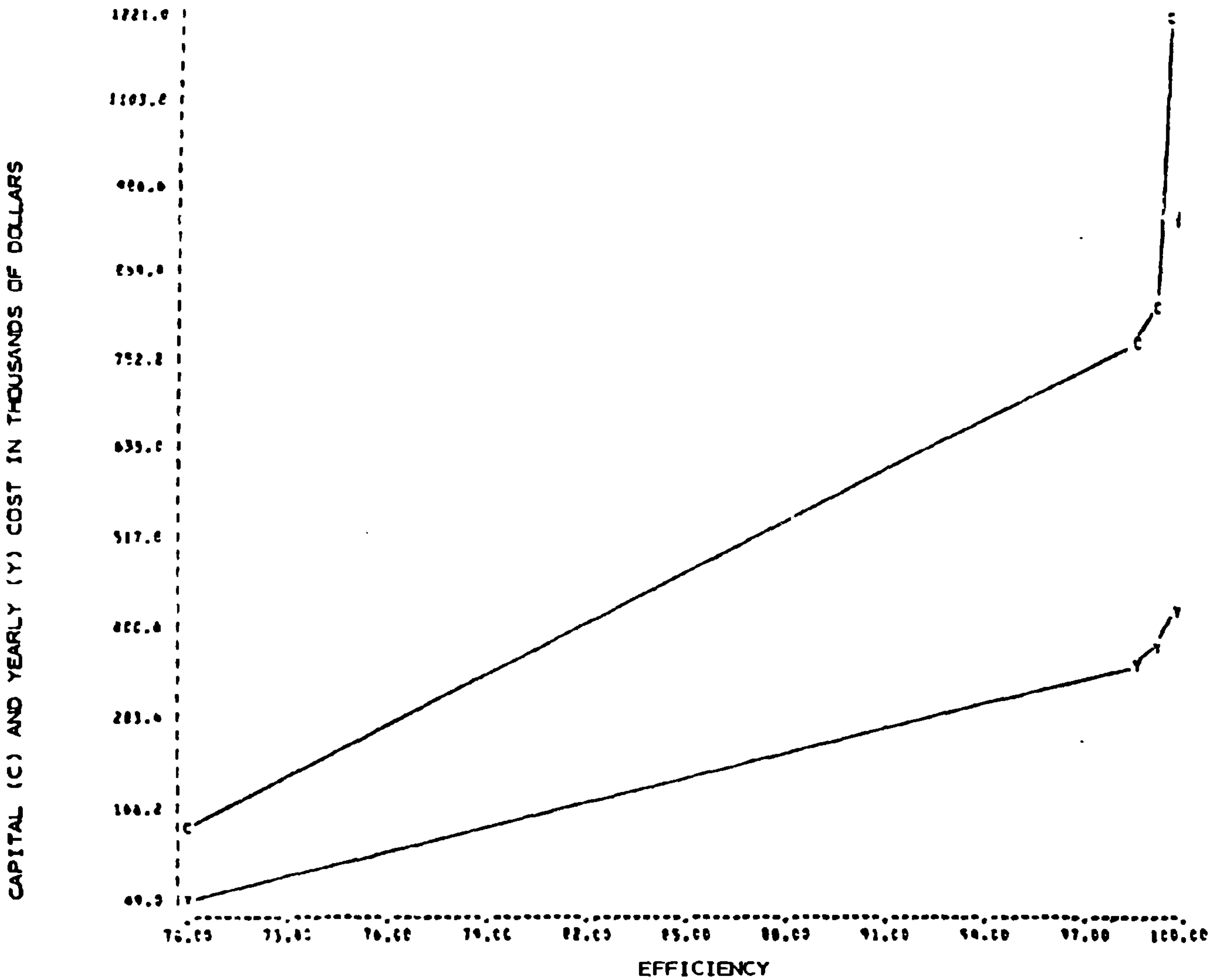


FIGURE 282

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A11, ALTERNATIVES II AND VI THROUGH VIII

An itemized breakdown of costs is presented in Table 225. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 70.1 percent
SS: 69.6 percent
O&G: 69.5 percent

Alternative A 12-III - This alternative provides in addition to Alternative A 12-II complete mix activated sludge, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every five days. The activated sludge unit also includes a control house and two full-time operators.

The resulting BOD waste load is 0.24 kg/kkg (0.48 lb/ton), the suspended solids load is 0.29 kg/kkg (0.57 lb/ton), and the oil and grease load is 0.27 kg/kkg (0.54 lb/ton)

Costs: Total investment cost: $672,950
Total yearly cost: $152,640

An itemized breakdown of costs is presented in Table 226. It is assumed that land costs $82,040 per hectare ($33,200 per acre).

Reduction Benefits: BOD: 98.5 percent
SS: 97.0 percent
O&G: 97.0 percent

Alternative A 12-IV - This alternative provides in addition to Alternative A 12-III dual media pressure filtration with a pump station to generate a sufficient head for filter operation.

The resulting BOD waste load is 0.12 kg/kkg (0.24 lb/ton), the suspended solids load is 0.14 kg/kkg (0.29 lb/ton), and the oil and grease load is 0.060 kg/kkg (0.12 lb/ton).

Costs: Total investment cost: $722,000
Total yearly cost: $166,810

An itemized breakdown of costs is presented in Table 227. It is assumed that land costs $82,040 per nectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.3 percent
SS: 98.5 percent
O&G: 99.3 percent

Alternative A 12-V - This alternative provides in addition to Alternative A 12-IV activated carbon adsorption before final discharge to navigable waters.

DRAFT

TABLE 225

ITEMIZED COST SUMMARY FOR ALTERNATIVE A12-II (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

91..CONTROL HOUSE
6...PUMPING STATION
J...AIR FLOTATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	105280.00
	2. LAND	76630.00
	3. ENGINEERING	10530.00
	4. CONTINGENCY	10530.00
	TOTAL	202970.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	4330.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	7040.00
	TOTAL	36360.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	36360.00
	2. YEARLY INVESTMENT COST RECOVERY	8120.00
	3. DEPRECIATION	6320.00
	TOTAL	50800.00

DRAFT

TABLE 226

ITEMIZED COST SUMMARY FOR ALTERNATIVE A12-III
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	496940.00
2. LAND	76630.00
3. ENGINEERING	49690.00
4. CONTINGENCY	49690.00
TOTAL	672950.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	48150.00
3. CHEMICALS	5490.00
4. MAINTENANCE&SUPPLIES	17270.00
TOTAL	95900.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	95900.00
2. YEARLY INVESTMENT COST RECOVERY	26920.00
3. DEPRECIATION	29820.00
TOTAL	152640.00

DRAFT

TABLE 227

ITEMIZED COST SUMMARY FOR ALTERNATIVE A12-IV
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	537810.00
2. LAND	76630.00
3. ENGINEERING	53780.00
4. CONTINGENCY	53780.00
TOTAL	722000.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	57160.00
3. CHEMICALS	5490.00
4. MAINTENANCE&SUPPLIES	18020.00
TOTAL	105660.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	105660.00
2. YEARLY INVESTMENT COST RECOVERY	28880.00
3. DEPRECIATION	32270.00
TOTAL	166810.00

The resulting BOD waste load is 0.060 kg/kkg (0.12 lb/ton), the suspended solids load is 0.072 kg/kkg (0.14 lb/ton), and the oil and grease load is 0.03 kg/kkg (0.06 lb/ton).

Costs: Total investment cost: $1,063,760
Total yearly cost: $ 225,270

An itemized breakdown of costs is presented in Table 228. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.6 percent

A cost efficiency curve is presented in Figure 283.

Alternative A 12-VI - This alternative provides in addition to Alternative A 12-II (i.e., dissolved air flotation) an aerated lagoon system including a settling pond.

The resulting BOD waste load is 0.24 kg/kkg (0.48 lb/ton), the suspended solids load is 0.29 kg/kkg (0.57 lb/ton), and the oil and grease load is 0.27 kg/kkg (0.54 lb/ton).

Costs: Total investment cost: $706,850
Total yearly cost: $319,260

An itemized breakdown of costs is presented in Table 229. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 97.0 percent
O&G: 97.0 percent

Alternative A 12-VII - This alternative provides in addition to Alternative A 12-VI dual media pressure filtration and a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.12 kg/kkg (0.24 lb/ton), the suspended solids load is 0.14 kg/kkg (0.29 lb/ton), and the oil and grease load is 0.060 kg/kkg (0.12 lb/ton).

Costs: Total investment cost: $755,880
Total yearly cost: $333,450

An itemized breakdown of costs is presented in Table 230. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

DRAFT

TABLE 228

ITEMIZED COST SUMMARY FOR ALTERNATIVE A12-V
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:
B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	822610.00
2.	LAND	76630.00
3.	ENGINEERING	82260.00
4.	CONTINGENCY	82260.00
TOTAL		1063760.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	67130.00
3.	CHEMICALS	5490.00
4.	MAINTENANCE&SUPPLIES	35750.00
TOTAL		133360.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	133360.00
2.	YEARLY INVESTMENT COST RECOVERY	42550.00
3.	DEPRECIATION	49360.00
TOTAL		225270.00

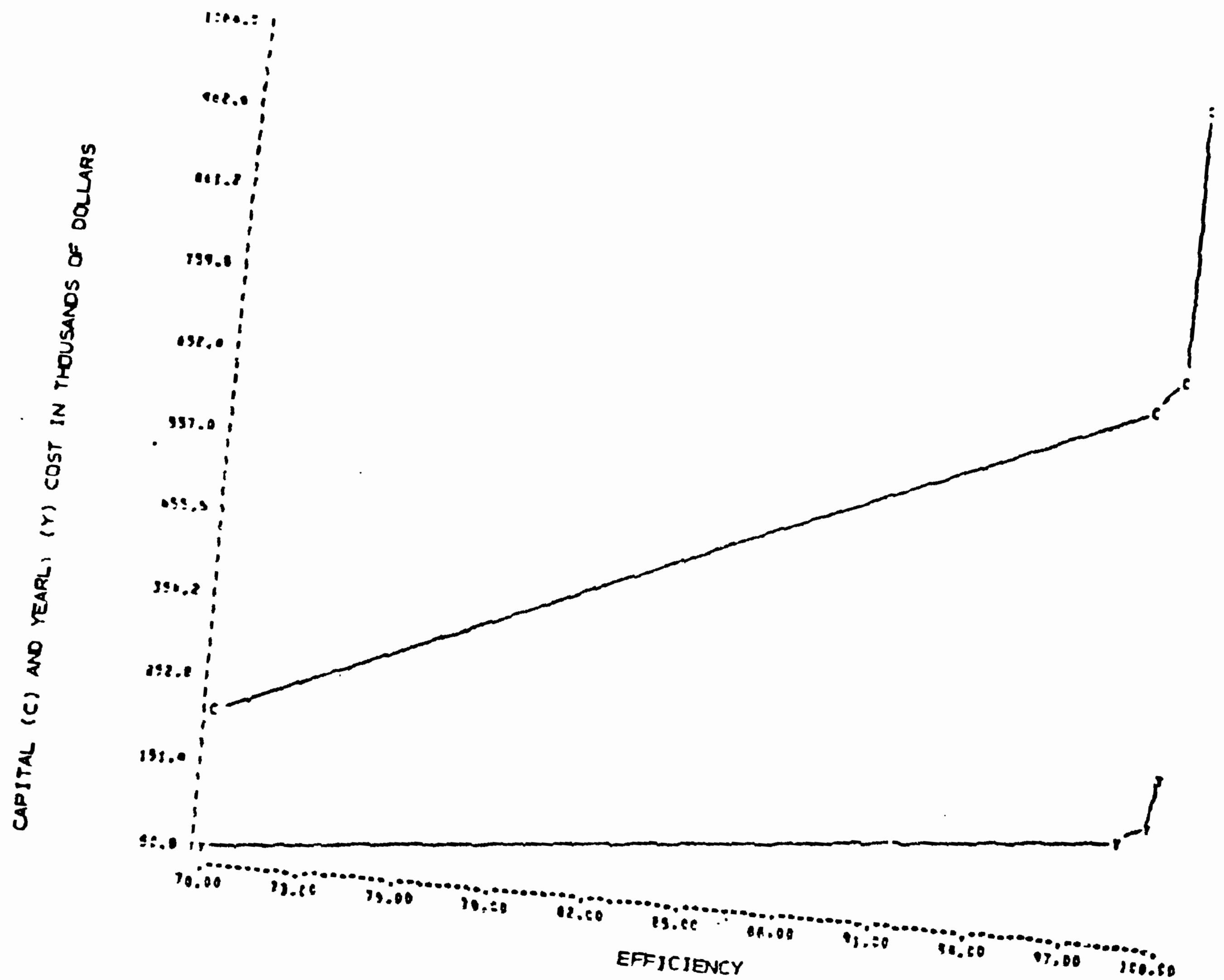


FIGURE 283

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A12, ALTERNATIVES II THROUGH V

DRAFT

TABLE 229

ITEMIZED COST SUMMARY FOR ALTERNATIVE A12-VI
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	565780.00
2.	LAND	8000.00
3.	ENGINEERING	56580.00
4.	CONTINGENCY	56580.00
5.	PVC LINER	19910.00
TOTAL		706850.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	204790.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	25390.00
5.	PVC LINER	880.00
TOTAL		256050.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	256050.00
2. YEARLY INVESTMENT COST RECOVERY	28270.00
3. DEPRECIATION	34940.00
TOTAL	319260.00

TABLE 230

ITEMIZED COST SUMMARY FOR ALTERNATIVE A12-VII (EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT COD REDUCTION

TREATMENT MODULES:

- 01..CONTROL HOUSE
- G...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON
- 6...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	606650.00
2.	LAND	8000.00
3.	ENGINEERING	60660.00
4.	CONTINGENCY	60660.00
5.	PVC LINER	19910.00
TOTAL		755880.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	213800.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	26150.00
5.	PVC LINER	880.00
TOTAL		265820.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	265820.00
2.	YEARLY INVESTMENT COST RECOVERY	30240.00
3.	DEPRECIATION	37390.00
TOTAL		333450.00

Reduction Benefits: BOD: 99.3 percent
SS: 98.5 percent
O&G: 99.3 percent

Alternative A 12-VIII - This alternative provides in addition to Alternative A 12-VII activated carbon adsorption before final discharge to navigable waters.

The resulting BOD waste load is 0.060 kg/kkg (0.12 lb/ton), the suspended solids load is 0.072 kg/kkg (0.14 lb/ton), and the oil and grease load is 0.030 kg/kkg (0.060 lb/ton).

Costs: Total investment cost: $1,097,630
Total yearly cost: $ 391,900

An itemized breakdown of costs is presented in Table 231. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.2 percent
O&G: 99.6 percent

A cost efficiency curve is presented in Figure 284.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 13, Plasticizing and Packaging of Margarine

A model plant representative of Subcategory A 13 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, six alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 227 kkg (250 ton) of margarine per day.

Alternative A 13-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 227 kkg per day plant is 340 cu m (0.09 MG) per day. The BOD waste load is 3.92 kg/kkg (7.84 lb/ton), the suspended solids load is 2.72 kg/kkg (5.44 lb/ton), and the oil and grease load is 5.81 kg/kkg (11.62 lb/ton).

The model plant developed for Subcategory A 13 is assumed to have separate discharge of process and non-contact wastewaters, in-plant gravity separation and skimming, pH control, and an oil recovery system for reclamation of waste oil and grease skimmings.

Cost: 0
Reduction Benefits: None

Alternative A 13-II - This alternative provides for the addition of pressurized air flotation utilizing chemical flocculating agents to enhance floc formation and floatability of wastes. Oil, water, and solid

DARFT

TABLE 231

ITEMIZED COST SUMMARY FOR ALTERNATIVE A12-VIII
(EDIBLE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATN
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	891440.00
2.	LAND	8000.00
3.	ENGINEERING	89140.00
4.	CONTINGENCY	89140.00
5.	PVC LINER	19910.00
	TOTAL	1097630.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	223770.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	43870.00
5.	PVC LINER	880.00
	TOTAL	293510.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	293510.00
2.	YEARLY INVESTMENT COST RECOVERY	43910.00
3.	DEPRECIATION	54480.00
	TOTAL	391900.00

DRAFT

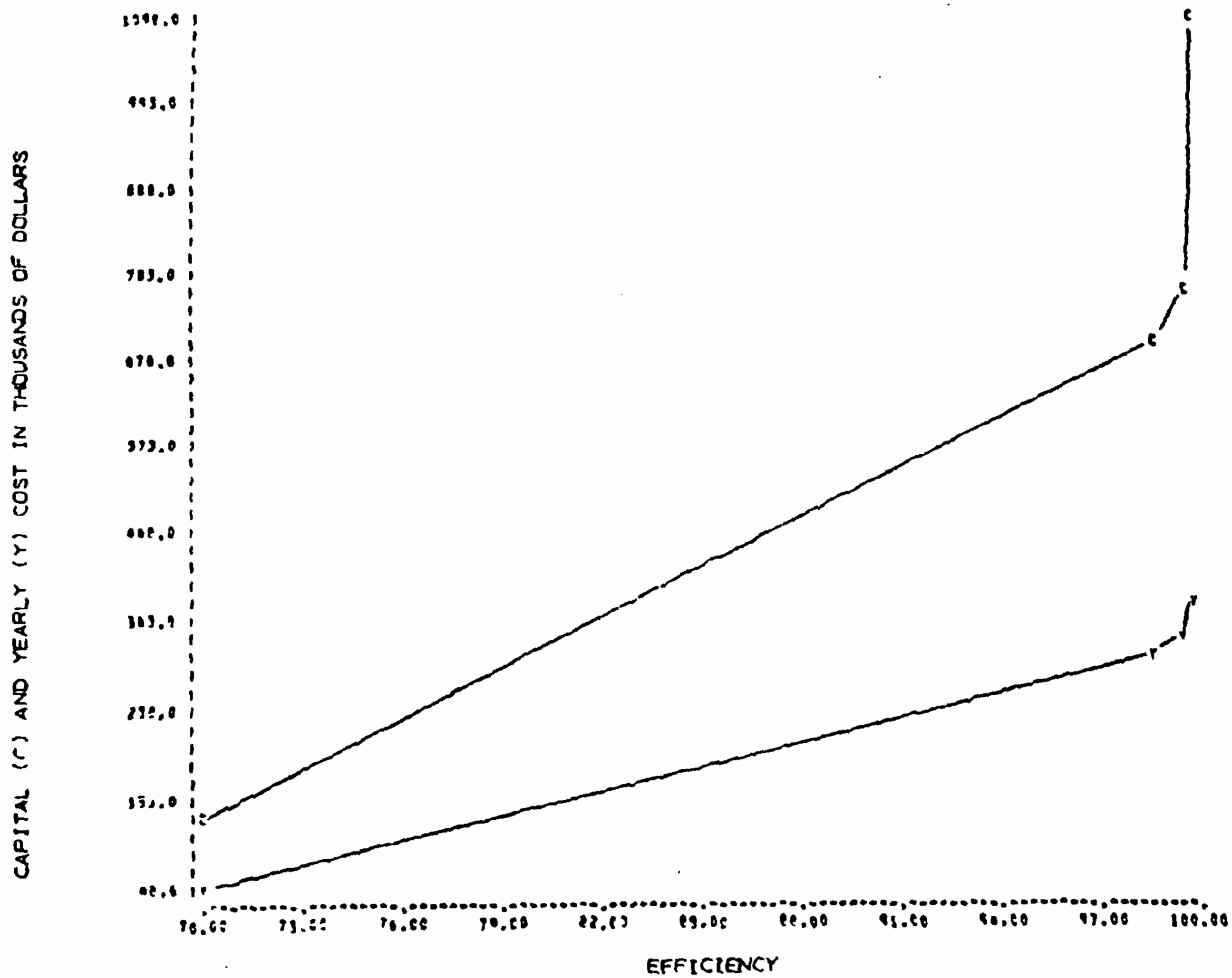


FIGURE 284

DRAFT

TABLE 232

ITEMIZED COST SUMMARY FOR ALTERNATIVE A13-II
(MARGARINE PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION

INVESTMENT COSTS:

1.	CONSTRUCTION	72150.00
2.	LAND	59970.00
3.	ENGINEERING	7210.00
4.	CONTINGENCY	7210.00
TOTAL		146540.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	1570.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	5970.00
TOTAL		32530.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	32530.00
2. YEARLY INVESTMENT COST RECOVERY	5860.00
3. DEPRECIATION	4330.00
TOTAL	42720.00

DRAFT

TABLE 233

ITEMIZED COST SUMMARY FOR ALTERNATIVE A13-III (MARGARINE PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- C...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	196030.00
2. LAND	59970.00
3. ENGINEERING	19600.00
4. CONTINGENCY	19600.00
TOTAL	295200.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	9690.00
3. CHEMICALS	2080.00
4. MAINTENANCE&SUPPLIES	9870.00
TOTAL	46630.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	46630.00
2. YEARLY INVESTMENT COST RECOVERY	11810.00
3. DEPRECIATION	11760.00
TOTAL	70200.00

An itemized breakdown of costs is presented in Table 234. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	99.2 percent
	SS:	98.6 percent
	O&G:	99.4 percent

A cost efficiency curve is presented in Figure 285.

<u>Alternative A 13-V</u> - This alternative provides in addition to Alternative A 13-II (pressurized air flotation) an aerated lagoon system with a settling pond.

The resulting BOD waste load is 0.060 kg/kkg (0.12 lb/ton), the suspended solids load is 0.075 kg/kkg (0.15 lb/ton), and the oil and grease load is 0.075 kg/kkg (0.15 lb/ton).

Costs:	Total investment cost:	$277,070
	Total yearly cost:	$110,220

An itemized breakdown of costs is presented in Table 235. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits:	BOD:	98.5 percent
	SS:	97.2 percent
	O&G:	98.7 percent

<u>Alternative A 13-VI</u> - This alternative provides in addition to Alternative A 13-V dual media pressure filtration and a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.030 kg/kkg (0.060 lb/ton), the suspended solids load is 0.037 kg/kkg (0.074 lb/ton), and the oil and grease load is 0.037 kg/kkg (0.074 lb/ton).

Costs:	Total investment cost:	$209,790
	Total yearly cost:	$119,300

An itemized breakdown of costs is presented in Table 236. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits:	BOD:	99.2 percent
	SS:	98.6 percent
	O&G:	99.4 percent

A cost efficiency curve is presented in Figure 286.

DRAFT

TABLE 234

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 13-IV
(MARGARINE PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN (B)BJKGSY)HN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- M1..CONTROL HOUSE
- B...PUMPING STATION
- J...AIR FLOTATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- H...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	223300.00
	2. LAND	59970.00
	3. ENGINEERING	22330.00
	4. CONTINGENCY	22330.00
	TOTAL	327930.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	15110.00
	3. CHEMICALS	2080.00
	4. MAINTENANCE&SUPPLIES	10580.00
	TOTAL	52760.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	52760.00
	2. YEARLY INVESTMENT COST RECOVERY	13120.00
	3. DEPRECIATION	13400.00
	TOTAL	79280.00

DRAFT

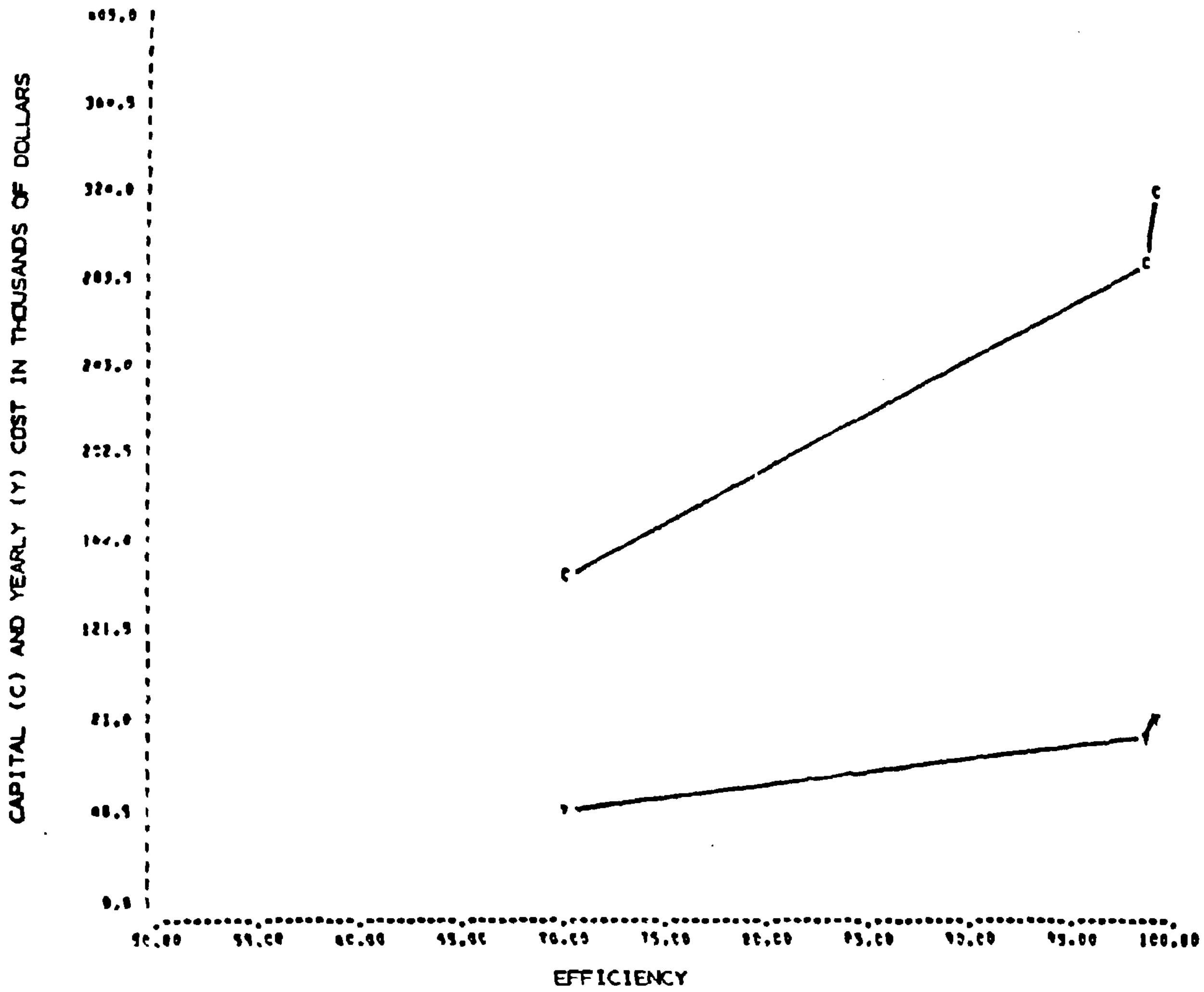


FIGURE 285

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A13, ALTERNATIVES II THRU IV.

DARFT

TABLE 235

ITEMIZED COST SUMMARY FOR ALTERNATIVE A13- V
(MARGARINE PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
A1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	223910.00
	2. LAND	4000.00
	3. ENGINEERING	22390.00
	4. CONTINGENCY	22390.00
	5. PVC LINER	4380.00
	TOTAL	277070.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	50100.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	10170.00
	5. PVC LINER	230.00
	TOTAL	85490.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	85490.00
	2. YEARLY INVESTMENT COST RECOVERY	11080.00
	3. DEPRECIATION	13650.00
	TOTAL	110220.00

DRAFT

TABLE 236

ITEMIZED COST SUMMARY FOR ALTERNATIVE A13-VI
(MARGARINE PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:
H1..CONTROL HOUSE
B...PUMPING STATION
J...AIR FLOTATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	251170.00
	2. LAND	4000.00
	3. ENGINEERING	25120.00
	4. CONTINGENCY	25120.00
	5. PVC LINER	4380.00
	TOTAL	309790.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	55520.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	10880.00
	5. PVC LINER	230.00
	TOTAL	91620.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	91620.00
	2. YEARLY INVESTMENT COST RECOVERY	12390.00
	3. DEPRECIATION	15290.00
	TOTAL	119300.00

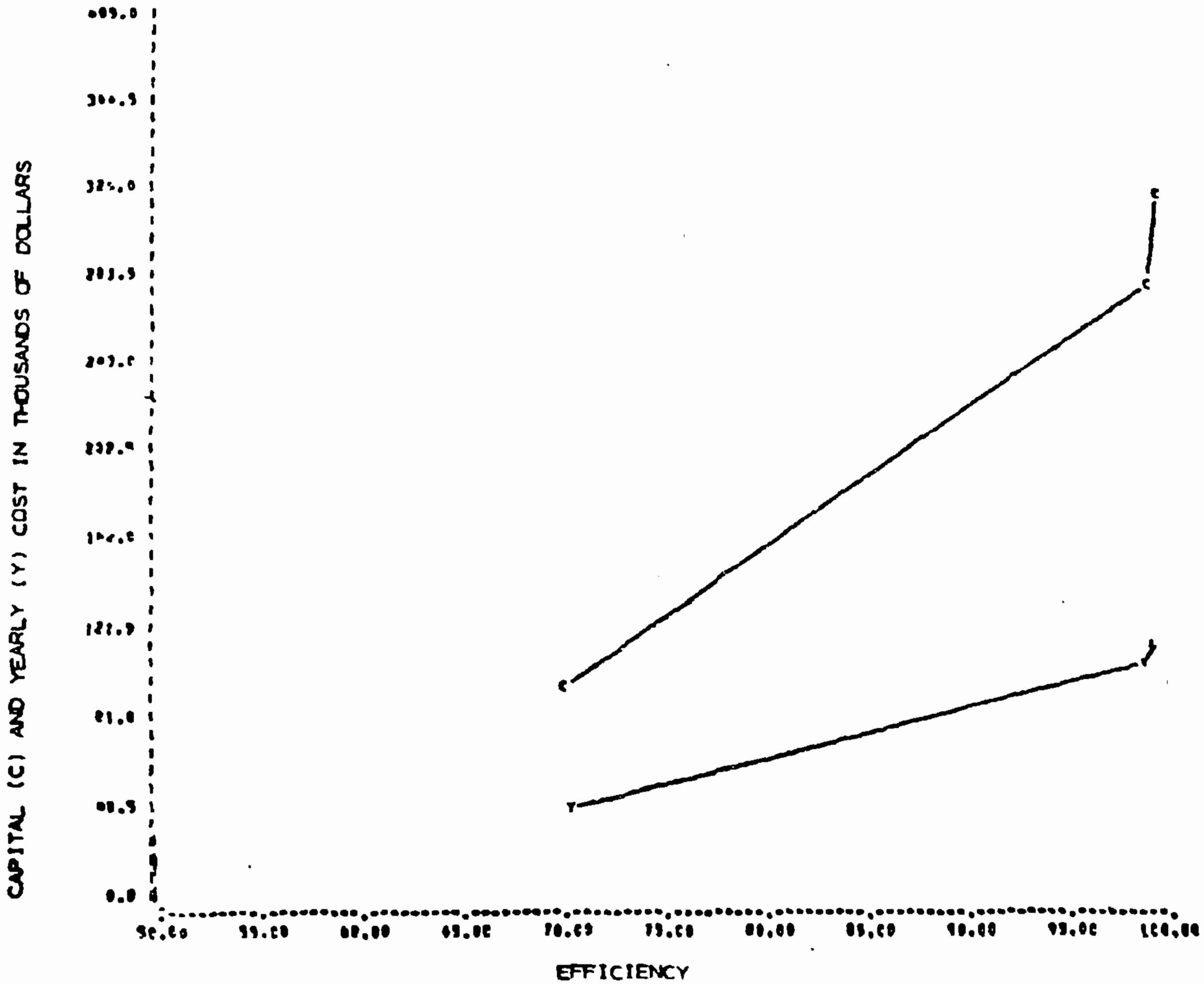


FIGURE 286

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 13, ALTERNATIVES II, V, AND VI

DRAFT

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 14, Plasticizing and Packaging Shortening and Table Oils

A model plant representative of Subcategory A 14 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, seven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 227 kkg (250 ton) of finished edible oil products per day.

Alternative A 14-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 227 kkg per day plant is 87 cu m (0.023 MG) per day. The BOD waste load is 0.56 kg/kkg (1.12 lb/ton), the suspended solids load is 0.42 kg/kkg (0.84 lb/ton), and the oil and grease load is 0.21 kg/kkg (0.42 lb/ton).

The model plant developed for Subcategory A 14 is assumed to have separate discharge of process and non-contact wastewaters, in-plant gravity separation and skimming, pH control, and an oil recovery system for reclamation of waste oil and grease skimmings.

Alternative A 14-II - This alternative provides for the addition of a complete mix activated sludge unit, secondary clarification, sludge recirculating pump, a sludge thickening tank, vacuum filtration, and a sludge holding tank. Sludge is hauled to a landfill facility every 26 days. The activated sludge unit also includes a control house and two full-time operators.

The resulting BOD waste load is 0.029 kg/kkg (0.058 lb/ton), the suspended solids load is 0.038 kg/kkg (0.076 lb/ton), and the oil and grease load is 0.021 kg/kkg (0.042 lb/ton).

Costs: Total investment cost: $201,390
Total yearly cost: $ 39,350

An itemized breakdown of costs is presented in Table 237. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.8 percent
SS: 90.9 percent
O&G: 90.0 percent

Alternative A 14-III - This alternative provides in addition to Alternative A 14-II dual media filtration and a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.015 kg/kkg (0.030 lb/ton), the suspended solids load is 0.015 kg/kkg (0.030 lb/ton), and the oil and grease load is 0.008 kg/kkg (0.016 lb/ton).

DRAFT

TABLE 237

ITEMIZED COST SUMMARY FOR ALTERNATIVE A14-II
(SHORTENING AND TABLE OIL PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN B1PKGSY
DESIGN EFFICIENCY... 94.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- P...PUMPING STATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	122710.00
2. LAND	54140.00
3. ENGINEERING	12270.00
4. CONTINGENCY	12270.00
TOTAL	201390.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	6050.00
3. CHEMICALS	1870.00
4. MAINTENANCE&SUPPLIES	3520.00
TOTAL	23930.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	23930.00
2. YEARLY INVESTMENT COST RECOVERY	8060.00
3. DEPRECIATION	7360.00
TOTAL	39350.00

Costs: Total investment cost: $217,340
Total yearly cost: $ 44,070

An itemized breakdown of costs is presented in Table 238. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.3 percent
SS: 96.4 percent
O&G: 96.2 percent

Alternative A 14-IV - This alternative provides in addition to Alternative A 14-III activated carbon adsorption prior to discharge to navigable waters.

The resulting BOD waste load is 0.008 kg/kkg (0.016 lb/ton), the suspended solids load is 0.008 kg/kkg (0.016 lb/ton), and the oil and grease load is 0.004 kg/kkg (0.008 lb/ton).

Costs: Total investment cost: $259,260
Total yearly cost: $ 62,190

An itemized breakdown of costs is presented in Table 239. It is assumed that land costs $82,040 per hectare ($33,200 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.6 percent
SS: 98.1 percent
O&G: 98.1 percent

A cost efficiency curve is presented in Figure 287.

Alternative A 14-V - This alternative provides in addition to Alternative A 14-I an aerated lagoon system with a settling pond.

The resulting BOD waste load is 0.029 kg/kkg (0.058 lb/ton), the suspended solids load is 0.038 kg/kkg (0.076 lb/ton), and the oil and grease load is 0.021 kg/kkg (0.042 lb/ton).

Costs: Total investment cost: $147,390
Total yearly cost: $ 34,810

An itemized breakdown of costs is presented in Table 240. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits: BOD: 94.8 percent
SS: 90.9 percent
O&G: 90.0 percent

DRAFT

TABLE 23B

ITEMIZED COST SUMMARY FOR ALTERNATIVE A14-III (SHORTENING AND TABLE OIL PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN (B19KGSY)BN
DESIGN EFFICIENCY... 97.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- 9...PUMPING STATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	136000.00
2.	LAND	54140.00
3.	ENGINEERING	13600.00
4.	CONTINGENCY	13600.00
	TOTAL	217340.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	7670.00
3.	CHEMICALS	1870.00
4.	MAINTENANCE&SUPPLIES	5190.00
	TOTAL	27220.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	27220.00
2.	YEARLY INVESTMENT COST RECOVERY	8690.00
3.	DEPRECIATION	8160.00
	TOTAL	44070.00

DRAFT

TABLE 239

ITEMIZED COST SUMMARY FOR ALTERNATIVE A14-IV (SHORTENING AND TABLE OIL PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN (B1BKCSYBN)Z
DESIGN EFFICIENCY... 98.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
K...ACTIVATED SLUDGE
C...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
N...DUAL MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	170940.00
2. LAND	54140.00
3. ENGINEERING	17090.00
4. CONTINGENCY	17090.00
TOTAL	259260.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	10020.00
3. CHEMICALS	1870.00
4. MAINTENANCE&SUPPLIES	17180.00
TOTAL	41560.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	41560.00
2. YEARLY INVESTMENT COST RECOVERY	10370.00
3. DEPRECIATION	10260.00
TOTAL	62190.00

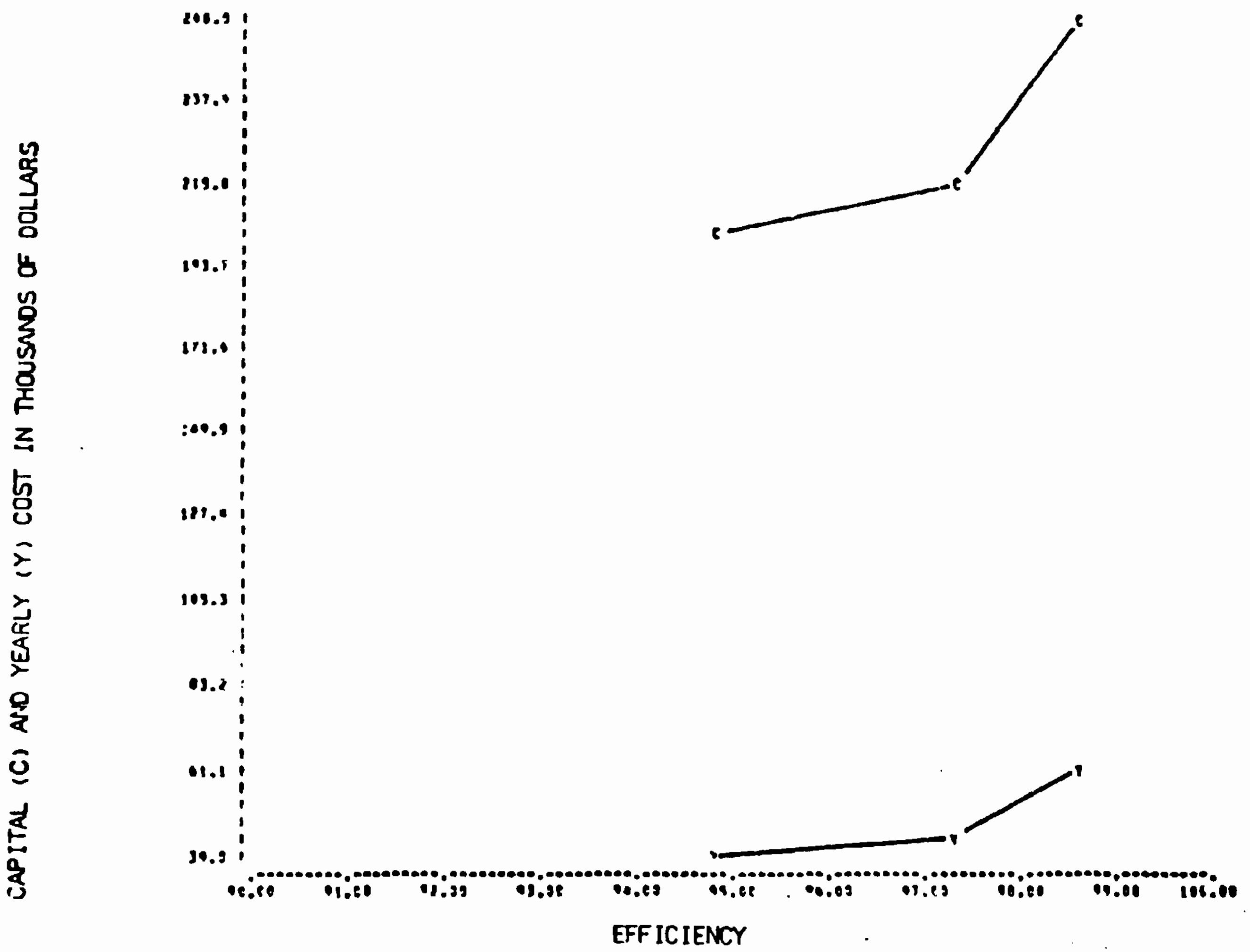


FIGURE 287

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A14, ALTERNATIVES II THROUGH IV

TABLE 240

ITEMIZED COST SUMMARY FOR ALTERNATIVE A14-V (SHORTENING AND TABLE OIL PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN BL
DESIGN EFFICIENCY... 94.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	116910.00
2.	LAND	3330.00
3.	ENGINEERING	11690.00
4.	CONTINGENCY	11690.00
5.	PVC LINER	3770.00
TOTAL		147390.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	13680.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	1640.00
5.	PVC LINER	140.00
TOTAL		21710.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	21710.00
2.	YEARLY INVESTMENT COST RECOVERY	5900.00
3.	DEPRECIATION	7200.00
TOTAL		34810.00

Alternative A 14-VI - This alternative provides in addition to Alternative A 14-V dual media pressure filtration and a pump station to generate sufficient head for filter operation.

The resulting BOD waste load is 0.015 kg/kkg (0.030 lb/ton), the suspended solids load is 0.015 kg/kkg (0.030 lb/ton), and the oil and grease load is 0.008 kg/kkg (0.016 lb/ton).

Costs:	Total investment cost:	$163,350
	Total yearly cost:	$ 39,520

An itemized breakdown of costs is presented in Table 241. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits:	BOD:	97.3 percent
	SS:	96.4 percent
	O&G:	96.2 percent

Alternative A 14-VII - This alternative provides in addition to Alternative A 14-VI activated carbon adsorption before final discharge to navigable waters.

The resulting BOD waste load is 0.008 kg/kkg (0.016 lb/ton), the suspended solids load is 0.008 kg/kkg (0.016 lb/ton), and the oil and grease load is 0.004 kg/kkg (0.008 lb/ton).

Costs:	Total investment cost:	$205,260
	Total yearly cost:	$ 57,640

An itemized breakdown of costs is presented in Table 242. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that a one-half time operator is required.

Reduction Benefits:	BOD:	98.6 percent
	SS:	98.1 percent
	O&G:	98.1 percent

A cost efficiency curve is presented in Figure 288.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 15 - Olive Oil Refining

A model plant representative of subcategory A 15 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 7.6 cu m (0.002 MG) of refined olive oil per day.

DRAFT

TABLE 241

ITEMIZED COST SUMMARY FOR ALTERNATIVE A14-VI
(SHORTENING AND TABLE OIL PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN (BL)BN
DESIGN EFFICIENCY... 97.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:		
	1. CONSTRUCTION	130210.00
	2. LAND	3330.00
	3. ENGINEERING	13020.00
	4. CONTINGENCY	13020.00
	5. PVC LINER	3770.00
	TOTAL	163350.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	15290.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	3310.00
	5. PVC LINER	140.00
	TOTAL	24990.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	24990.00
	2. YEARLY INVESTMENT COST RECOVERY	6530.00
	3. DEPRECIATION	8000.00
	TOTAL	39520.00

DRAFT

TABLE 242

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 14-VII
(SHORTENING AND TABLE OIL PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN (BLBN)Z
DESIGN EFFICIENCY... 98.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:		
1.	CONSTRUCTION	165140.00
2.	LAND	3330.00
3.	ENGINEERING	16510.00
4.	CONTINGENCY	16510.00
5.	PVC LINER	3770.00
TOTAL		205260.00
YEARLY OPERATING COSTS:		
1.	LABOR	6250.00
2.	POWER	17650.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	15290.00
5.	PVC LINER	140.00
TOTAL		39330.00
TOTAL YEARLY COSTS:		
1.	YEARLY OPERATING COST	39330.00
2.	YEARLY INVESTMENT COST RECOVERY	8210.00
3.	DEPRECIATION	10100.00
TOTAL		57640.00

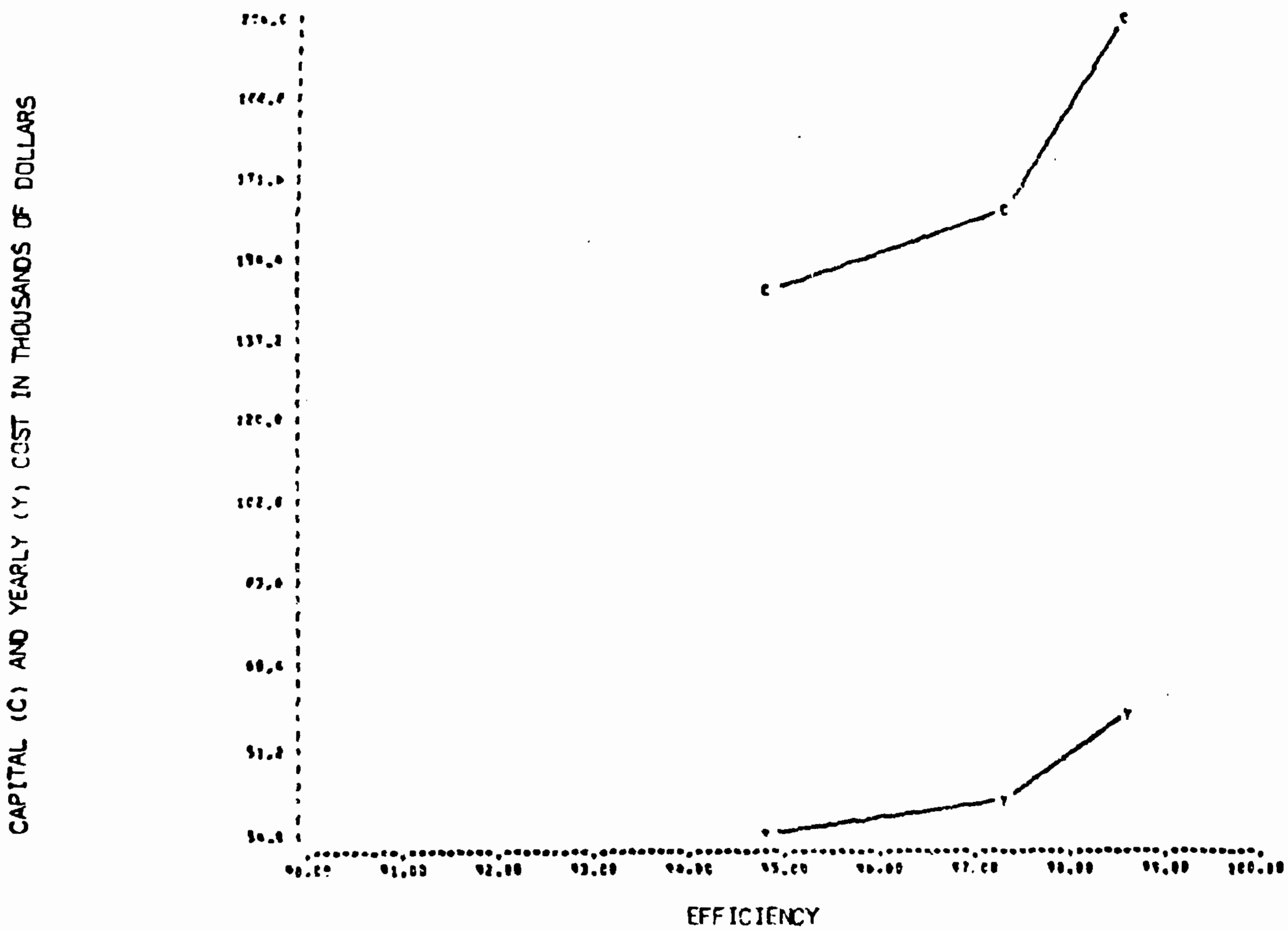


FIGURE 288

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A1C, ALTERNATIVE V THROUGH VII

It is estimated that the effluent from a 7.6 cu m (0.002 MG) per day plant is 1.1 cu m (0.0003 MG) per day. The BOD waste load is 0.85 kg/cu m (7.1 lb/1000 gal), the suspended solids load is 0.044 kg/cu m (0.37 lb/1000 gal) and the oil and grease load is 0.029 kg/cu m (0.24 lb/gal).

Alternative A 15-I - This alternative consists of pumping station, a holding tank and spray irrigation of the raw waste effluent. It is assumed that a minimum of 0.65 ha (1.6 acres) of land is required.

The resulting BOD waste load is 0.0 kg/cu m (0.0 lb/1000 gal), the suspended solids load is 0.0 kg/cu m (0.0 lb/1000 gal) and the oil and grease load is 0.0 kg/cu m (0.0 lb/1000 gal).

Costs: Total investment cost: $37,730
Total yearly cost: $ 5,170

An itemized breakdown of costs is presented in Table 243. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 15-II - This alternative consists of land spreading the raw waste effluent. It is assumed that a minimum of 0.4 ha (one acre) of land is required and that the effluent does not need to be pumped more than 150 m (500 ft).

The resulting BOD waste load is 0.0 kg/cu m (0.0 lb/1000 gal), the suspended solids load is 0.0 kg/cu m (0.0 lb/1000 gal) and the oil and grease load is 0.0 kg/cu m (0.0 lb/1000 gal).

Costs: Total investment cost: $5,260
Total yearly cost: $ 540

An itemized breakdown of costs is presented in Table 244. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

DRAFT

TABLE 243

ITEMIZED COST SUMMARY FOR ALTERNATIVE A15-I
(OLIVE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	29220.00
	2. LAND	2670.00
	3. ENGINEERING	2920.00
	4. CONTINGENCY	2920.00
	TOTAL	37730.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	830.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1080.00
	TOTAL	1910.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	1910.00
	2. YEARLY INVESTMENT COST RECOVERY	1510.00
	3. DEPRECIATION	1750.00
	TOTAL	5170.00

DRAFT

TABLE 244

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 15-II
(OLIVE OIL REFINING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 100 PERCENT BOD REDUCTION

TREATMENT MODULES:
LAND SPREADING

INVESTMENT COSTS:		
	1. CONSTRUCTION	3000.00
	2. LAND	1660.00
	3. ENGINEERING	300.00
	4. CONTINGENCY	300.00
	TOTAL	5260.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.00
	2. POWER	0.00
	3. CHEMICALS	0.00
	4. MAINTENANCE & SUPPLIES	150.00
	TOTAL	150.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	150.00
	2. YEARLY INVESTMENT COST RECOVERY	210.00
	3. DEPRECIATION	180.00
	TOTAL	540.00

Alternative A 15-III - This alternative consists of hauling the wastewater to a municipal treatment facility.

The resulting BOD waste load is 0.0 kg/cu m (0.0 lb/1000 gal), the suspended solids load is 0.0 kg/cu m (0.0 lb/1000 gal) and the oil and grease load is 0.0 kg/cu m (0.0 lb/1000 gal).

Costs: Total investment cost: $0.
Total yearly cost: $1,200

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

BEVERAGES

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 16 - New Large Breweries

A model plant representative of subcategory A 16 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, thirteen alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 1500 cu m (12,800 bbl) per day.

Alternative A 16-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 1500 cu m (12,800 bbl) per day plant is 8300 cu m (2.2 m) per day. The BOD waste load is 10.55 kg/cu m (2.722 lb/bbl), and the suspended solids load is 3.89 kg/cu m (1.004 lb/bbl).

Costs: 0
Reduction Benefits: None

Alternative A 16-II - This alternative provides screening and a grit chamber, flow equalization, neutralization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load 150.28 kg/cu m (0.072 lb/bbl) and the suspended solids load is 0.39 kg/cu m (0.100 lb/bbl).

Costs: Total investment cost: $2,355,740
Total yearly cost: $1,055,530

An itemized breakdown of costs is presented in Table 245. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 97.4 percent
SS: 90.0 percent

DRAFT

TABLE 245

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-II (NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..SCREENING & GRIT CHAMBER
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	1879640.00
2.	LAND	26410.00
3.	ENGINEERING	187960.00
4.	CONTINGENCY	187960.00
5.	PVC LINER	73770.00
TOTAL		2355740.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	678780.00
3.	CHEMICALS	74190.00
4.	MAINTENANCE&SUPPLIES	61670.00
5.	PVC LINER	5200.00
TOTAL		844830.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	844830.00
2.	YEARLY INVESTMENT COST RECOVERY	94230.00
3.	DEPRECIATION	116470.00
TOTAL		1055530.00

Alternative A 16-III - This alternative provides in addition to Alternative A 16-II dual media filtration.

The resulting BOD waste load is 0.14 kg/cu m (0.036 lb/bbl), and the suspended solids load is 0.19 kg/cu m (0.049 lb/bbl).

Costs: Total investment cost: $2,495,160
Total yearly cost: $1,088,090

An itemized breakdown of costs is presented in Table 246. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.7 percent
SS: 95.0 percent

Alternative A 16-IV - This alternative adds activated carbon to Alternative A 16-III.

The resulting BOD waste load is 0.07 kg/cu m (0.018 lb/bbl), and the suspended solids load is 0.09 kg/cu m (0.023 lb/bbl).

Costs: Total investment cost: $3,798,200
Total yearly cost: $1,324,820

An itemized breakdown of costs is presented in Table 247. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.4 percent
SS: 97.6 percent

A cost efficiency curve is presented in Figure 239.

Alternative A 16-V - This alternative provides a control house, screening and a grit chamber, flow equalization, neutralization, nutrient addition, a complete-mix activated sludge system, sludge thickening, aerobic digestion, and vacuum filtration.

The resulting BOD waste load is 0.28 kg/cu m (0.072 lb/bbl), and the suspended solids load is 0.39 kg/cu m (0.100 lb/bbl).

Costs: Total investment cost: $3,730,960
Total yearly cost: $1,029,500

An itemized breakdown of costs is presented in Table 248. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 97.4 percent
SS: 90.0 percent

DARFT

TABLE 246

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-III (NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..SCREENING & GRIT CHAMBER
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	1995820.00
2. LAND	26410.00
3. ENGINEERING	199580.00
4. CONTINGENCY	199580.00
5. PVC LINER	73770.00
TOTAL	2495160.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	696880.00
3. CHEMICALS	74190.00
4. MAINTENANCE&SUPPLIES	63580.00
5. PVC LINER	5200.00
TOTAL	864840.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	864840.00
2. YEARLY INVESTMENT COST RECOVERY	99810.00
3. DEPRECIATION	123440.00
TOTAL	1088090.00

TABLE 247

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-IV
(NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

E1..SCREENING & GRIT CHAMBER
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRAIN
Z.. ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	3081680.00
2.	LAND	26410.00
3.	ENGINEERING	308170.00
4.	CONTINGENCY	308170.00
5.	PVC LINER	73770.00
TOTAL		3798200.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	728220.00
3.	CHEMICALS	74190.00
4.	MAINTENANCE&SUPPLIES	151700.00
5.	PVC LINER	5200.00
TOTAL		984300.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	984300.00
2.	YEARLY INVESTMENT COST RECOVERY	151930.00
3.	DEPRECIATION	188590.00
TOTAL		1324820.00

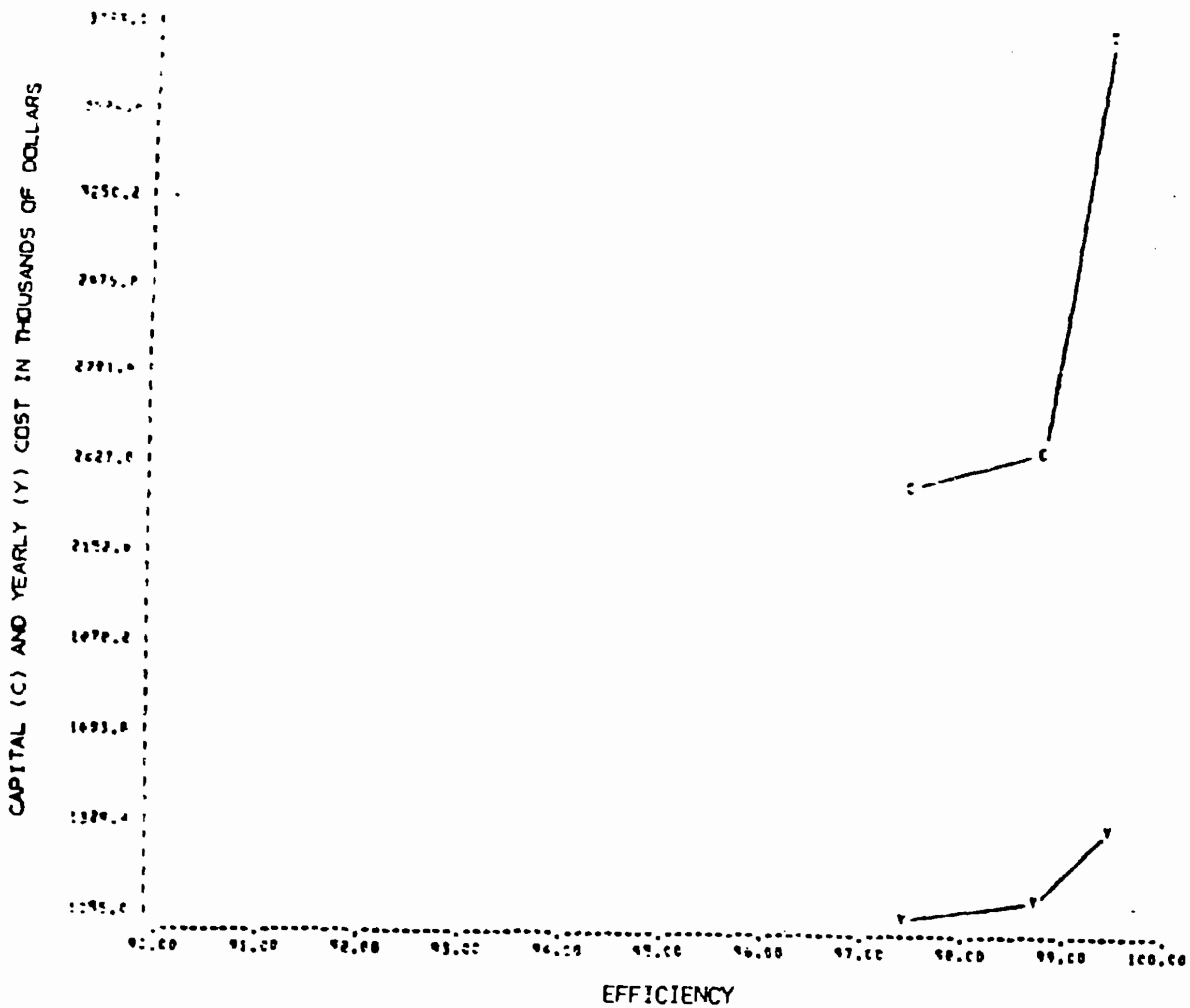


FIGURE 289

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A.16, ALTERNATIVE IV

DRAFT

TABLE 248

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-V (NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- E1..SCREENING & GRIT CHAMBER
- 9...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTER
- S...VACUUM FILTRATION
- Y...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	3028620.00
2. LAND	96620.00
3. ENGINEERING	302860.00
4. CONTINGENCY	302860.00
TOTAL	3730960.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	458410.00
3. CHEMICALS	113770.00
4. MAINTENANCE&SUPPLIES	51390.00
TOTAL	698540.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	698540.00
2. YEARLY INVESTMENT COST RECOVERY	149240.00
3. DEPRECIATION	181720.00
TOTAL	1029500.00

Alternative A 16-VI - This alternative provides dual media filtration in addition to Alternative A 16-V.

The resulting BOD waste load is 0.14 kg/cu m (0.036 lb/bbl), and the suspended solids load is 0.19 kg/cu m (0.049 lb/bbl).

Costs:	Total investment cost:	$3,870,380
	Total yearly cost:	$1,062,060

An itemized breakdown of costs is presented in Table 249. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits:	BOD:	98.7 percent
	SS:	95.0 percent

Alternative A 16-VII - This alternative adds activated carbon to Alternative A 16-VI.

The resulting BOD waste load is 0.07 kg/cu m (0.018 lb/bbl), and the suspended solids load is 0.09 kg/cu m (0.023 lb/bbl).

Costs:	Total investment cost:	$5,173,420
	Total yearly cost:	$1,298,800

An itemized breakdown of costs is presented in Table 250. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits:	BOD:	99.4 percent
	SS:	97.6 percent

A cost efficiency curve is presented in Figure 290.

Alternative A 16-VIII - This alternative replaces vacuum filtration in A 16-V with sludge storage and spray irrigation.

The resulting BOD waste load is 0.28 kg/cu m (0.072 lb/bbl), and the suspended solids load is 0.39 kg/cu m (0.100 lb/bbl).

Costs:	Total investment cost:	$3,652,280
	Total yearly cost:	$ 933,750

An itemized breakdown of costs is presented in Table 251. It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits:	BOD:	97.4 percent
	SS:	90.0 percent

Alternative A 16-IX - This alternative adds dual media filtration to Alternative A 16-VIII.

DRAFT

TABLE 249

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-VI
(NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTER
S...VACUUM FILTRATION
Y...HOLDING TANK
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	3144800.00
2.	LAND	96620.00
3.	ENGINEERING	314480.00
4.	CONTINGENCY	314480.00
TOTAL		3870380.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	476510.00
3.	CHEMICALS	113770.00
4.	MAINTENANCE&SUPPLIES	53300.00
TOTAL		718550.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	718550.00
2.	YEARLY INVESTMENT COST RECOVERY	154820.00
3.	DEPRECIATION	188690.00
TOTAL		1062060.00

DRAFT

TABLE 250

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-VII (NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- E1..SCREENING & GRIT CHAMBER
- P...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- F...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- N...DUAL MEDIA PRESSURE FILTRATION
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	4230660.00
2. LAND	96620.00
3. ENGINEERING	423070.00
4. CONTINGENCY	423070.00
TOTAL	5173420.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	507850.00
3. CHEMICALS	113770.00
4. MAINTENANCE&SUPPLIES	141430.00
TOTAL	838020.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	838020.00
2. YEARLY INVESTMENT COST RECOVERY	206940.00
3. DEPRECIATION	253840.00
TOTAL	1298800.00

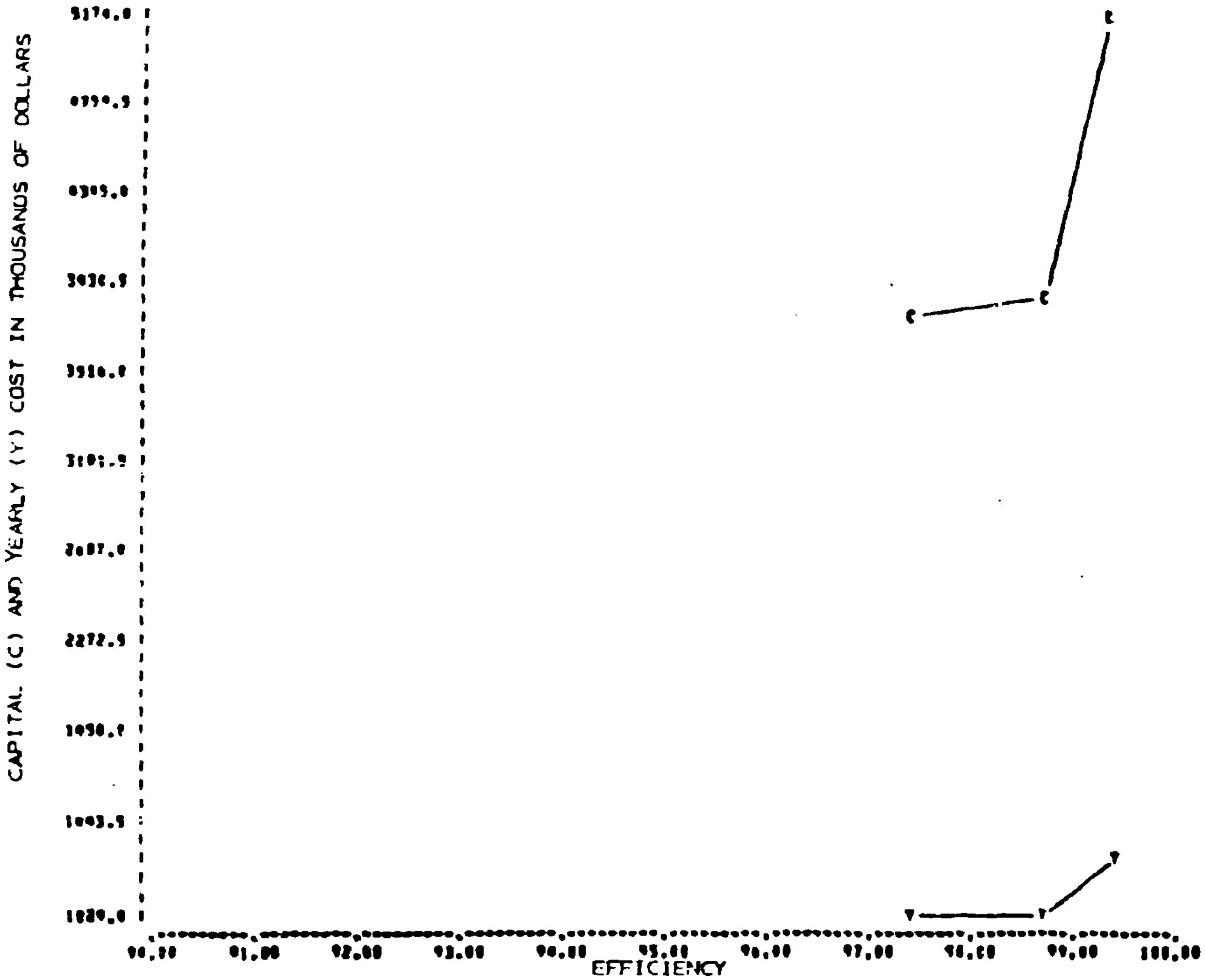


FIGURE 290

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 16, ALTERNATIVE VII

DRAFT

TABLE 251

ITEMIZED COST SUMMARY FOR ALTERNATIVE A1C-VIII (NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
A1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
D...SLUDGE THICKENER
F...AEROBIC DIGESTOR
Y...HOLDING TANK
L. .SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	3006770.00
2. LAND	44150.00
3. ENGINEERING	300680.00
4. CONTINGENCY	300680.00
TOTAL	3652280.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	430350.00
3. CHEMICALS	74190.00
4. MAINTENANCE&SUPPLIES	27740.00
TOTAL	607250.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	607250.00
2. YEARLY INVESTMENT COST RECOVERY	146090.00
3. DEPRECIATION	180410.00
TOTAL	933750.00

DRAFT

The resulting BOD waste load is 0.14 kg/cu m (0.036 lb/bbl), and the suspended solids load is 0.19 kg/cu m (0.049 lb/bbl).

Costs: Total investment cost: $3,791,680
Total yearly cost: $ 966,310

An itemized breakdown of costs is presented in Table 252 It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.7 percent
SS: 95.0 percent

Alternative A 16-X - This alternative adds activated carbon to Alternative A 16-IX.

The resulting BOD waste load is 0.07 kg/cu m (0.018 lb/bbl), and the suspended solids load is 0.09 kg/cu m (0.023 lb/bbl).

Costs: Total investment cost: $5,094,720
Total yearly cost: $1,203,040

An itemized breakdown of costs is presented in Table 253 It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.4 percent
SS: 97.6 percent

A cost efficiency curve is presented in Figure 291.

Alternative A 16-XI - This alternative replaces vacuum filtration in Alternative A 16V with sand drying.

The resulting BOD waste load is 0.28 kg/cu m (0.072 lb/bbl), and the suspended solids load is 0.39 kg/cum (0.100 lb/bbl).

Costs: Total investment cost: $6,764,510
Total yearly cost: $1,527,890

An itemized breakdown of costs is presented in Table 254 It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 97.4 percent
SS: 90.0 percent

Alternative A 16-XII - This alternative adds dual media filtration to Alternative A 16-XI.

The resulting BOD waste load is 0.014 kg/cu m (0.036 lb/bbl), and the suspended solids load is 0.019 kg/cu m (0.049 lb/bbl).

DRAFT

TABLE 252

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-IX
(NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
P...AEROBIC DIGESTOR
Y...HOLDING TANK
L...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	3122950.00
2. LAND	44150.00
3. ENGINEERING	312290.00
4. CONTINGENCY	312290.00
TOTAL	3791680.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	448450.00
3. CHEMICALS	74190.00
4. MAINTENANCE&SUPPLIES	29650.00
TOTAL	627260.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	627260.00
2. YEARLY INVESTMENT COST RECOVERY	151670.00
3. DEPRECIATION	187380.00
TOTAL	966310.00

DRAFT

TABLE 253

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-X (NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- E1..SCREENING & GRIT CHAMBER
- P...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- L...SPRAY IRRIGATION
- N...DUAL MEDIA PRESSURE FILTRATION
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	4208810.00
2. LAND	44150.00
3. ENGINEERING	420880.00
4. CONTINGENCY	420880.00
TOTAL	5094720.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	479790.00
3. CHEMICALS	74190.00
4. MAINTENANCE&SUPPLIES	117770.00
TOTAL	746720.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	746720.00
2. YEARLY INVESTMENT COST RECOVERY	203790.00
3. DEPRECIATION	252530.00
TOTAL	1203040.00

DRAFT

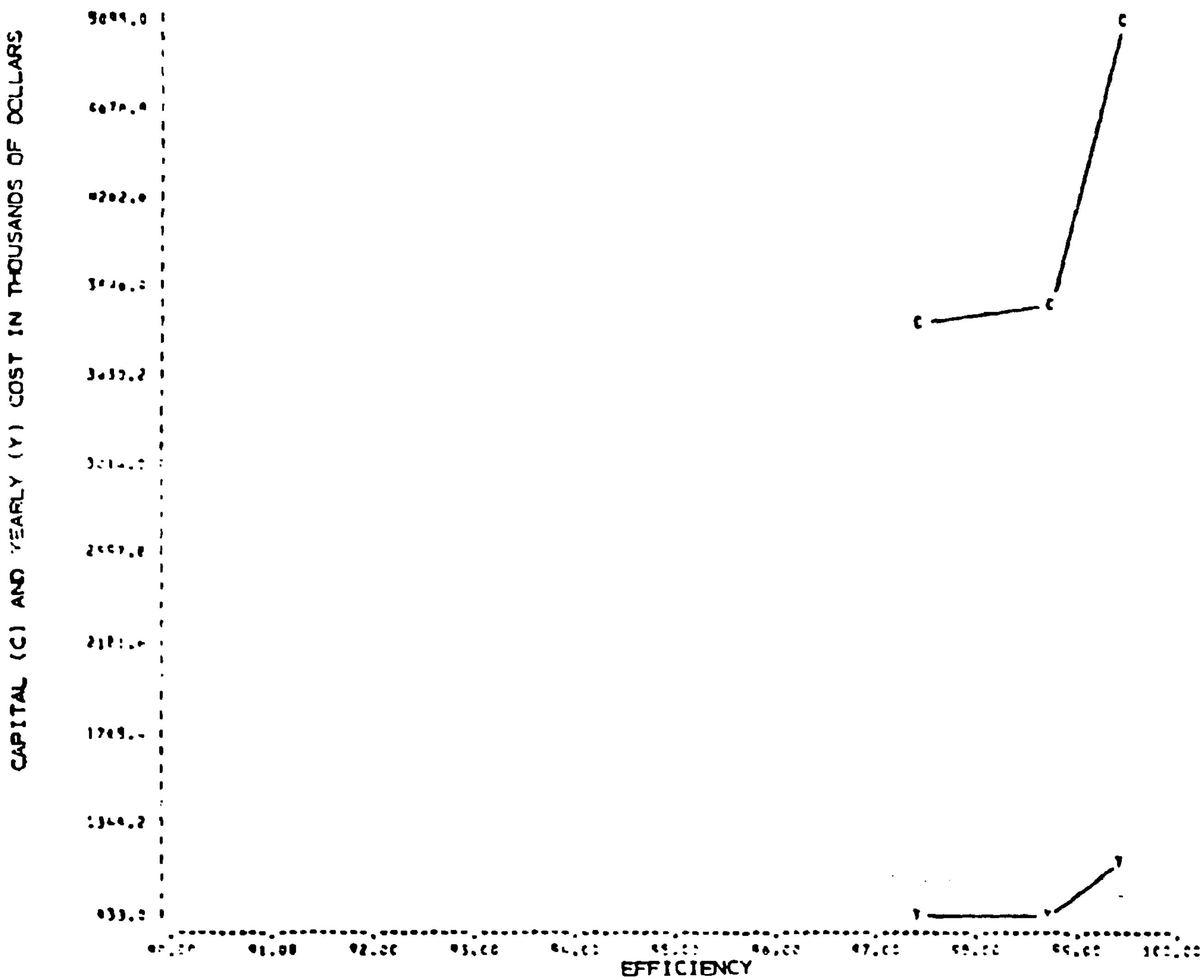


FIGURE 291

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 16, ALTERNATIVE X

DRAFT

TABLE 254

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-XI (NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

M1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
H...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS

INVESTMENT COSTS:

1.	CONSTRUCTION	5455920.00
2.	LAND	217410.00
3.	ENGINEERING	545590.00
4.	CONTINGENCY	545590.00
TOTAL		6764510.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	429170.00
3.	CHEMICALS	74190.00
4.	MAINTENANCE&SUPPLIES	351630.00
TOTAL		929960.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	929960.00
2.	YEARLY INVESTMENT COST RECOVERY	270580.00
3.	DEPRECIATION	327350.00
TOTAL		1527890.00

Costs: Total investment cost: $6,903,930
Total yearly cost: $1,560,460

An itemized breakdown of costs is presented in Table 255. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.7 percent
SS: 95.0 percent

Alternative A 16-XIII - This alternative adds activated carbon to Alternative A 16-XII.

The resulting BOD waste load is 0.07 kg/cu m (0.018 lb/bbl), and the suspended solids load is 0.09 kg/cu m (0.023 lb/bbl).

Costs: Total investment cost: $8,206,970
Total yearly cost: $1,797,190

An itemized breakdown of costs is presented in Table 256. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.4 percent
SS: 97.6 percent

A cost efficiency curve is presented in Figure 292.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 17 - Old Large Breweries

A model plant representative of subcategory A 17 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, thirteen alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 2600 cu m (22,000 bbl) per day.

Alternative A 17-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 2600 cu m (22,000 bbl) per day plant is 28,000 cu m (7.5 MG) per day. The BOD waste load is 18.56 kg/cu m (4.78 lb/bbl), and the suspended solids load is 7.32 kg/cu m (1.89 lb/bbl).

Costs: 0
Reduction Benefits: None

Alternative A 17-II - This alternative provides screening and a grit chamber, flow equalization, neutralization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 0.55 kg/cu m (0.14 lb/bbl), and the suspended solids load is 0.76 kg/cu m (0.20 lb/bbl).

DRAFT

TABLE 255

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-XII
(NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- E1..SCREENING & GRIT CHAMBER
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTER
- T...SAND DRYING BEDS
- W...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:	
1. CONSTRUCTION	5572100.00
2. LAND	217410.00
3. ENGINEERING	557210.00
4. CONTINGENCY	557210.00
TOTAL	6903930.00

YEARLY OPERATING COSTS:	
1. LABOR	74970.00
2. POWER	447270.00
3. CHEMICALS	74190.00
4. MAINTENANCE&SUPPLIES	353540.00
TOTAL	949970.00

TOTAL YEARLY COSTS:	
1. YEARLY OPERATING COST	949970.00
2. YEARLY INVESTMENT COST RECOVERY	276160.00
3. DEPRECIATION	334330.00
TOTAL	1560460.00

DRAFT

TABLE 256

ITEMIZED COST SUMMARY FOR ALTERNATIVE A16-XIII
(NEW LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS
W...DUAL MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	6657960.00
2.	LAND	217410.00
3.	ENGINEERING	665800.00
4.	CONTINGENCY	665800.00
	TOTAL	8206970.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	478610.00
3.	CHEMICALS	74190.00
4.	MAINTENANCE&SUPPLIES	441660.00
	TOTAL	1069430.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	1069430.00
2.	YEARLY INVESTMENT COST RECOVERY	328280.00
3.	DEPRECIATION	399480.00
	TOTAL	1797190.00

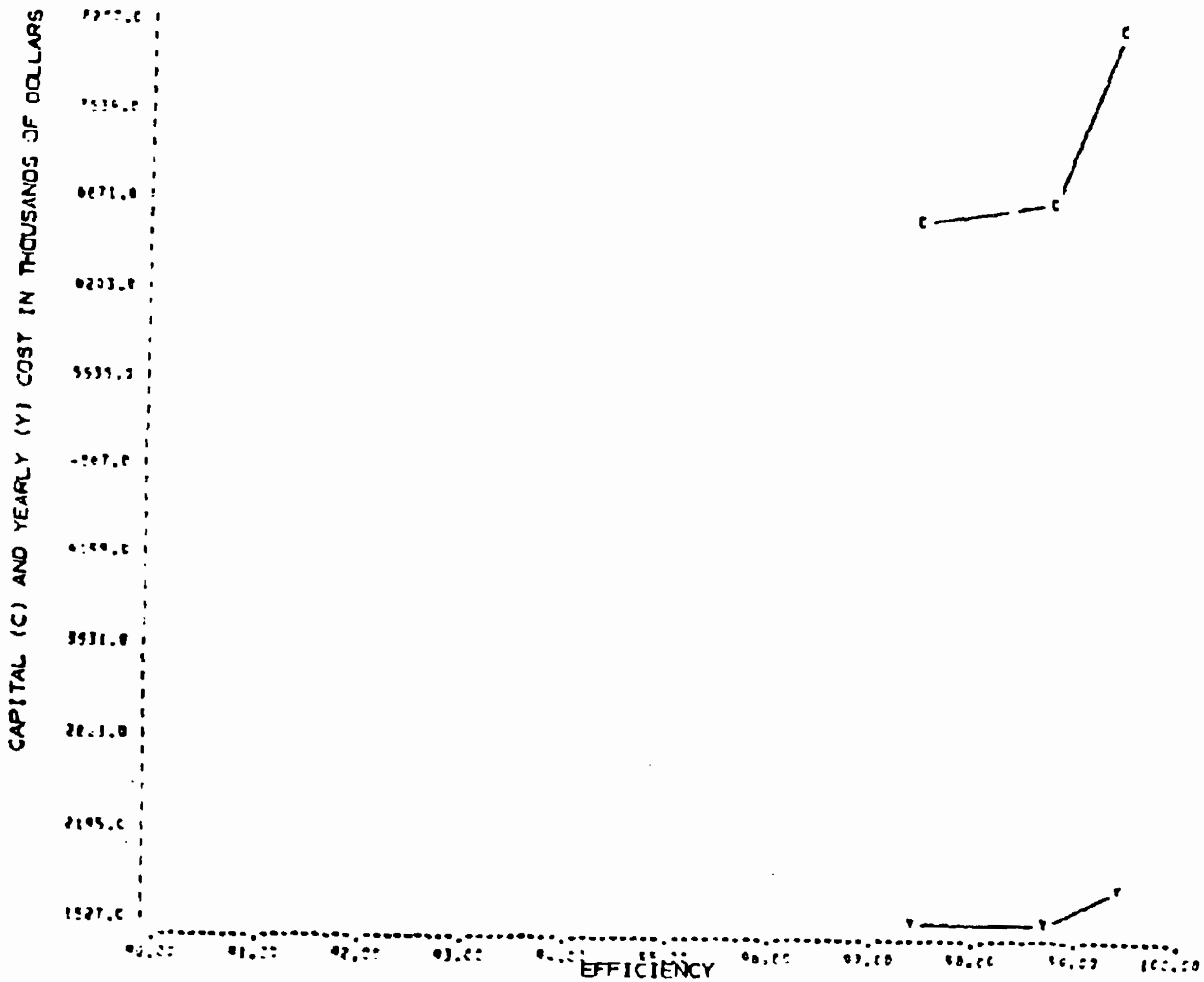


FIGURE 292

INVESTMENT AND YEARLY COST FOR SUBCATEGORY A 16, SUBCATEGORY Y1

Costs: Total investment cost: $7,125,250
Total yearly cost: $3,328,060

An itemized breakdown of costs is presented in Table 257. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 97.0 percent
SS: 89.5 percent

Alternative A 17-III - This alternative provides in addition to Alternative A 17-II dual media filtration.

The resulting BOD waste load is 0.27 kg/cu m (0.07 lb/bbl), and the suspended solids load is 0.38 kg/cu m (0.10 lb/bbl).

Costs: Total investment cost: $7,526,890
Total yearly cost: $3,422,120

An itemized breakdown of costs is presented in Table 258. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 94.7 percent

Alternative A 17-IV - This alternative adds activated carbon to Alternative A 17-III.

The resulting BOD waste load is 0.13 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.19 kg/cu m (0.05 lb/bbl).

Costs: Total investment cost: $11,677,060
Total yearly cost: $ 4,195,440

An itemized breakdown of costs is presented in Table 259. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.3 percent
SS: 97.5 percent

A cost efficiency curve is presented in Figure 293.

Alternative A 17-V - This alternative provides a control house, screening and a grit chamber, flow equalization, neutralization, nutrient addition, a complete mix activated sludge system, sludge thickening, aerobic digestion, and vacuum filtration.

DRAFT

TABLE 257

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-II (OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON
L...AERATED LAGOON
M...SETTLING POND

INVESTMENT COSTS:

1.	CONSTRUCTION	5697460.00
2.	LAND	55310.00
3.	ENGINEERING	569750.00
4.	CONTINGENCY	569750.00
5.	PVC LINER	232980.00
	TOTAL	7125250.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	2259300.00
3.	CHEMICALS	241780.00
4.	MAINTENANCE&SUPPLIES	145680.00
5.	PVC LINER	17800.00
	TOTAL	2689550.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	2689550.00
2.	YEARLY INVESTMENT COST RECOVERY	285010.00
3.	DEPRECIATION	353500.00
	TOTAL	3328060.00

DRAFT

TABLE 258

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-III
(OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- E1..SCREENING & GRIT CHAMBER
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- L...AERATED LAGOON
- M...SETTLING POND
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	6032160.00
2.	LAND	55310.00
3.	ENGINEERING	603220.00
4.	CONTINGENCY	603220.00
5.	PVC LINER	232980.00
TOTAL		7526890.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	2311710.00
3.	CHEMICALS	241780.00
4.	MAINTENANCE&SUPPLIES	151180.00
5.	PVC LINER	17800.00
TOTAL		2747460.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	2747460.00
2.	YEARLY INVESTMENT COST RECOVERY	301080.00
3.	DEPRECIATION	373580.00
TOTAL		3422120.00

DRAFT

TABLE 259

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-IV (OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

- E1..SCREENING & GRIT CHAMBER
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- L...AERATED LAGOON
- M...SETTLING POND
- N...DUAL MEDIA PRESSURE FILTRATN
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	9490650.00
2.	LAND	55310.00
3.	ENGINEERING	949060.00
4.	CONTINGENCY	949060.00
5.	PVC LINER	232980.00
	TOTAL	11677060.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	2412030.00
3.	CHEMICALS	241780.00
4.	MAINTENANCE&SUPPLIES	450670.00
5.	PVC LINER	17800.00
	TOTAL	3147270.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	3147270.00
2.	YEARLY INVESTMENT COST RECOVERY	467080.00
3.	DEPRECIATION	581090.00
	TOTAL	4195440.00

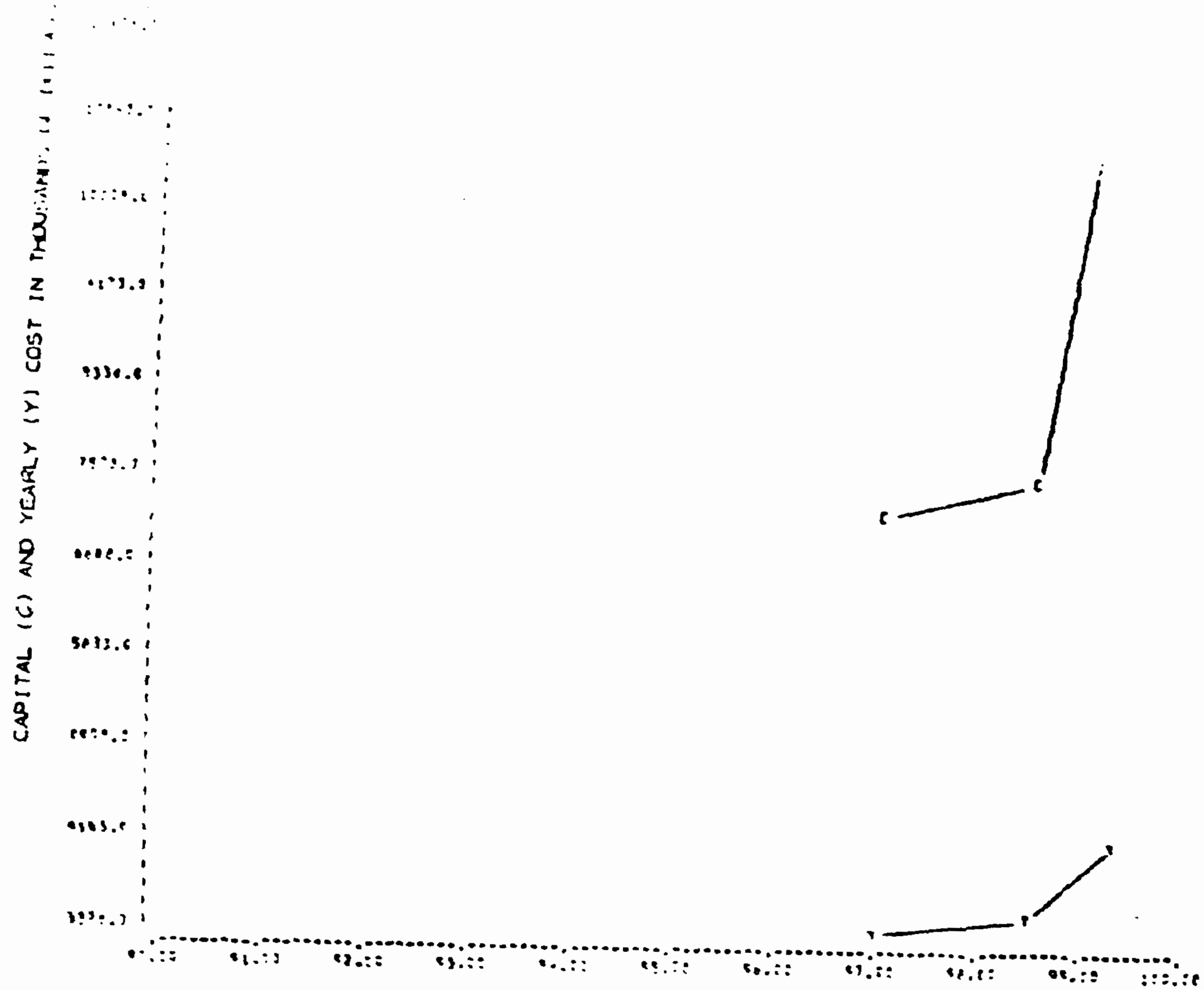


FIGURE 273

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 17, ALTERNATIVE IV

The resulting BOD waste load is 0.55 kg/cu m (0.14 lb/bbl), and the suspended solids load is 0.76 kg/cu m (0.20 lb/bbl).

Costs: Total investment cost: $11,377,110
Total yearly cost: $ 3,107,230

An itemized breakdown of costs is presented in Table 260. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 97.0 percent
SS: 89.5 percent

Alternative A 17-VI - This alternative provides dual media filtration in addition to Alternative A 17-V.

The resulting BOD waste load is 0.27 kg/cu m (0.07 lb/bbl), and the suspended solids load is 0.38 kg/cu m (0.10 lb/bbl).

Costs: Total investment cost: $11,778,750
Total yearly cost: $ 3,201,290

An itemized breakdown of costs is presented in Table 261. It is assumed that land costs $41,000 per hectare (16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 94.7 percent

Alternative A 17-VII - This alternative adds activated carbon to Alternative A 17-VI.

The resulting BOD waste load is 0.13 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.19 kg/cu m (0.05 lb/bbl).

Costs: Total investment cost: $15,928,940
Total yearly cost: $ 3,974,630

An itemized breakdown of costs is presented in Table 262. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.3 percent
SS: 97.5 percent

A cost efficiency curve is presented in Figure 294.

Alternative A 17-VIII - This alternative replaces vacuum filtration in A 17-V with sludge storage and spray irrigation.

DRAFT

TABLE 260

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-V (OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- M1..CONTROL HOUSE
- F...ACID NEUTRALIZATION
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- R...SLUDGE THICKENER
- P...AEROBIC DIGESTER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1.	CONSTRUCTION	9260880.00
2.	LAND	264050.00
3.	ENGINEERING	926090.00
4.	CONTINGENCY	926090.00
TOTAL		11377110.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	1518390.00
3.	CHEMICALS	481670.00
4.	MAINTENANCE&SUPPLIES	21470.00
TOTAL		2096500.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	2096500.00
2.	YEARLY INVESTMENT COST RECOVERY	455080.00
3.	DEPRECIATION	555650.00
TOTAL		3107230.00

TABLE 261

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-VI
(OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

01..CONTROL HOUSE
F...ACID NEUTRALIZATION
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTOR
S...VACUUM FILTRATION
Y...HOLDING TANK
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	9595580.00
2.	LAND	264050.00
3.	ENGINEERING	959560.00
4.	CONTINGENCY	959560.00
TOTAL		11778750.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	1570810.00
3.	CHEMICALS	481670.00
4.	MAINTENANCE&SUPPLIES	26960.00
TOTAL		2154410.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	2154410.00
2.	YEARLY INVESTMENT COST RECOVERY	471150.00
3.	DEPRECIATION	575730.00
TOTAL		3201290.00

DRAFT

TABLE 262

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-VII (OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
F...ACID NEUTRALIZATION
P...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
S...VACUUM FILTRATION
Y...HOLDING TANK
N...DUAL MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	13054070.00
2. LAND	264050.00
3. ENGINEERING	1305410.00
4. CONTINGENCY	1305410.00
TOTAL	15928940.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	1671120.00
3. CHEMICALS	481670.00
4. MAINTENANCE&SUPPLIES	326470.00
TOTAL	2554230.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	2554230.00
2. YEARLY INVESTMENT COST RECOVERY	637160.00
3. DEPRECIATION	783240.00
TOTAL	3974630.00

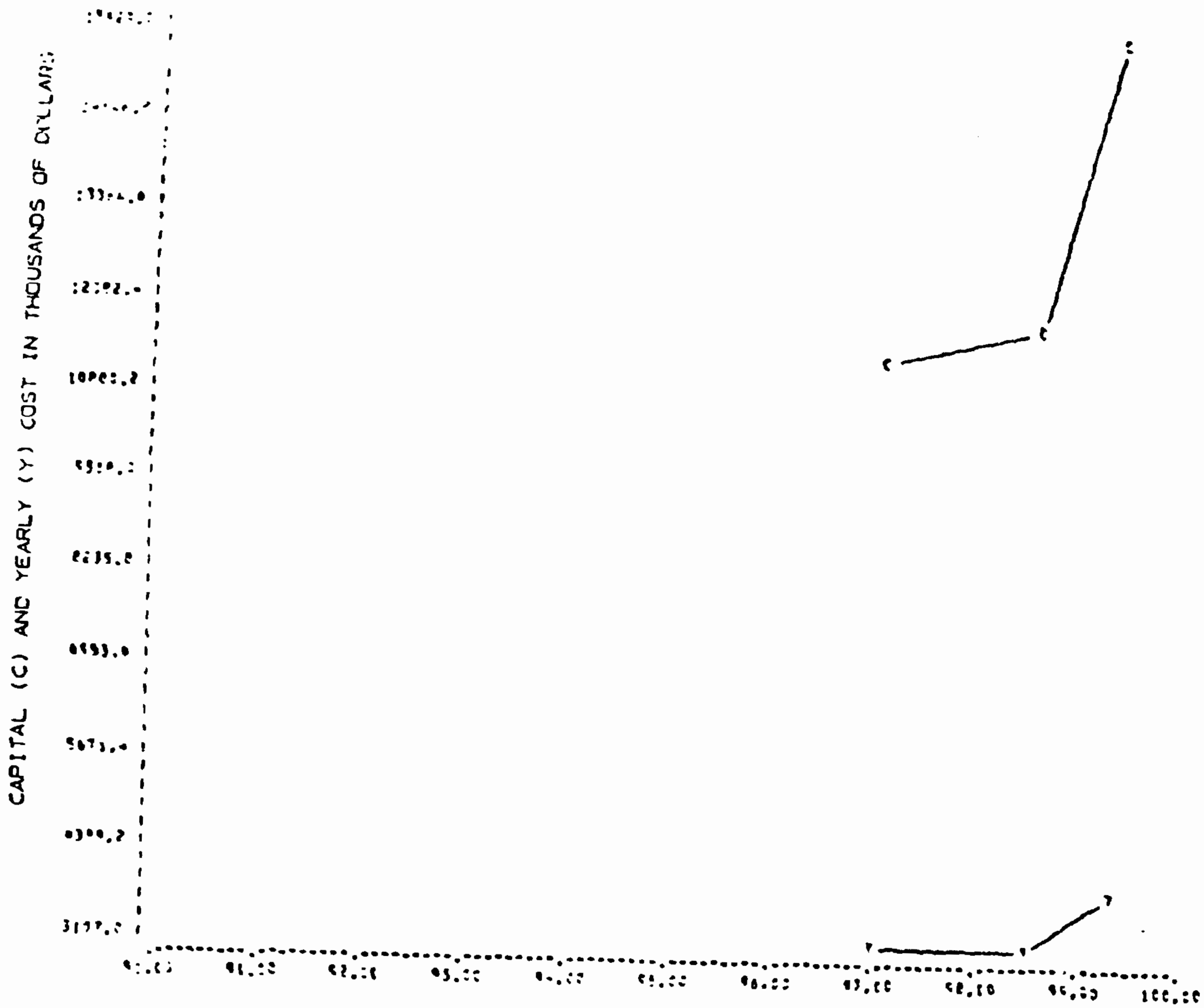


FIGURE 234

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 17 ALTERNATIVE VII

The resulting BOD waste load is 0.55 kg/cu m (0.14 lb/bbl), and the suspended solids load is 0.76 kg/cu m (0.20 lb/bbl).

Costs: Total investment cost: $11,233,200
Total yearly cost: $ 2,833,190

An itemized breakdown of costs is presented in Table 263. It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 97.0 percent
SS: 89.5 percent

Alternative A 17-IX - This alternative adds dual media filtration to Alternative A 17-VIII.

The resulting BOD waste load is 0.27 kg/cu m (0.07 lb/bbl), and the suspended solids load is 0.38 kg/cu m (0.10 lb/bbl).

Costs: Total investment cost: $11,634,840
Total yearly cost. $ 2,927,240

An itemized breakdown of costs is presented in Table 264. It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 94.7 percent

Alternative A 17-X - This alternative adds activated carbon to Alternative A 17-IX.

The resulting BOD waste load is 0.13 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.19 kg/cu m (0.05 lb/bbl).

Costs: Total investment cost: $15,785,030
Total yearly cost: $ 3,700,570

An itemized breakdown of costs is presented in Table 265. It is assumed that land costs assumed that six operators are required.

Reduction Benefits: BOD: 99.3 percent
SS: 97.5 percent

A cost efficiency curve is presented in Figure 295.

Alternative A 17-XI - This alternative replaces vacuum filtration in Alternative A 17-V with sand drying beds. This alternative was not deemed economically viable and therefore was not costed.

DRAFT

TABLE 263

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-VIII (OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
P...PUMPING STATION
Q...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
S...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	9252610.00
2. LAND	130070.00
3. ENGINEERING	925260.00
4. CONTINGENCY	925260.00
TOTAL	11233200.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	1430180.00
3. CHEMICALS	241780.00
4. MAINTENANCE&SUPPLIES	81770.00
TOTAL	1828700.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	1828700.00
2. YEARLY INVESTMENT COST RECOVERY	449330.00
3. DEPRECIATION	555160.00
TOTAL	2833190.00

DRAFT

TABLE 264

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-IX (OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B1..SCREENING & GRIT CHAMBER
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- L...SPRAY IRRIGATION
- N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	9587310.00
2. LAND	130070.00
3. ENGINEERING	958730.00
4. CONTINGENCY	958730.00
TOTAL	11634840.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	1482600.00
3. CHEMICALS	241780.00
4. MAINTENANCE&SUPPLIES	87260.00
TOTAL	1886610.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	1886610.00
2. YEARLY INVESTMENT COST RECOVERY	465390.00
3. DEPRECIATION	575240.00
TOTAL	2927240.00

DRAFT

TABLE 265

ITEMIZED COST SUMMARY FOR ALTERNATIVE A17-X
(OLD LARGE BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
L...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATION
Z.. ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	13045800.00
2. LAND	130070.00
3. ENGINEERING	1304580.00
4. CONTINGENCY	1304580.00
TOTAL	15785030.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	1582910.00
3. CHEMICALS	241780.00
4. MAINTENANCE&SUPPLIES	386760.00
TOTAL	2286420.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	2286420.00
2. YEARLY INVESTMENT COST RECOVERY	631400.00
3. DEPRECIATION	782750.00
TOTAL	3700570.00

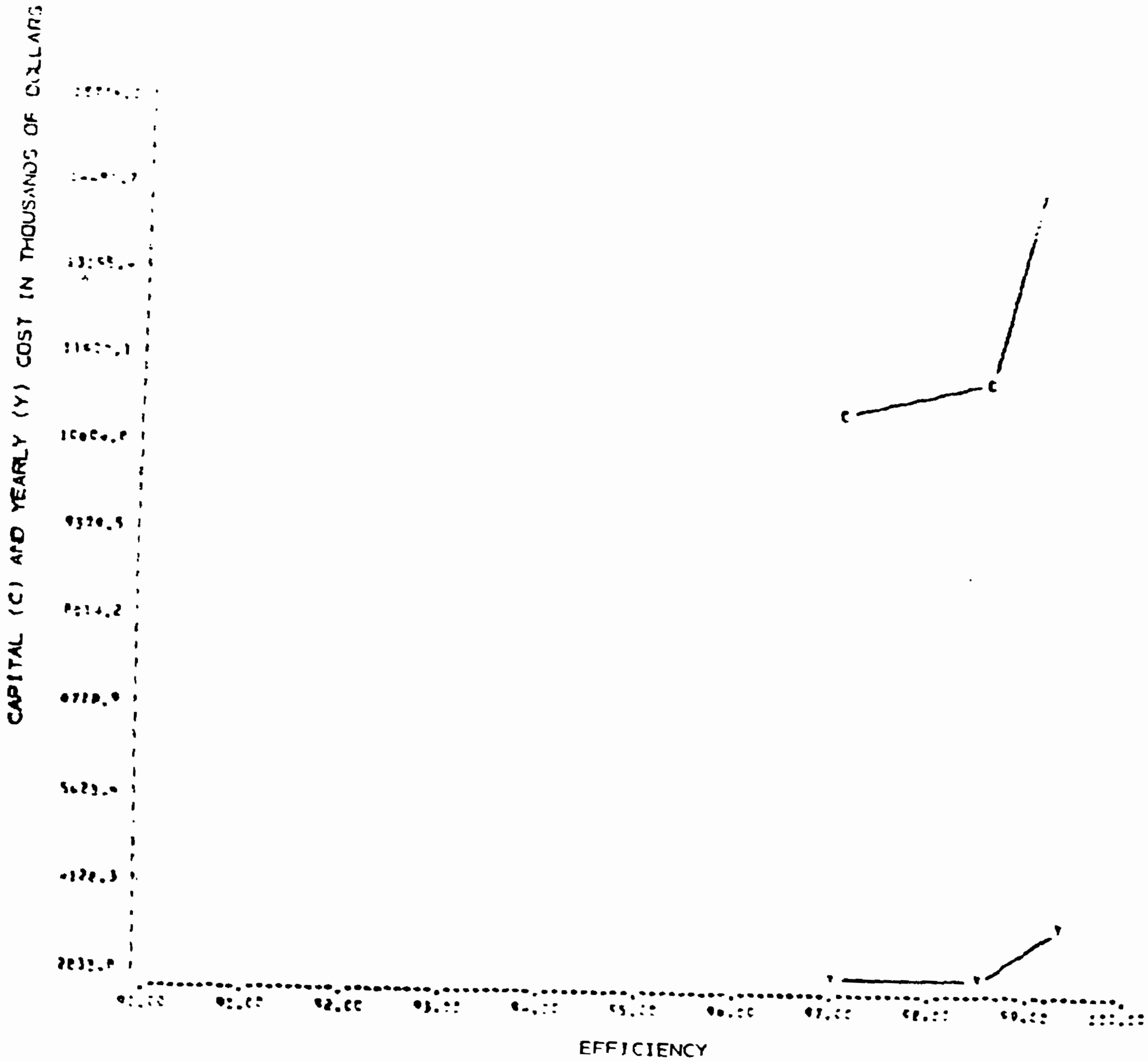


FIGURE 295

[illegible] AND YEARLY COSTS FOR SUBCATEGORY A 17, ALTERNATIVE X

The resulting BOD waste load is 0.55 kg/cu m (0.14 lb/bbl), and the suspended solids load is 0.76 kg/cu m (0.20 lb/bbl).

Reduction Benefits: BOD: 97.0 percent
SS: 89.5 percent

Alternative A 17-XII - This alternative adds dual media filtration to Alternative A 17-XI. This alternative was not deemed economically viable and therefore was not costed.

The resulting BOD waste load is 0.27 kg/cu m (0.07 lb/bbl), and the suspended solids load is 0138 kg/cu m (0.10 lb/bbl).

Reduction Benefits: BOD: 98.5 percent
SS: 94.7 percent

Alternative A 17-XIII - This alternative adds activated carbon to Alternative A 17-XII. This alternative was not deemed economically viable and therefore was not costed.

The resulting BOD waste load is 0.13 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.19 kg/cu m (0.05 lb/bbl).

Reduction Benefits: BOD: 99.3 percent
SS: 97.5 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 18 - All Other Breweries

A model plant representative of subcategory A 18 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, thirteen alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 470 cu m (4000 bbl) per day.

Alternative A 18-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 470 cu m (4000 bbl) per day plant is 4500 cu m (1.2 MG) per day. The BOD waste load is 13.53 kg/cu m (3.491 lb/bbl), and the suspended solids load is 6.19 kg/cu m (1.60 lb/bbl).

Costs: 0
Reduction Benefits: None

Alternative A 18-II - This alternative provides screening and a grit chamber, flow equalization, neutralization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 0.48 kg/cu m (0.12 lb/bbl), and the suspended solids load is 0.68 kg/cu m (0.18 lb/bbl).

Costs: Total investment cost: $1,344,140
Total yearly cost: $ 530,240

An itemized breakdown of costs is presented in Table 266. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 96.4 percent
SS: 89.1 percent

Alternative A 18-III - This alternative provides in addition to Alternative A 18-II dual media filtration.

The resulting BOD waste load is 0.24 kg/cu m (0.06 lb/bbl), and the suspended solids load is 0.34 kg/cu m (0.09 lb/bbl).

Costs: Total investment cost: $1,432,200
Total yearly cost: $ 551,760

An itemized breakdown of costs is presented in Table 267. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.2 percent
SS: 94.5 percent

Alternative A 18-IV - This alternative adds activated carbon to Alternative A 18-III.

The resulting BOD waste load is 0.12 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.17 kg/cu m (0.04 lb/bbl).

Costs: Total investment cost: $2,337,000
Total yearly cost: $ 706,630

An itemized breakdown of costs is presented in Table 268. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.0 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 296.

Alternative A 18-V - This alternative provides a control house, screening and a grit chamber, flow equalization, neutralization, nutrient addition, a complete mix activated sludge system, sludge thickening, aerobic digestion, and vacuum filtration.

DRAFT

TABLE 266

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-II (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A...PUMPING STATION
- B1..SCREENING & GRIT CHAMBER
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	1073410.00
	2. LAND	17950.00
	3. ENGINEERING	107340.00
	4. CONTINGENCY	107340.00
	5. PVC LINER	38100.00
	TOTAL	1344140.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	372080.00
	3. CHEMICALS	34400.00
	4. MAINTENANCE&SUPPLIES	25600.00
	5. PVC LINER	2890.00
	TOTAL	410160.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	410160.00
	2. YEARLY INVESTMENT COST RECOVERY	53770.00
	3. DEPRECIATION	66310.00
	TOTAL	530240.00

DRAFT

TABLE 267

ITEMIZED COST SUMMARY FOR ALTERNATIVE A1B-III (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- E1..SCREENING & GRIT CHAMBER
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- L...AERATED LAGOON
- M...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	1146790.00
2.	LAND	17950.00
3.	ENGINEERING	114680.00
4.	CONTINGENCY	114680.00
5.	PVC LINER	38100.00
TOTAL		1432200.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	333470.00
3.	CHEMICALS	34400.00
4.	MAINTENANCE&SUPPLIES	28010.00
5.	PVC LINER	2890.00
TOTAL		423760.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	423760.00
2.	YEARLY INVESTMENT COST RECOVERY	57290.00
3.	DEPRECIATION	70710.00
TOTAL		551760.00

DRAFT

TABLE 268

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-IV (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
E1..SCREENING & GRIT CHAMBER
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRATN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	1900790.00
2. LAND	17950.00
3. ENGINEERING	190080.00
4. CONTINGENCY	190080.00
5. PVC LINER	38100.00
TOTAL	2337000.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	357830.00
3. CHEMICALS	34400.00
4. MAINTENANCE&SUPPLIES	77090.00
5. PVC LINER	2890.00
TOTAL	497200.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	497200.00
2. YEARLY INVESTMENT COST RECOVERY	93480.00
3. DEPRECIATION	115950.00
TOTAL	706630.00

DRAFT

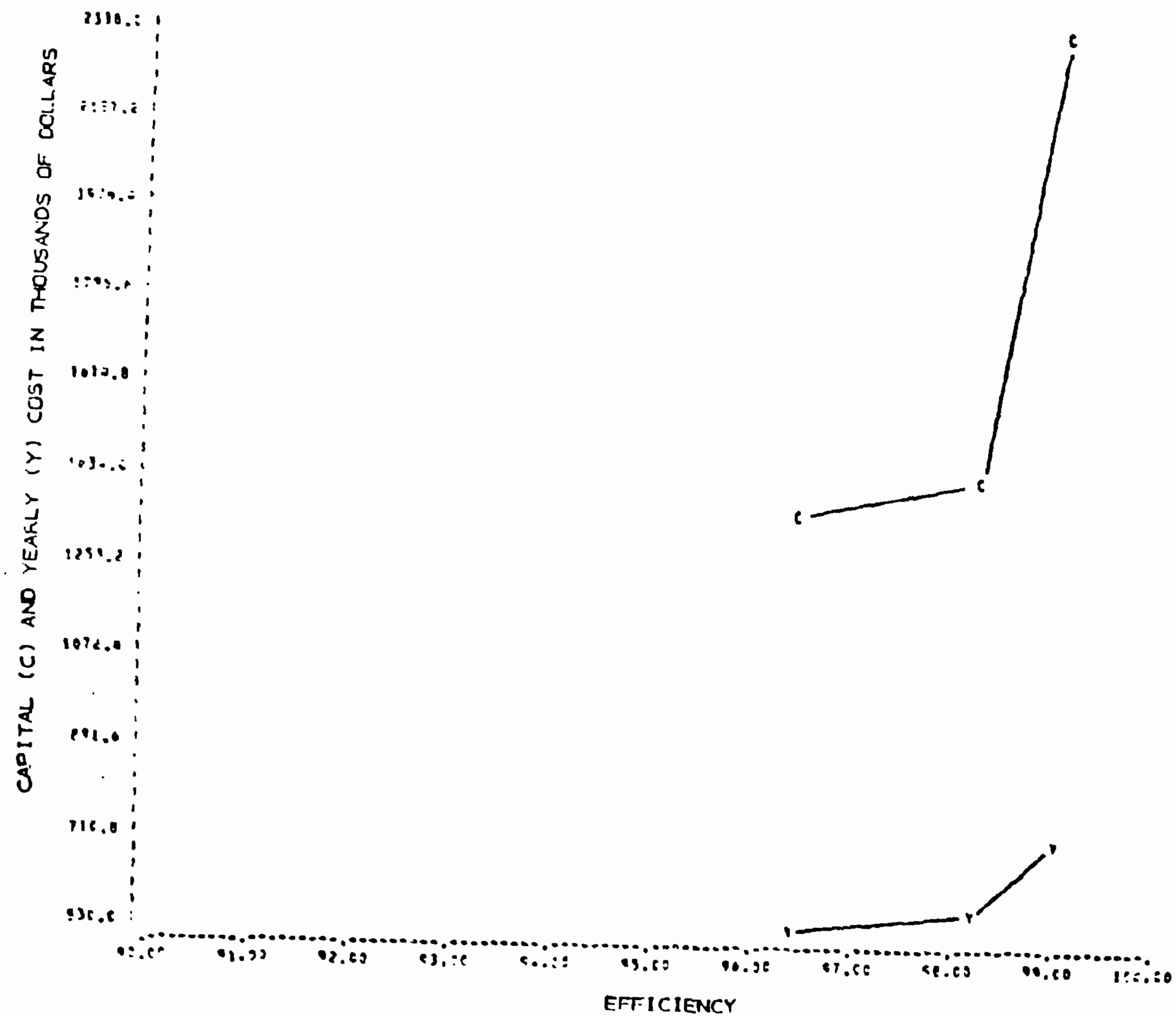


FIGURE 296

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 1B, ALTERNATIVE IV

The resulting BOD waste load is 0.48 kg/cu m (0.12 lb/bbl), and the suspended solids load is 0.68 kg/cu m (0.18 lb/bbl).

Costs: Total investment cost: $1,506,780
Total yearly cost: $ 440,710

An itemized breakdown of costs is presented in Table 269. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 96.4 percent
SS: 89.1 percent

Alternative A 18-VI - This alternative provides dual media filtration in addition to Alternative A 18-V.

The resulting BOD waste load is 0.24 kg/cu m (0.06 lb/bbl), and the suspended solids load is 0.34 kg/cu m (0.09 lb/bbl).

Costs: Total investment cost: $1,594,850
Total yearly cost: $ 461,230

An itemized breakdown of costs is presented in Table 270. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.2 percent
SS: 94.5 percent

Alternative A 18-VII - This alternative adds activated carbon to Alternative A 18-VI.

The resulting BOD waste load is 0.12 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.17 kg/cu m (0.04 lb/bbl).

Costs: Total investment cost: $2,499,660
Total yearly cost: $ 616,110

An itemized breakdown of costs is presented in Table 271. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.0 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 297.

Alternative A 18-VIII - This alternative replaces vacuum filtration in A 18-V with sludge storage and spray irrigation.

DRAFT

TABLE 269

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-V (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- E1..SCREENING & GRIT CHAMBER
- P...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- P...AEROBIC DIGESTER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	1201780.00
2. LAND	64640.00
3. ENGINEERING	120180.00
4. CONTINGENCY	120180.00
TOTAL	1506780.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	165870.00
3. CHEMICALS	50320.00
4. MAINTENANCE&SUPPLIES	17170.00
TOTAL	308330.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	308330.00
2. YEARLY INVESTMENT COST RECOVERY	60270.00
3. DEPRECIATION	72110.00
TOTAL	440710.00

DRAFT

TABLE 270

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-VI
(OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
S...VACUUM FILTRATION
Y...HOLDING TANK
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	1275170.00
2.	LAND	64640.00
3.	ENGINEERING	127520.00
4.	CONTINGENCY	127520.00
TOTAL		1594850.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	177250.00
3.	CHEMICALS	50320.00
4.	MAINTENANCE&SUPPLIES	18390.00
TOTAL		320930.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	320930.00
2.	YEARLY INVESTMENT COST RECOVERY	63790.00
3.	DEPRECIATION	76510.00
TOTAL		461230.00

DRAFT

TABLE 271

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-VII (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- E1..SCREENING & GRIT CHAMBER
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- N...DUAL MEDIA PRESSURE FILTRATN
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	2029180.00
2. LAND	64640.00
3. ENGINEERING	202920.00
4. CONTINGENCY	202920.00
TOTAL	2499660.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	201610.00
3. CHEMICALS	50320.00
4. MAINTENANCE&SUPPLIES	67470.00
TOTAL	394370.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	394370.00
2. YEARLY INVESTMENT COST RECOVERY	99990.00
3. DEPRECIATION	121750.00
TOTAL	616110.00

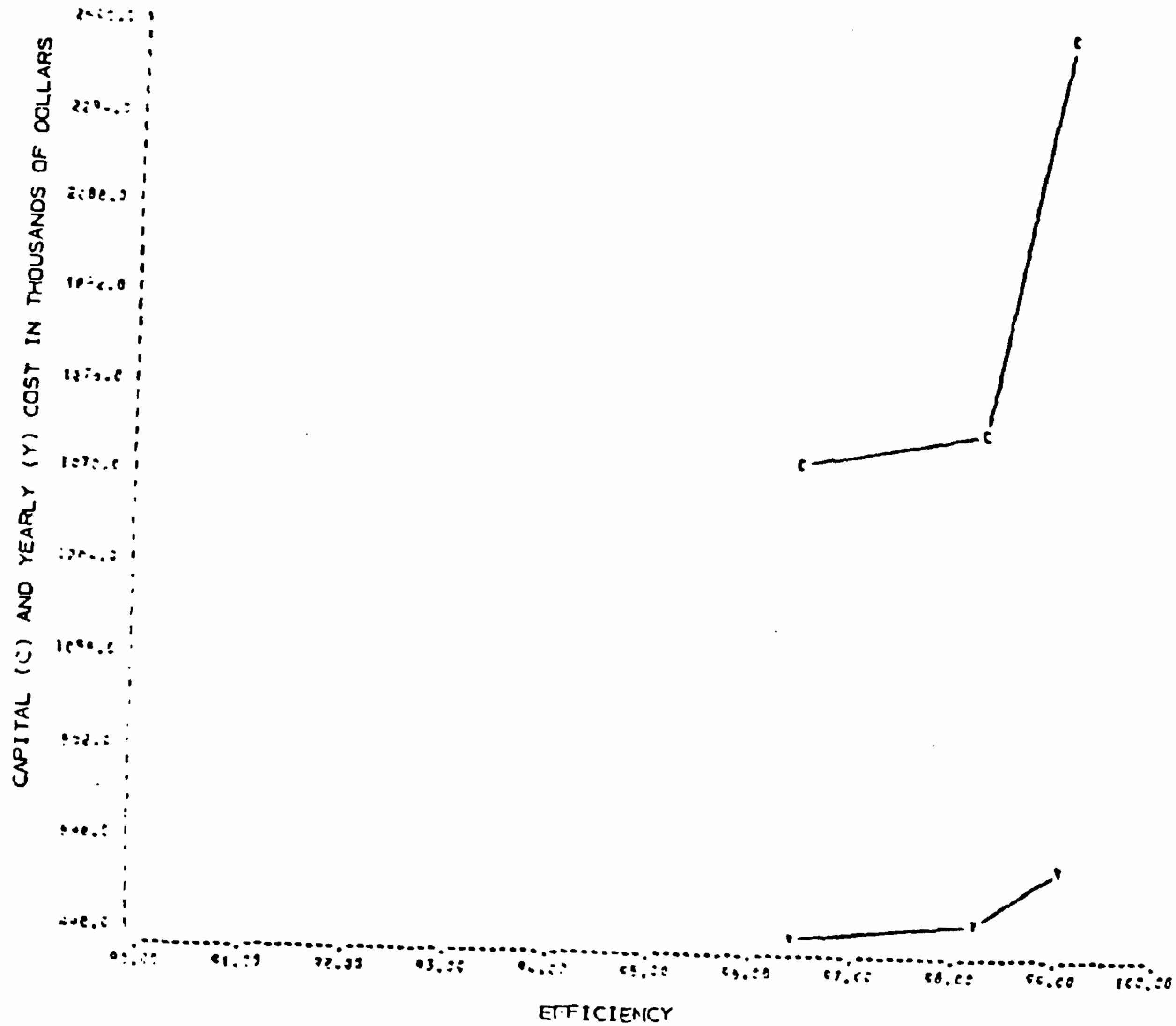


FIGURE 297

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 18, ALTERNATIVE VII

The resulting BOD waste load is 0.48 kg/cu m (0.12 lb/bbl), and the suspended solids load is 0.68 kg/cu m (0.18 lb/bbl).

Costs: Total investment cost: $1,473,950
Total yearly cost: $ 405,140

An itemized breakdown of costs is presented in Table 272. It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 96.4 percent
SS: 89.1 percent

Alternative A 18-IX - This alternative adds dual media filtration to Alternative A 18-VIII.

The resulting BOD waste load is 0.24 kg/cu m (0.06 lb/bbl), and the suspended solids load is 0.34 kg/cu m (0.09 lb/bbl).

Costs: Total investment cost: $1,562,010
Total yearly cost: $ 425,670

An itemized breakdown of costs is presented in Table 273. It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.2 percent
SS: 94.5 percent

Alternative A 18-X - This alternative adds activated carbon to Alternative A 18-IX.

The resulting BOD waste load is 0.12 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.17 kg/cu m (0.04 lb/bbl).

Costs: Total investment cost: $2,466,820
Total yearly cost: $ 580,540

An itemized breakdown of costs is presented in Table 274. It is assumed that land costs $6150 per hectare ($2490 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.0 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 290.

Alternative A 18-XI - This alternative replaces vacuum filtration in Alternative A 18-V with sand drying beds.

DRAFT

TABLE 272

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-VIII
(OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- F1..SCREENING & GRIT CHAMBER
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- L...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	1210250.00
2. LAND	21660.00
3. ENGINEERING	121020.00
4. CONTINGENCY	121020.00
TOTAL	1473950.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	155730.00
3. CHEMICALS	34400.00
4. MAINTENANCE&SUPPLIES	8470.00
TOTAL	273570.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	273570.00
2. YEARLY INVESTMENT COST RECOVERY	58960.00
3. DEPRECIATION	72610.00
TOTAL	405140.00

DRAFT

TABLE 273

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-IX (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- 51..CONTROL HOUSE
- F1..SCREENING & GRIT CHAMBER
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K1..ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- L...SPRAY IRRIGATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	1283630.00
2. LAND	21660.00
3. ENGINEERING	128360.00
4. CONTINGENCY	128360.00
TOTAL	1562010.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	167120.00
3. CHEMICALS	34400.00
4. MAINTENANCE&SUPPLIES	9680.00
TOTAL	286170.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	286170.00
2. YEARLY INVESTMENT COST RECOVERY	62480.00
3. DEPRECIATION	77020.00
TOTAL	425670.00

TABLE 274

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-X (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
2...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
S...SLUDGE THICKENER
W...AEROBIC DIGESTOR
Y...HOLDING TANK
L...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	2037640.00
2. LAND	21660.00
3. ENGINEERING	203760.00
4. CONTINGENCY	203760.00
TOTAL	2466820.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	191480.00
3. CHEMICALS	34400.00
4. MAINTENANCE&SUPPLIES	58760.00
TOTAL	359610.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	359610.00
2. YEARLY INVESTMENT COST RECOVERY	98670.00
3. DEPRECIATION	122260.00
TOTAL	580540.00

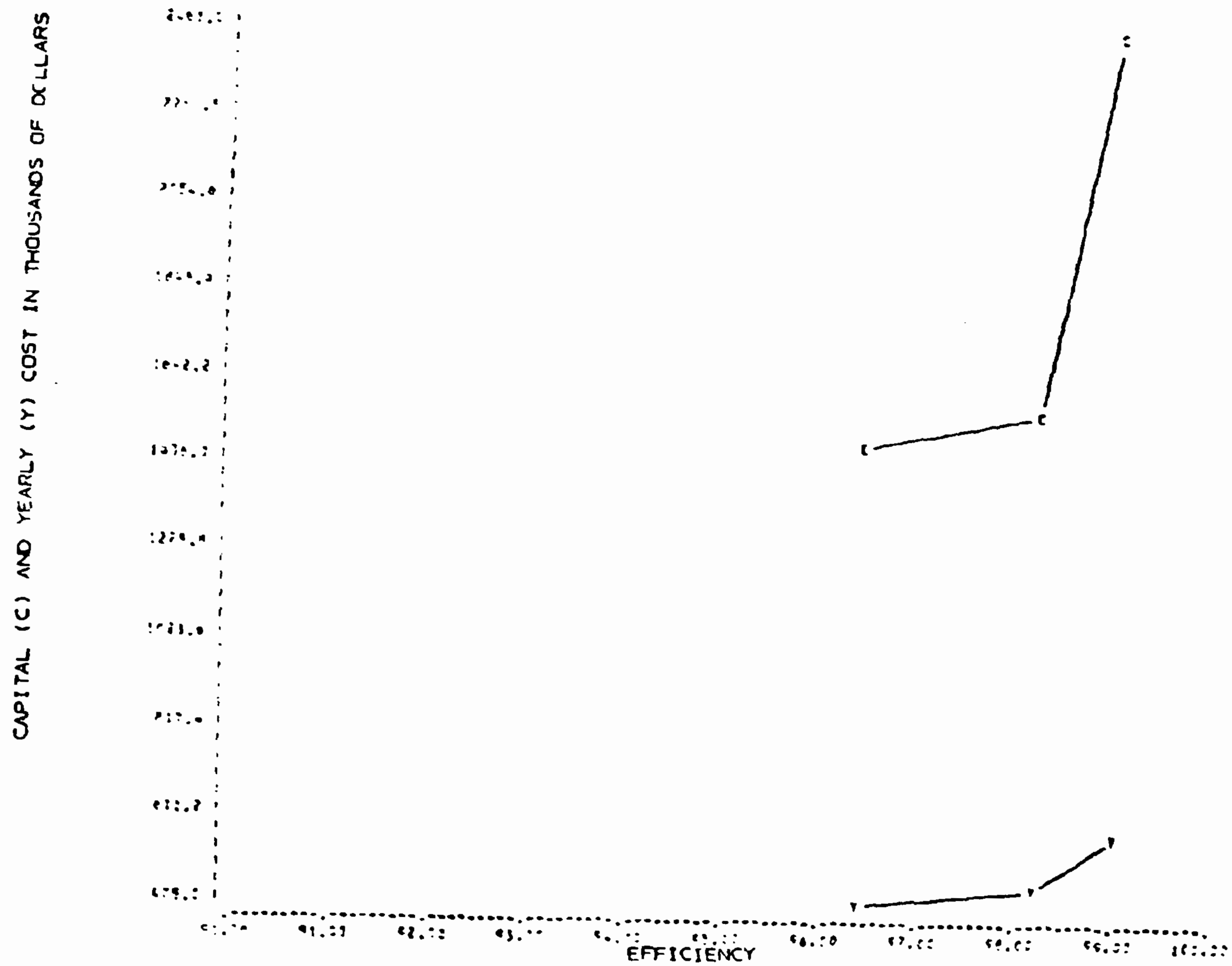


FIGURE 223

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 18, ALTERNATIVE X

The resulting BOD waste load is 0.48 kg/cu m (0.12 lb/bbl), and the suspended solids load is 0.68 kg/cu m (0.18 lb/bbl).

Costs: Total investment cost: $2,694,560
Total yearly cost: $ 638,610

An itemized breakdown of costs is presented in Table 275. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 96.4 percent
SS: 89.1 percent

Alternative A 18-XII - This alternative adds dual media filtration to Alternative A 18-XI.

The resulting BOD waste load is 0.24 kg/cu m (0.06 lb/bbl), and the suspended solids load is 0.34 kg/cu m (0.09 lb/bbl).

Costs: Total investment cost: $2,782,630
Total yearly cost: $ 659,140

An itemized breakdown of costs is presented in Table 276. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.2 percent
SS: 94.5 percent

Alternative A 18-XIII - This alternative adds activated carbon to Alternative A 18-XII.

The resulting BOD waste load is 0.12 kg/cu m (0.03 lb/bbl), and the suspended solids load is 0.17 kg/cu m (0.04 lb/bbl).

Costs: Total investment cost: $3,687,440
Total yearly cost: $ 814,010

An itemized breakdown of costs is presented in Table 277. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.0 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 299.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 19 - Malt

A model plant representative of subcategory A 18 was developed in Section V for the purpose of applying control and treatment alter-

DRAFT

TABLE 275

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-XI
(OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

R1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
P...AEROBIC DIGESTOR
T...SAND DRYING BEDS

INVESTMENT COSTS:

1.	CONSTRUCTION	2162100.00
2.	LAND	100040.00
3.	ENGINEERING	216210.00
4.	CONTINGENCY	216210.00
TOTAL		2694560.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	154780.00
3.	CHEMICALS	34400.00
4.	MAINTENANCE&SUPPLIES	136950.00
TOTAL		401100.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	401100.00
2.	YEARLY INVESTMENT COST RECOVERY	107780.00
3.	DEPRECIATION	129730.00
TOTAL		638610.00

DRAFT

TABLE 276

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-XII
(OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
E1..SCREENING & GRIT CHAMBER
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	2235490.00
2. LAND	100040.00
3. ENGINEERING	223550.00
4. CONTINGENCY	223550.00
TOTAL	2782630.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	166170.00
3. CHEMICALS	34400.00
4. MAINTENANCE&SUPPLIES	138160.00
TOTAL	413700.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	413700.00
2. YEARLY INVESTMENT COST RECOVERY	111310.00
3. DEPRECIATION	134130.00
TOTAL	659140.00

DRAFT

TABLE 277

ITEMIZED COST SUMMARY FOR ALTERNATIVE A18-XIII (OTHER BREWERIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- E1..SCREENING & GRIT CHAMBER
- P...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTER
- T...SAND DRYING BEDS
- N...DUAL MEDIA PRESSURE FILTRAIN
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	2989500.00
2. LAND	100040.00
3. ENGINEERING	298950.00
4. CONTINGENCY	298950.00
TOTAL	3687440.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	190530.00
3. CHEMICALS	34000.00
4. MAINTENANCE&SUPPLIES	187240.00
TOTAL	487140.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	487140.00
2. YEARLY INVESTMENT COST RECOVERY	147500.00
3. DEPRECIATION	179370.00
TOTAL	814010.00

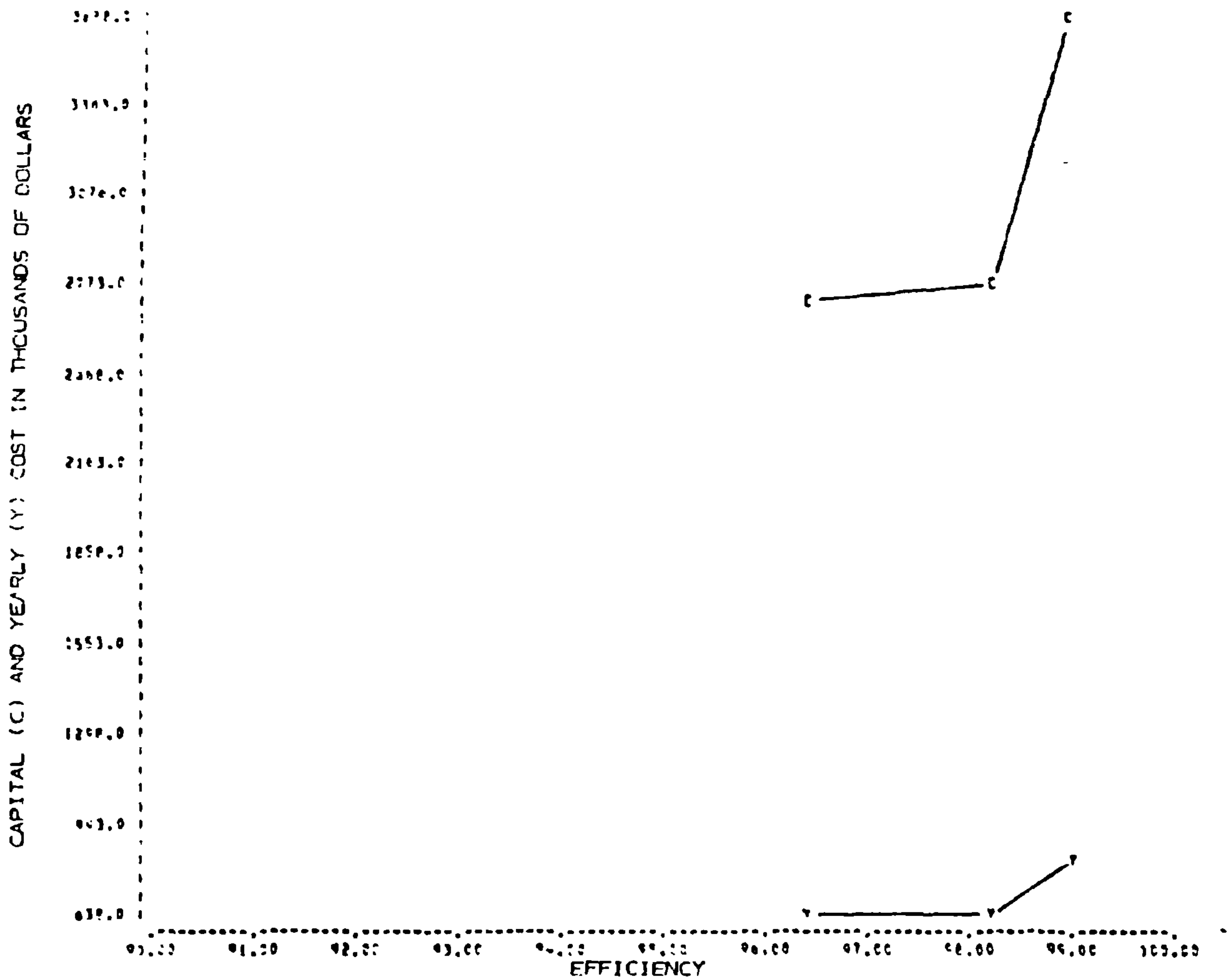


FIGURE 299

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 18, ALTERNATIVE XIII natives. In Section VII, seven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 350 kkg (16,000 bu) per day.

Alternative A 19-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 350 kkg (16,000 bu) per day plant is 2590 cu m (0.685 MG) per day. The BOD waste load is 4.55 kg/kkg (0.218 lb/bu), and the suspended solids load is 0.77 kg/kkg (0.037 lb/bu).

Suspended solids in the waste, consisting mostly of grain and sprouts, are assumed to be removed by screening prior to discharge.

Costs: 0
Reduction Benefits: None

Alternative A 19-II - This alternative provides a control house, flow equalization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 0.22 kg/kkg (0.011 lb/bu), and the suspended solids load is 0.13 kg/kkg (0.0062 lb/bu).

Costs: Total investment cost: $1,200,150
Total yearly cost: $ 572,660

An itemized breakdown of costs is presented in Table 278. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Suspended solids in the waste, consisting mostly of grain and sprouts, is assumed to be removed by screening prior to discharge.

Reduction Benefits: BOD: 95.2 percent
SS: 83.1 percent

Alternative A 19-III - This alternative provides in addition to Alternative A 19-II dual media filtration.

The resulting BOD waste load is 0.11 kg/kkg (0.0053 lb/bu), and the suspended solids load is 0.06 kg/kkg (0.0029 lb/bu).

Costs: Total investment cost: $1,245,740
Total yearly cost: $ 583,300

An itemized breakdown of costs is presented in Table 279. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Suspended solids in the waste, consisting mostly of grain and sprouts, is assumed to be removed by screening prior to discharge.

DRAFT

TABLE 278

ITEMIZED COST SUMMARY FOR ALTERNATIVE A19-II (MALT)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	959690.00
2.	LAND	12740.00
3.	ENGINEERING	95970.00
4.	CONTINGENCY	95970.00
5.	PVC LINER	35780.00
TOTAL		1200150.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	401540.00
3.	CHEMICALS	3030.00
4.	MAINTENANCE&SUPPLIES	34080.00
5.	PVC LINER	1640.00
TOTAL		465280.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	465280.00
2.	YEARLY INVESTMENT COST RECOVERY	48010.00
3.	DEPRECIATION	59370.00
TOTAL		572660.00

DRAFT

TABLE 279

ITEMIZED COST SUMMARY FOR ALTERNATIVE A19-III
(MALT)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	997680.00
2.	LAND	12740.00
3.	ENGINEERING	99770.00
4.	CONTINGENCY	99770.00
5.	PVC LINER	35780.00
TOTAL		1245740.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	407450.00
3.	CHEMICALS	3030.00
4.	MAINTENANCE&SUPPLIES	34710.00
5.	PVC LINER	1640.00
TOTAL		471820.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	471820.00
2.	YEARLY INVESTMENT COST RECOVERY	49830.00
3.	DEPRECIATION	61650.00
TOTAL		583300.00

Reduction Benefits: BOD: 97.6 percent
SS: 92.2 percent

A cost efficiency curve is presented in Figure 300.

Alternative A 19-IV - This alternative provides a control house, flow equalization, nutrient addition, a complete mix activated sludge system, sludge thickening, aerobic digestion, and spray irrigation.

The resulting BOD waste load is 0.22 kg/kkg (0.011 lb/bu), and the suspended solids load is 0.13 kg/kkg (0.0062 lb/bu).

Costs: Total investment cost: $709,240
Total yearly cost: $176,410

An itemized breakdown of costs is presented in Table 280. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Suspended solids in the waste, consisting mostly of grain and sprouts, is assumed to be removed by screening prior to discharge.

Reduction Benefits: BOD: 95.2 percent
SS: 83.1 percent

Alternative A 19-V - This alternative adds dual media filtration to Alternative A 19-IV.

The resulting BOD waste load is 0.11 kg/kkg (0.0053 lb/bu), and the suspended solids load is 0.06 kg/kkg (0.0029 lb/bu).

Costs: Total investment cost: $761,830
Total yearly cost: $187,330

An itemized breakdown of costs is presented in Table 281. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Suspended solids in the waste, consisting mostly of grain and sprouts, is assumed to be removed by screening prior to discharge.

Reduction Benefits: BOD: 97.6 percent
SS: 92.2 percent

A cost efficiency curve is presented in Figure 301.

Alternative A 19-VI - This alternative replaces spray irrigation of sludge in Alternative A 19-IV with sand bed drying.

The resulting BOD waste load is 0.22 kg/kkg (0.011 lb/bu), and the suspended solids load is 0.13 kg/kkg (0.0062 lb/bu).

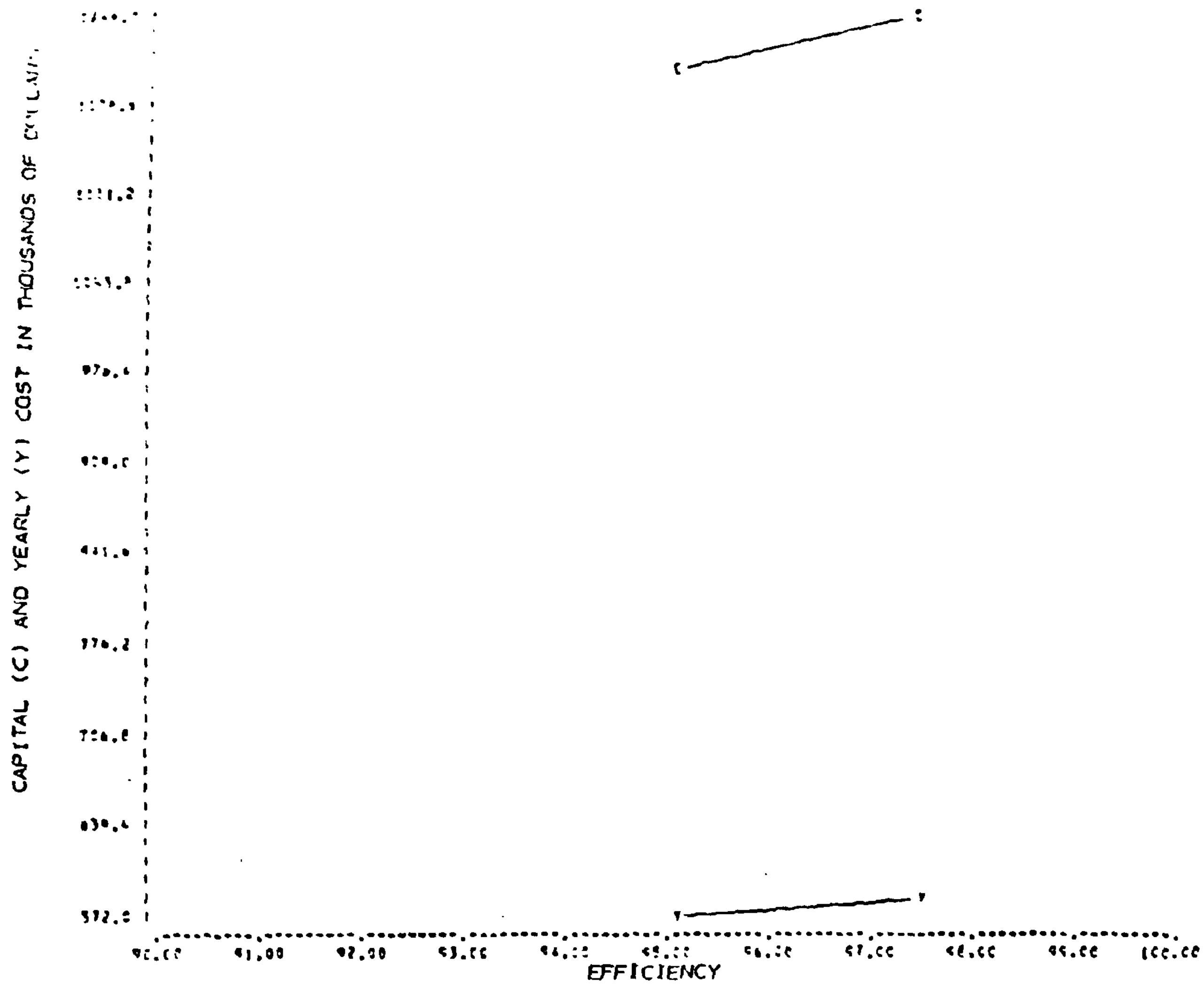


FIGURE 300

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 19, ALTERNATIVE III

DRAFT

DRAFT

TABLE 280

ITEMIZED COST SUMMARY FOR ALTERNATIVE A19-IV (MALT)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.1 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- U...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	562570.00
2. LAND	34150.00
3. ENGINEERING	56260.00
4. CONTINGENCY	56260.00
TOTAL	709240.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	62790.00
3. CHEMICALS	3030.00
4. MAINTENANCE&SUPPLIES	10990.00
TOTAL	114290.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	114290.00
2. YEARLY INVESTMENT COST RECOVERY	28370.00
3. DEPRECIATION	33750.00
TOTAL	176410.00

DRAFT

TABLE 281

ITEMIZED COST SUMMARY FOR ALTERNATIVE A19-V (MALT)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTER
- Y...HOLDING TANK
- L...SPRAY IRRIGATION
- B...PUMPING STATION
- W...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	600560.00
2.	LAND	41150.00
3.	ENGINEERING	60060.00
4.	CONTINGENCY	60060.00
TOTAL		761830.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	68700.00
3.	CHEMICALS	3030.00
4.	MAINTENANCE&SUPPLIES	11620.00
TOTAL		120830.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	120830.00
2.	YEARLY INVESTMENT COST RECOVERY	30470.00
3.	DEPRECIATION	36030.00
TOTAL		187330.00

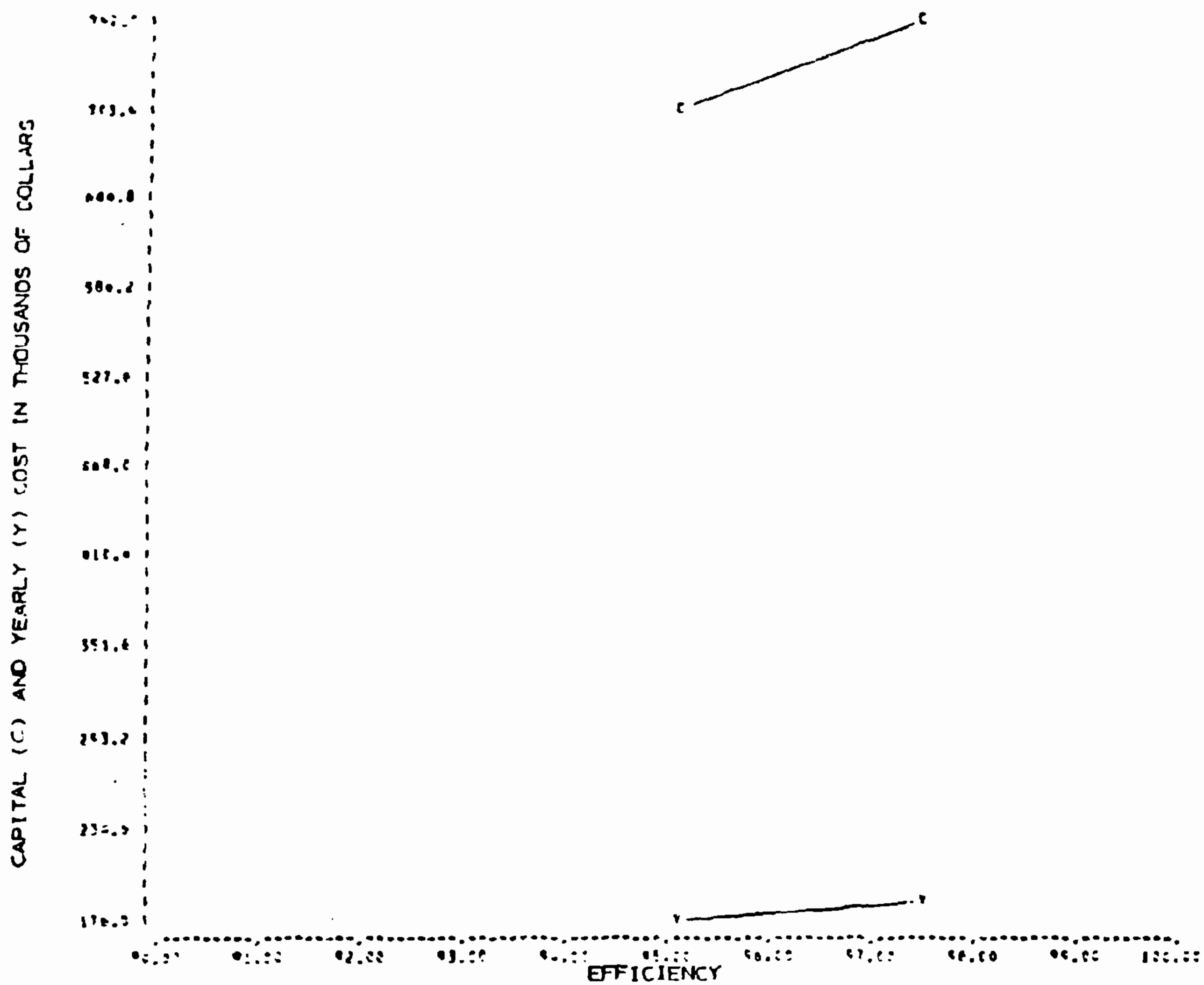


FIGURE 301

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 19, ALTERNATIVE V

Costs: Total investment cost: $971,480
Total yearly cost: $229,830

An itemized breakdown of costs is presented in Table 282. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Suspended solids in the waste, consisting mostly of grain and sprouts, is assumed to be removed by screening prior to discharge.

Reduction Benefits: BOD: 95.2 percent
SS: 83.1 percent

Alternative A 19-VII - This alternative adds dual media filtration to Alternative A 19-VI.

The resulting BOD waste load is 0.11 kg/kkg (0.0053 lb/bu), and the suspended solids load is 0.06 kg/kkg (0.0029 lb/bu).

Costs: Total investment cost: $1,017,070
Total yearly cost: $ 240,470

An itemized breakdown of costs is presented in Table 283. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Suspended solids in the waste, consisting mostly of grain and sprouts, is assumed to be removed by screening prior to discharge.

Reduction Benefits: BOD: 97.6 percent
SS: 92.2 percent

A cost efficiency curve is presented in Figure 302.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 20 - Wineries Without Stills

A model plant representative of subcategory A 20 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, ten alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 180 kkg (200 tons) of grapes per day during crushing, and produces 41 cu m (10,800 gal) per day during processing. Since the treatment system was sized on crushing season design values, those are the costs which will be presented.

The following process operations are assumed for the model plant: (1) stems are considered a solid waste to be spread on vineyard property, (2) pressed pomace may be used for distilling material,

DRAFT

TABLE 282

ITEMIZED COST SUMMARY FOR ALTERNATIVE A19-VI
(MALT)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.1 PERCENT BOD REDUCTION

TREATMENT MODULES:
B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
T...SAND DRYING BEDS

INVESTMENT COSTS:

1.	CONSTRUCTION	775270.00
2.	LAND	41150.00
3.	ENGINEERING	77530.00
4.	CONTINGENCY	77530.00
TOTAL		971480.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	61920.00
3.	CHEMICALS	3030.00
4.	MAINTENANCE&SUPPLIES	42020.00
TOTAL		144450.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	144450.00
2.	YEARLY INVESTMENT COST RECOVERY	38860.00
3.	DEPRECIATION	46520.00
TOTAL		229830.00

DRAFT

TABLE 203

ITEMIZED COST SUMMARY FOR ALTERNATIVE A19-VII (MALT)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
P...AEROBIC DIGESTOR
Y...HOLDING TANK
T...SAND DRYING BEDS
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	813260.00
2. LAND	41150.00
3. ENGINEERING	81330.00
4. CONTINGENCY	81330.00
TOTAL	1017070.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	67830.00
3. CHEMICALS	3030.00
4. MAINTENANCE&SUPPLIES	42650.00
TOTAL	150990.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	150990.00
2. YEARLY INVESTMENT COST RECOVERY	40680.00
3. DEPRECIATION	48800.00
TOTAL	240470.00

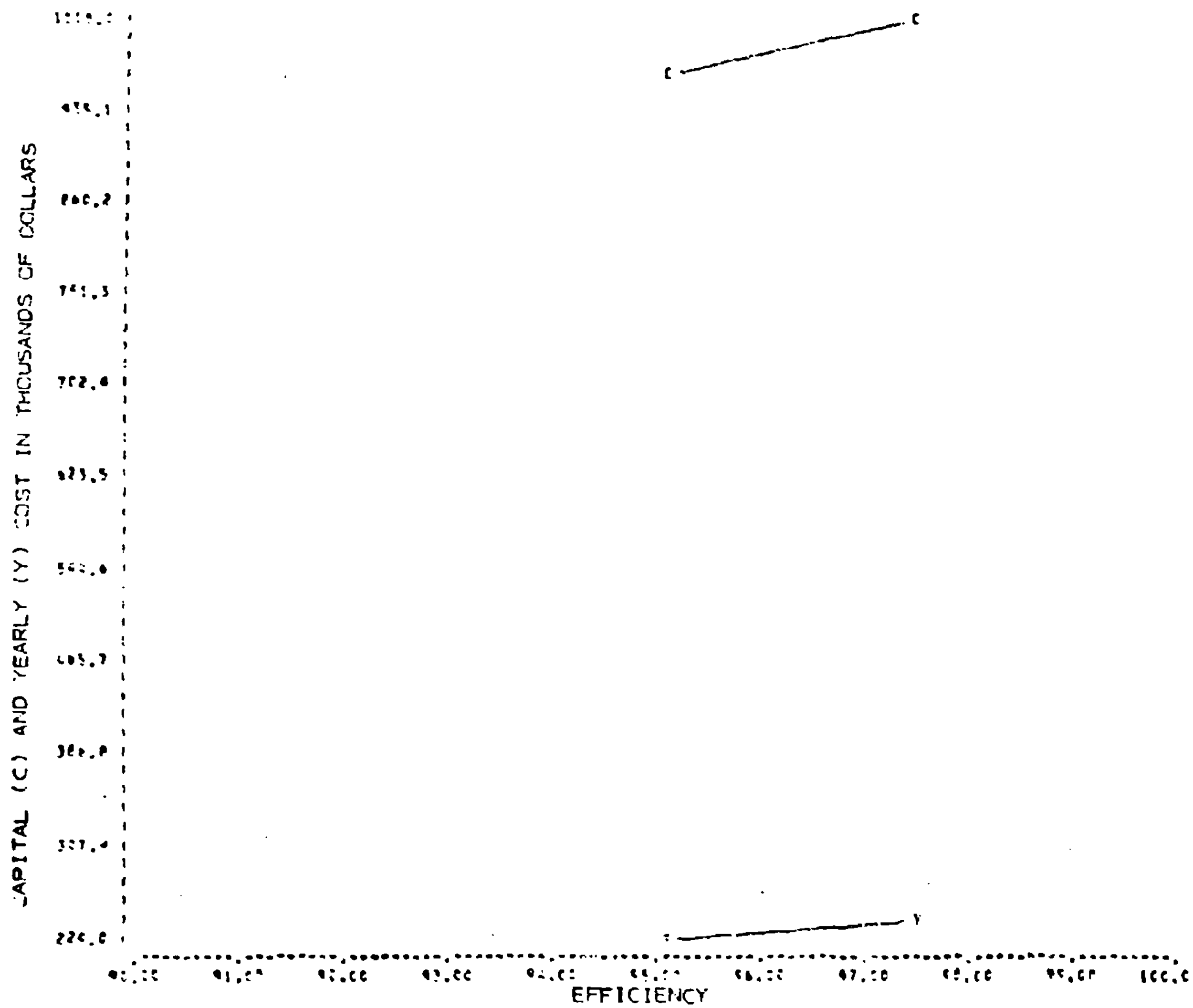


FIGURE 302

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 19, ALTERNATIVE VII

may be spread on vineyard property, or may be recovered as a by-product (3) diatomaceous earth (spent filter aid) is considered to be a solid waste to be spread on vineyard property, (4) no distillation is done on the premises, and (5) wastewater is screened prior to discharge.

Alternative A 20-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 180 kkg (200.0 ton) per day plant is 276 cu m (0.073 MG) per day. The BOD waste load is 3.57 kg/kkg (7.14 lb/ton), and the suspended solids load is 1.16 kg/kkg (2.32 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative A 20-II - This alternative provides a control house, flow equalization, nutrient addition, neutralization, a complete mix activated sludge system, sludge thickening, aerobic digestion, dual media filtration, and spray irrigation of sludge.

The resulting BOD waste load is 0.77 kg/kkg (1.54 lb/ton), and the suspended solids load is 0.115 kg/kkg (0.230 lb/ton).

Costs: Total investment cost: $414,130
Total yearly cost: $116,400

An itemized breakdown of costs is presented in Table 284. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97.8 percent
SS: 90.1 percent

Alternative A 20-III - This alternative adds dual media filtration to Alternative A 20-II.

The resulting BOD waste load is 0.38 kg/kkg (0.76 lb/ton), and the suspended solids load is 0.0540 kg/kkg (0.108 lb/ton).

Costs: Total investment cost: $434,350
Total yearly cost: $122,300

An itemized breakdown of costs is presented in Table 285. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits BOD: 98.9 percent
SS: 95.3 percent

DRAFT

TABLE 284

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-II
(WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
F...ACID NEUTRALIZATION
G...CAUSTIC NEUTRALIZATION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTER
Y...HOLDING TANK
U...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	331230.00
	2. LAND	16660.00
	3. ENGINEERING	33120.00
	4. CONTINGENCY	33120.00
	TOTAL	414130.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	25510.00
	3. CHEMICALS	7530.00
	4. MAINTENANCE&SUPPLIES	9440.00
	TOTAL	79960.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	79960.00
	2. YEARLY INVESTMENT COST RECOVERY	16570.00
	3. DEPRECIATION	19870.00
	TOTAL	116400.00

DRAFT

TABLE 285

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-III (WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- M1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- F...ACID NEUTRALIZATION
- G...CAUSTIC NEUTRALIZATION
- K...ACTIVATED SLUDGE
- S...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- U...SPRAY IRRIGATION
- N...DUAL MEDIA PRESSURE FILTRATN
- N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	348070.00
2. LAND	16660.00
3. ENGINEERING	34810.00
4. CONTINGENCY	34810.00
TOTAL	434350.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	28830.00
3. CHEMICALS	7530.00
4. MAINTENANCE&SUPPLIES	10210.00
TOTAL	84050.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	84050.00
2. YEARLY INVESTMENT COST RECOVERY	17370.00
3. DEPRECIATION	20880.00
TOTAL	122300.00

Alternative A 20-IV - This alternative provides in addition to Alternative A 20-III activated carbon.

The resulting BOD waste load is 0.23 kg/kkg (0.46 lb/ton), and the suspended solids load is 0.031 kg/kkg (0.062 lb/ton).

Costs:	Total investment cost:	$502,200
	Total yearly cost:	$146,770

An itemized breakdown of costs is presented in Table 286. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits	BOD:	99.4 percent
	SS:	97.3 percent

A cost efficiency curve is presented in Figure 303.

Alternative A 20-V - This alternative replaces spray irrigation of sludge in Alternative A 20-II with sand drying beds.

The resulting BOD waste load is 0.77 kg/kkg (1.54 lb/ton), and the suspended solids load is 0.115 kg/kkg (0.230 lb/ton).

Costs:	Total investment cost:	$492,450
	Total yearly cost:	$134,160

An itemized breakdown of costs is presented in Table 287. It is assumed that land costs $41,000per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits	BOD:	97.8 percent
	SS:	90.1 percent

Alternative A 20-VI - This alternative provides in addition to Alternative A 20-V dual media filtration.

The resulting BOD waste load is 0.38 kg/kkg (0.76 lb/ton), and the suspended solids load is 0.054 kg/kkg (0.108 lb/ton).

Costs:	Total investment cost:	$512,680
	Total yearly cost:	$140,070

An itemized breakdown of costs is presented in Table 288. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits	BOD:	98.9 percent
	SS:	95.3 percent

DRAFT

TABLE 286

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-IV
(WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

M1...CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
N...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
F...ACID NEUTRALIZATION
G...CAUSTIC NEUTRALIZATION
K...ACTIVATED SLUDGE
L...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
U...SPRAY IRRIGATION
W...DUAL MEDIA PRESSURE FILTRATION
W...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:	
1. CONSTRUCTION	404620.00
2. LAND	16660.00
3. ENGINEERING	40460.00
4. CONTINGENCY	40460.00
TOTAL	502200.00
YEARLY OPERATING COSTS:	
1. LABOR	37480.00
2. POWER	31770.00
3. CHEMICALS	7530.00
4. MAINTENANCE&SUPPLIES	25620.00
TOTAL	102400.00
TOTAL YEARLY COSTS:	
1. YEARLY OPERATING COST	102400.00
2. YEARLY INVESTMENT COST RECOVERY	20090.00
3. DEPRECIATION	24280.00
TOTAL	146770.00

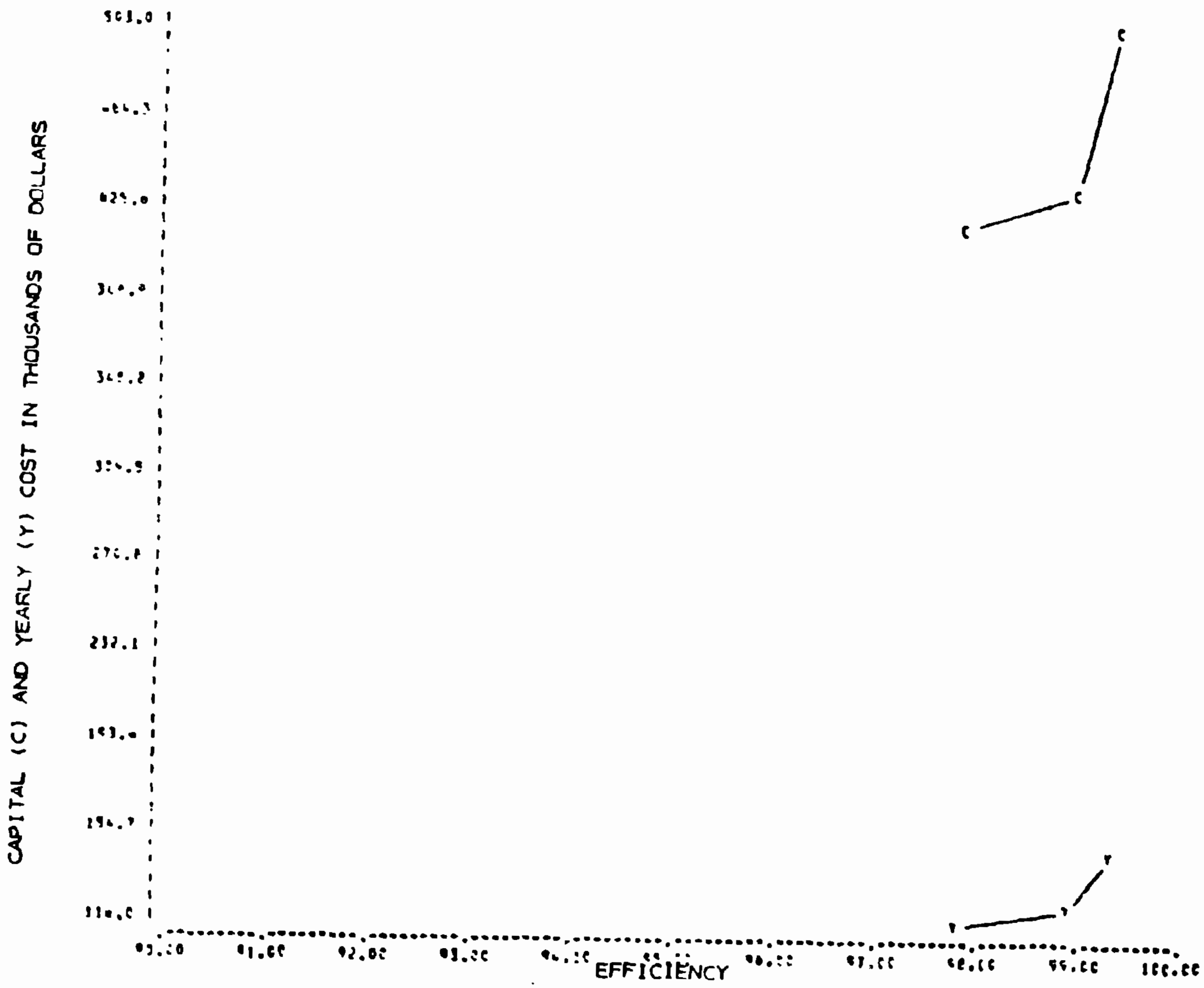


FIGURE 303

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 20, ALTERNATIVE IV

DRAFT

TABLE 287

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-V
(WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- F...ACID NEUTRALIZATION
- G...CAUSTIC NEUTRALIZATION
- K...ACTIVATED SLUDGE
- S...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	393720.00
2.	LAND	19990.00
3.	ENGINEERING	39370.00
4.	CONTINGENCY	39370.00
TOTAL		492450.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	24660.00
3.	CHEMICALS	7530.00
4.	MAINTENANCE&SUPPLIES	21170.00
TOTAL		90840.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	90840.00
2.	YEARLY INVESTMENT COST RECOVERY	19700.00
3.	DEPRECIATION	23620.00
TOTAL		134160.00

DRAFT

TABLE 288

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-V1
(WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
F...ACID NEUTRALIZATION
G...CAUSTIC NEUTRALIZATION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
P...AEROBIC DIGESTER
T...SAND DRYING BEDS
N...DUAL MEDIA PRESSURE FILTRATN
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	410570.00
2. LAND	19990.00
3. ENGINEERING	41060.00
4. CONTINGENCY	41060.00
TOTAL	512680.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	27980.00
3. CHEMICALS	7530.00
4. MAINTENANCE&SUPPLIES	21940.00
TOTAL	94930.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	94930.00
2. YEARLY INVESTMENT COST RECOVERY	20510.00
3. DEPRECIATION	24630.00
TOTAL	140070.00

Alternative A 20-VII - This alternative adds activated carbon to Alternative A 20-VI.

The resulting BOD waste load is 0.23 kg/kkg (0.46 lb/ton), and the suspended solids load is 0.031 kg/kkg (0.062 lb/ton).

Costs: Total investment cost: $580,520
Total yearly cost: $164,530

An itemized breakdown of costs is presented in Table 289. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits BOD: 99.4 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 304.

Alternative A 20-VIII - This alternative provides flow equalization, nutrient addition, neutralization, an aerated lagoon system, and dual media filtration.

The resulting BOD waste load is 0.77 kg/kkg (1.54 lb/ton), and the suspended solids load is 0.115 kg/kkg (0.230 lb/ton).

Costs: Total investment cost: $413,090
Total yearly cost: $172,300

An itemized breakdown of costs is presented in Table290. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits BOD: 97.8 percent
SS: 90.1 percent

Alternative A 20-IX - This alternative provides in addition to Alternative A 20-VIII dual media filtration.

The resulting BOD waste load is 0.38 kg/kkg (0.76 lb/ton), and the suspended solids load is 0.054 kg/kkg (0.108 lb/ton).

Costs: Total investment cost: $433,290
Total yearly cost: $178,210

An itemized breakdown of costs is presented in Table 291. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits BOD: 98.9 percent
SS: 95.3 percent

DRAFT

TABLE 289

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-VII
(WINERIES WITHOUT STILLS)

```
ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:
                      A1..CONTROL HOUSE
                      B...PUMPING STATION
                      C...EQUALIZATION BASIN
                      H...NITROGEN ADDITION
                      I...PHOSPHORUS ADDITION
                      F...ACID NEUTRALIZATION
                      G...CAUSTIC NEUTRALIZATION
                      K...ACTIVATED SLUDGE
                      G...SLUDGE THICKENER
                      P...AEROBIC DIGESTOR
                      T...SAND DRYING BEDS
                      N...DUAL MEDIA PRESSURE FILTRATN
                      N...DUAL MEDIA PRESSURE FILTRATN
                      Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:
                  1.  CONSTRUCTION              467110.00
                  2.  LAND                       19990.00
                  3.  ENGINEERING                46710.00
                  4.  CONTINGENCY                46710.00
                  TOTAL                         580520.00

YEARLY OPERATING COSTS:
                  1.  LABOR                      37480.00
                  2.  POWER                      30930.00
                  3.  CHEMICALS                   7530.00
                  4.  MAINTENANCE&SUPPLIES       37340.00
                  TOTAL                         113280.00

TOTAL YEARLY COSTS:
                  1. YEARLY OPERATING COST      113280.00
                  2. YEARLY INVESTMENT
                     COST RECOVERY               23220.00
                  3. DEPRECIATION                28030.00
                  TOTAL                         164530.00
```

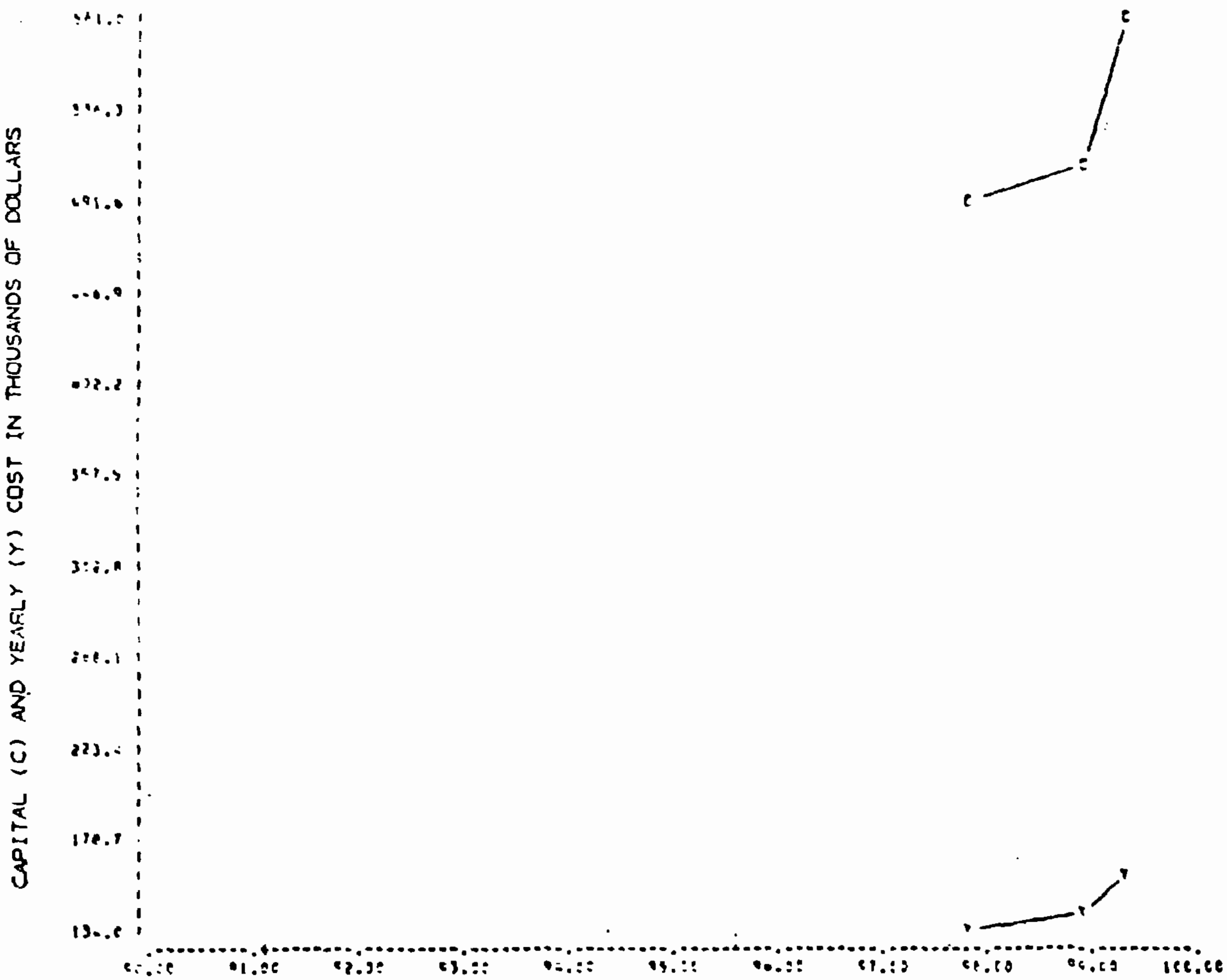


FIGURE 304

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 20, ALTERNATIVE VII

DRAFT

TABLE 290

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-VIII (WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.8 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
F...ACID NEUTRALIZATION
G...CAUSTIC NEUTRALIZATION
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	333480.00
2. LAND	4330.00
3. ENGINEERING	33350.00
4. CONTINGENCY	33350.00
5. PVC LINER	8580.00
TOTAL	413090.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	102900.00
3. CHEMICALS	7530.00
4. MAINTENANCE&SUPPLIES	12230.00
5. PVC LINER	190.00
TOTAL	135340.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	135340.00
2. YEARLY INVESTMENT COST RECOVERY	16520.00
3. DEPRECIATION	20440.00
TOTAL	172300.00

DRAFT

TABLE 291

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-IX
(WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
F...ACID NEUTRALIZATION
G...CAUSTIC NEUTRALIZATION
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRATION
M...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	350320.00
	2. LAND	4330.00
	3. ENGINEERING	35030.00
	4. CONTINGENCY	35030.00
	5. PVC LINER	8580.00
	TOTAL	433290.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	106220.00
	3. CHEMICALS	7530.00
	4. MAINTENANCESSUPPLIES	13000.00
	5. PVC LINER	190.00
	TOTAL	139430.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	139430.00
	2. YEARLY INVESTMENT COST RECOVERY	17330.00
	3. DEPRECIATION	21450.00
	TOTAL	178210.00

Alternative A 20-X - This alternative provides in addition to Alternative A 20-IX activated carbon.

The resulting BOD waste load is 0.23 kg/kkg (0.46 lb/ton), and the suspended solids load is 0.031 kg/kkg (0.062 lb/ton).

Costs: Total investment cost: $501,160
Total yearly cost: $202,670

An itemized breakdown of costs is presented in Table 292. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 99.4 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 305.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 21 - Wineries with Stills

A model plant representative of Subcategory A 21 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, two alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 700 kkg (760 ton) of grapes per day.

Alternative A 21-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 700 kkg (760 ton) per day plant is 1700 cu m (0.442 MG) per day. The BOD waste load is 13.9 kg/kkg (27.7 lb/ton), and the suspended solids load is 13.6 kg/kkg (27.3 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative A 21-II - This alternative consists of a holding tank, pumping station, pipeline, and land spreading.

The resulting BOD waste load is zero, and the suspended solids load is zero.

Costs: Total investment cost: $381,640
Total yearly cost: $ 52,310

DRAFT

TABLE 292

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 20-X
(WINERIES WITHOUT STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
F...ACID NEUTRALIZATION
G...CAUSTIC NEUTRALIZATION
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRATN
N...DUAL MEDIA PRESSURE FILTRATN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:		
	1. CONSTRUCTION	406870.00
	2. LAND	4330.00
	3. ENGINEERING	40690.00
	4. CONTINGENCY	40690.00
	5. PVC LINER	8580.00
	TOTAL	501160.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	109170.00
	3. CHEMICALS	7530.00
	4. MAINTENANCE&SUPPLIES	26400.00
	5. PVC LINER	190.00
	TOTAL	157780.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	157780.00
	2. YEARLY INVESTMENT COST RECOVERY	20050.00
	3. DEPRECIATION	24840.00
	TOTAL	202670.00

DRAFT

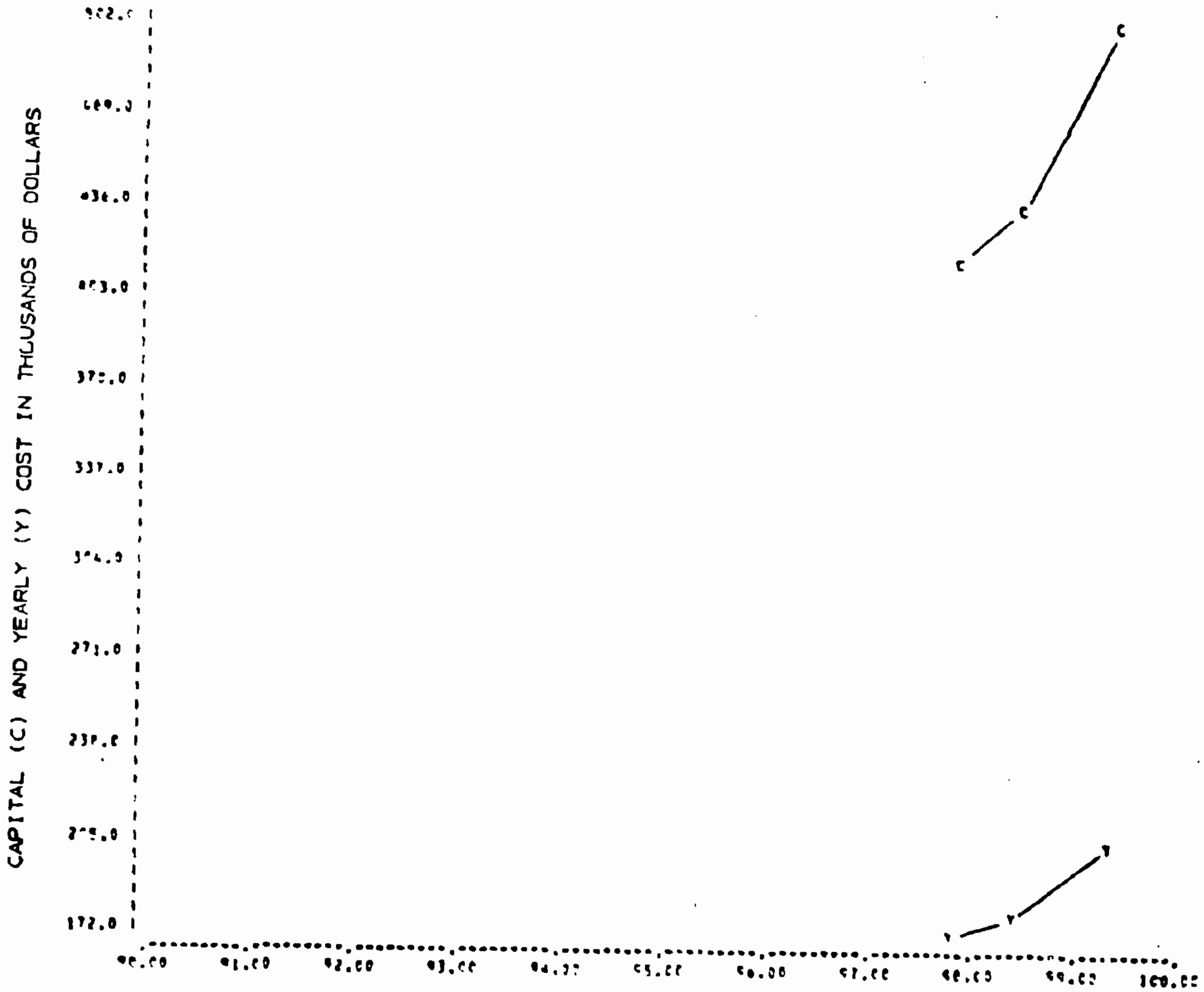


FIGURE 305

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 20, ALTERNATIVE X

An itemized breakdown of costs is presented in Table 293. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 22 - Grain Distillers Operating Stillage Recovery Systems

Two model plants representative of Subcategory A 22 were developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, nine alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for model plant A 22-A which produces 380 kkg (15,000 bu) per day.

Alternative A 22-A-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 380 kkg (15,000 bu) per day plant is 2500 cu m (0.650 MG) per day. The BOD waste load is 6.0_ kg/kkg (0.336 lb/bu), and the suspended solids load is 4.21 kg/kkg (0.236 lb/bu).

The model plant assumes screening of the effluent prior to discharge.

Costs: 0
Reduction Benefits: None

Alternative A 22-A-II - This alternative provides flow equalization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 0.26 kg/kkg (0.015 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $1,231,320
Total yearly cost: $ 602,940

An itemized breakdown of costs is presented in Table 294. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 95.7 percent
SS: 92.3 percent

Alternative A 22-A-III - This alternative provides in addition to Alternative A 22-A-II dual media filtration.

DRAFT

TABLE 293

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 21-II (WINERIES WITH STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

Y...HOLDING TANK
R...PUMPING STATION
W...PIPING

INVESTMENT COSTS:		
	1. CONSTRUCTION	275000.00
	2. LAND	51640.00
	3. ENGINEERING	27500.00
	4. CONTINGENCY	27500.00
	TOTAL	381640.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	4960.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	15580.00
	TOTAL	20540.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	20540.00
	2. YEARLY INVESTMENT COST RECOVERY	15270.00
	3. DEPRECIATION	16500.00
	TOTAL	52310.00

DRAFT

TABLE 294

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-A-II
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.7 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	983780.00
	2. LAND	12990.00
	3. ENGINEERING	98380.00
	4. CONTINGENCY	98380.00
	5. PVC LINER	37790.00
	TOTAL	1231320.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	433320.00
	3. CHEMICALS	6950.00
	4. MAINTENANCE&SUPPLIES	38420.00
	5. PVC LINER	1590.00
	TOTAL	492770.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	492770.00
	2. YEARLY INVESTMENT COST RECOVERY	49250.00
	3. DEPRECIATION	60920.00
	TOTAL	602940.00

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.016 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $1,276,250
Total yearly cost: $ 613,420

An itemized breakdown of costs is presented in Table 295. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 97.8 percent
SS: 96.9 percent

A cost efficiency curve is presented in Figure 306.

Alternative A 22-A-IV - This alternative provides a control house, flow equalization, a complete mix activated sludge system, sludge thickening, aerobic digestion, and sand drying beds.

The resulting BOD waste load is 0.26 kg/kkg (0.015 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $1,230,170
Total yearly cost: $ 289,080

An itemized breakdown of costs is presented in Table 296. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 95.7 percent
SS: 92.3 percent

Alternative A 22-A-V - This alternative provides in addition to Alternative A 22-A-IV dual media filtration.

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.16 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $1,275,110
Total yearly cost: $ 299,560

An itemized breakdown of costs is presented in Table 297. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

DRAI

TABLE 295

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-A-III
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
M...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	1021230.00
2. LAND	12990.00
3. ENGINEERING	102120.00
4. CONTINGENCY	102120.00
5. PVC LINER	37790.00
TOTAL	1276250.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	439140.00
3. CHEMICALS	6950.00
4. MAINTENANCE&SUPPLIES	39040.00
5. PVC LINER	1590.00
TOTAL	499210.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	499210.00
2. YEARLY INVESTMENT COST RECOVERY	51050.00
3. DEPRECIATION	63160.00
TOTAL	613420.00

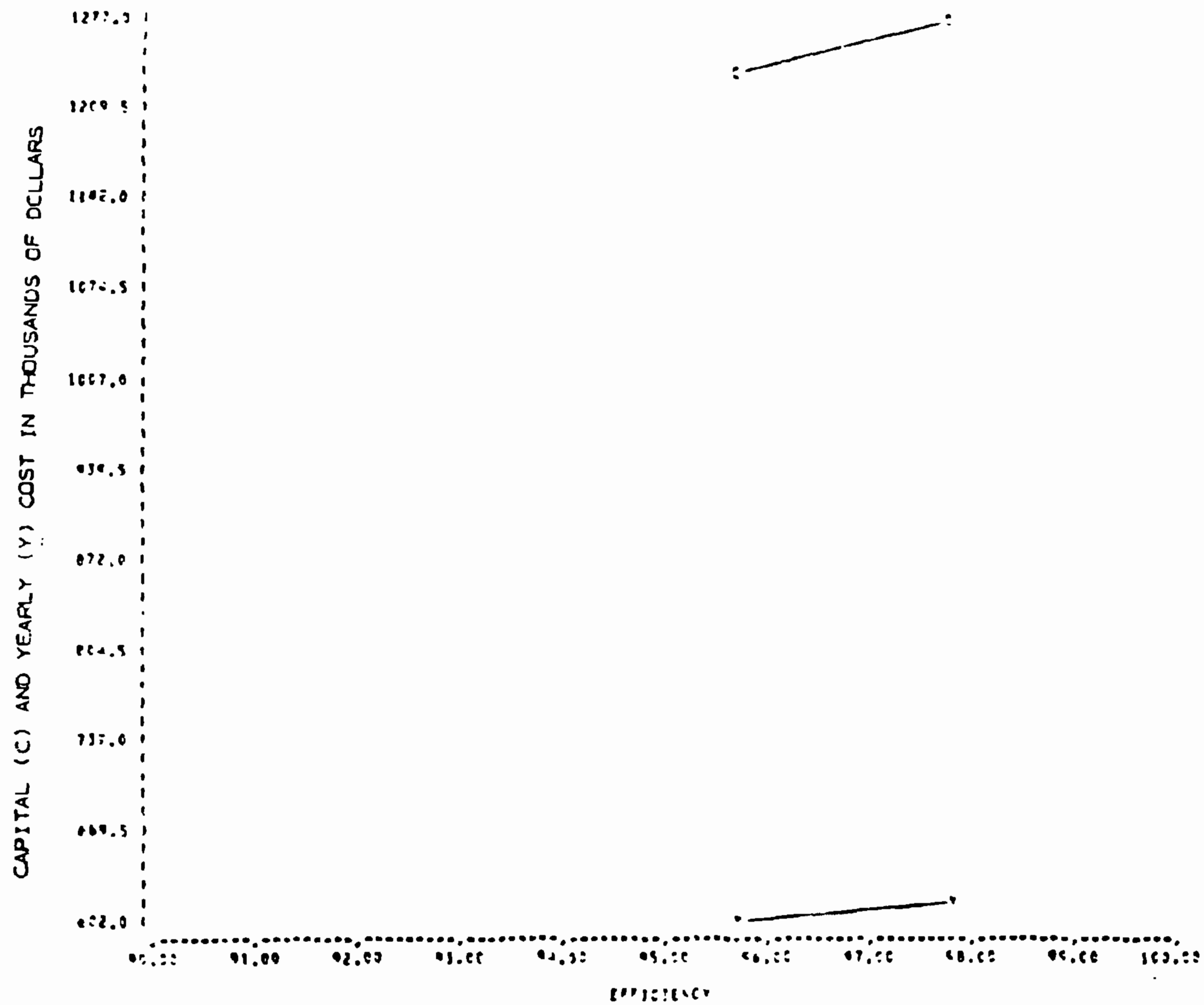


FIGURE 306

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-A-III

DRAFT

TABLE 297

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-A-V
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	1022820.00
2. LAND	47730.00
3. ENGINEERING	102280.00
4. CONTINGENCY	102280.00
TOTAL	1275110.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	84270.00
3. CHEMICALS	6950.00
4. MAINTENANCE&SUPPLIES	58490.00
TOTAL	187190.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	187190.00
2. YEARLY INVESTMENT COST RECOVERY	51000.00
3. DEPRECIATION	61370.00
TOTAL	299560.00

Reduction Benefits: BOD: 97.8 percent
SS: 96.9 percent

A cost efficiency curve is presented in Figure 307.

Alternative A 22-A-VI - This alternative replaces sand drying beds in Alternative A 22-A-IV with vacuum filtration.

The resulting BOD waste load is 0.26 kg/kkg (0.015 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $839,260
Total yearly cost: $221,570

An itemized breakdown of costs is presented in Table 298. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 95.7 percent
SS: 92.3 percent

Alternative A 22-A-VII - This alternative provides in addition to Alternative A 22-A-VI dual media filtration.

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.16 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $884,220
Total yearly cost: $232,060

An itemized breakdown of costs is presented in Table 299. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 97.8 percent
SS: 96.9 percent

A cost efficiency curve is presented in Figure 308.

Alternative A 22-A-VIII - This alternative replaces the sand drying beds in Alternative A 22-A-IV with spray irrigation.

The resulting BOD waste load is 0.26 kg/kkg (0.015 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $838,600
Total yearly cost: $212,850

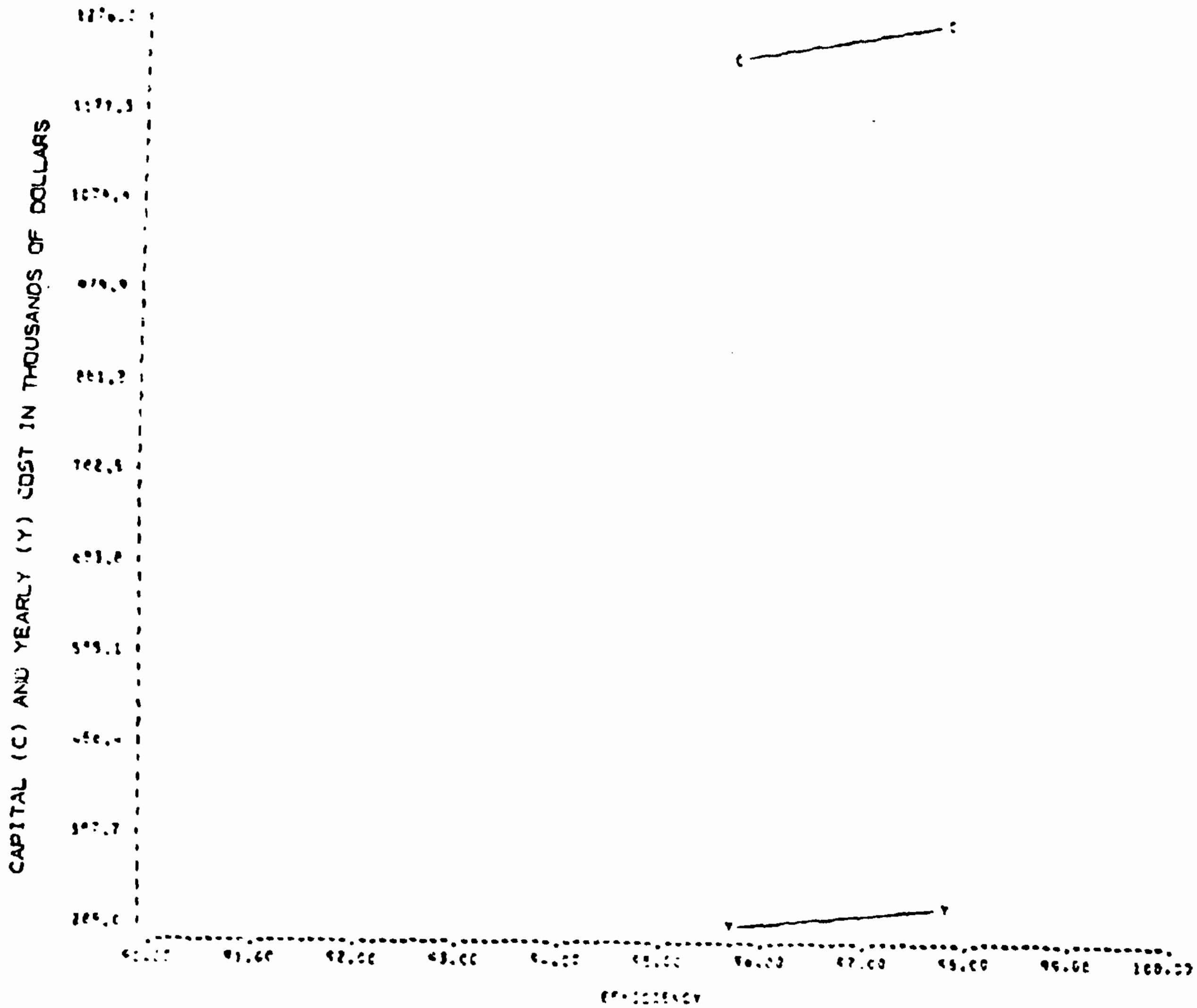


FIGURE 307

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-A-V

DRAFT

TABLE 298

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-A-VI
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
D...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	660510.00
	2. LAND	46650.00
	3. ENGINEERING	66050.00
	4. CONTINGENCY	66050.00
	TOTAL	839260.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	83060.00
	3. CHEMICALS	12700.00
	4. MAINTENANCE&SUPPLIES	15130.00
	TOTAL	148370.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	148370.00
	2. YEARLY INVESTMENT COST RECOVERY	33570.00
	3. DEPRECIATION	39630.00
	TOTAL	221570.00

DRAFT

TABLE 299

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-A-VII (GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- P...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	697970.00
	2. LAND	46650.00
	3. ENGINEERING	69800.00
	4. CONTINGENCY	69800.00
	TOTAL	884220.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	68880.00
	3. CHEMICALS	12700.00
	4. MAINTENANCE&SUPPLIES	15750.00
	TOTAL	154810.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	154810.00
	2. YEARLY INVESTMENT COST RECOVERY	35370.00
	3. DEPRECIATION	41880.00
	TOTAL	232060.00

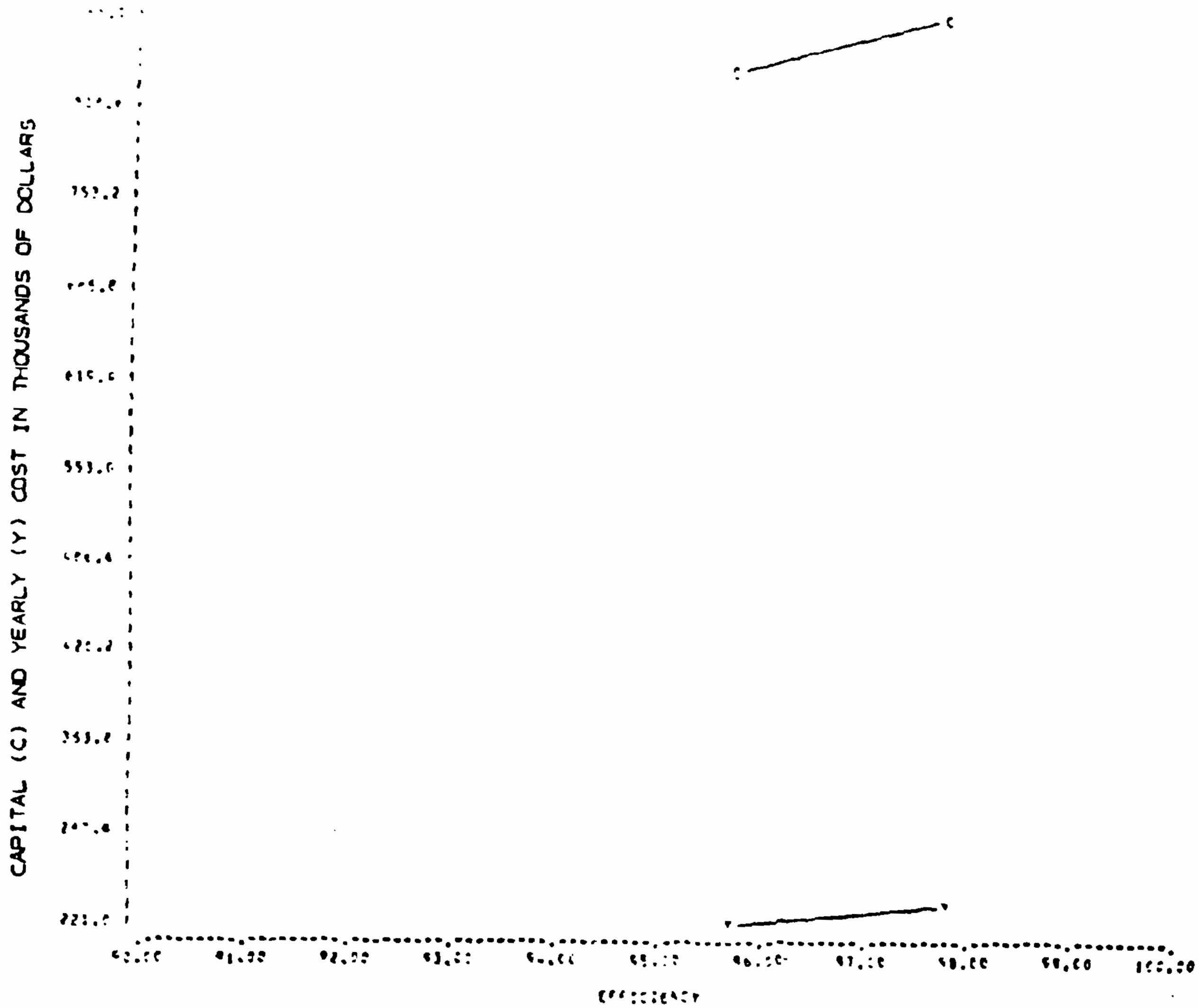


FIGURE 308

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-A-VII

DRAFT

An itemized breakdown of costs is presented in Table 300. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduciton Benefits: BOD: 95.7 percent
SS: 92.3 percent

Alternative A 22-A-IX - This alternative provides in addition to Alternative A 22-A-VIII dual media filtration.

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.16 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $863,810
Total yearly cost: $219,710

An itemized breakdown of costs is presented in Table 301. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assuems screening of the effluent prior to discharge.

Reduction Benefits: BOD: 97.8 percent
SS: 96.9 percent

A cost efficiency curve is presented in Figure 30.

Model plant B produces 90 kkg (3500 bu) per day.

Alternative A 22-B-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 90 kkg (3500 bu) per day plant is 570 cu m (0.15 MG) per day. The BOD waste load is 5.99 kg/kkg (0.335 lb/bu), and the suspended solids load is 4.23 kg/kkg (0.237 lb/bu).

The model plant assumes screening of the effluent prior to discharge.

Costs: 0
Reduction Benefits: None

DRAFT

TABLE 300

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-A-VIII
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1..CONTROL HOUSE
- P...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- U...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	667600.00
	2. LAND	37480.00
	3. ENGINEERING	66760.00
	4. CONTINGENCY	66760.00
	TOTAL	838600.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	79330.00
	3. CHEMICALS	6950.00
	4. MAINTENANCE&SUPPLIES	15490.00
	TOTAL	139250.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	139250.00
	2. YEARLY INVESTMENT COST RECOVERY	33540.00
	3. DEPRECIATION	40060.00
	TOTAL	212850.00

DRAFT

TABLE 301

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-A-IX
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY SYSTEMS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
W...AEROBIC DIGESTER
V...HOLDING TANK
U...SPRAY IRRIGATION
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	688610.00
2. LAND	37480.00
3. ENGINEERING	68860.00
4. CONTINGENCY	68860.00
TOTAL	863810.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	83590.00
3. CHEMICALS	6950.00
4. MAINTENANCE&SUPPLIES	15820.00
TOTAL	143840.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	143840.00
2. YEARLY INVESTMENT COST RECOVERY	34550.00
3. DEPRECIATION	41320.00
TOTAL	219710.00

DRAFT

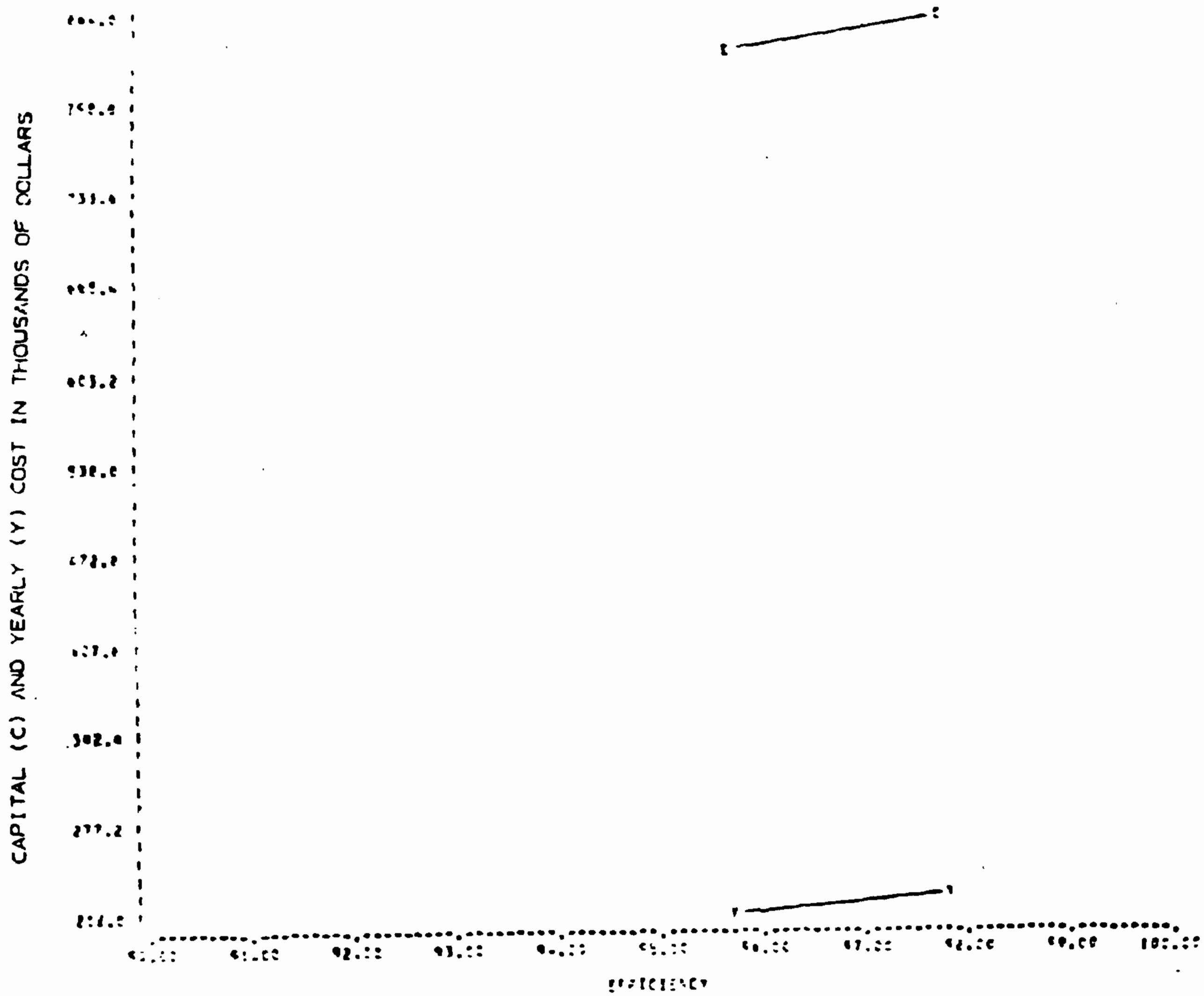


FIGURE 309

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-A-IX

Alternative A 22-B-II - This alternative provides flow equalization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 0.25 kg/kkg (0.014 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $348,170
Total yearly cost: $132,190

An itemized breakdown of costs is presented in Table 302. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 95.8 percent
SS: 92.5 percent

Alternative A 22-B-III - This alternative provides in addition to Alternative A 22-B-II dual media filtration.

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.16 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $373,380
Total yearly cost: $139,050

An itemized breakdown of costs is presented in Table 303. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 97.9 percent
SS: 96.3 percent

A cost efficiency curve is presented in Figure 310.

Alternative A 22-B-IV - This alternative provides a control house, flow equalization, a complete mix activated sludge system, sludge thickening, aerobic digestion, and sand drying beds.

The resulting BOD waste load is 0.25 kg/kkg (0.014 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $332,290
Total yearly cost: $ 97,130

An itemized breakdown of costs is presented in Table 304. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

DRAFT

TABLE 302

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-B-II (GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	279500.00
2.	LAND	4830.00
3.	ENGINEERING	27950.00
4.	CONTINGENCY	27950.00
5.	PVC LINER	7940.00
	TOTAL	348170.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	82700.00
3.	CHEMICALS	1860.00
4.	MAINTENANCE&SUPPLIES	9900.00
5.	PVC LINER	380.00
	TOTAL	101090.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	101090.00
2.	YEARLY INVESTMENT COST RECOVERY	13930.00
3.	DEPRECIATION	17170.00
	TOTAL	132190.00

DRAFT

TABLE 303

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-B-III
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	300510.00
2.	LAND	4630.00
3.	ENGINEERING	30050.00
4.	CONTINGENCY	30050.00
5.	PVC LINER	7940.00
TOTAL		373180.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	86960.00
3.	CHEMICALS	1860.00
4.	MAINTENANCE&SUPPLIES	10230.00
5.	PVC LINER	380.00
TOTAL		105680.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	105680.00
2. YEARLY INVESTMENT COST RECOVERY	14940.00
3. DEPRECIATION	18430.00
TOTAL	139050.00

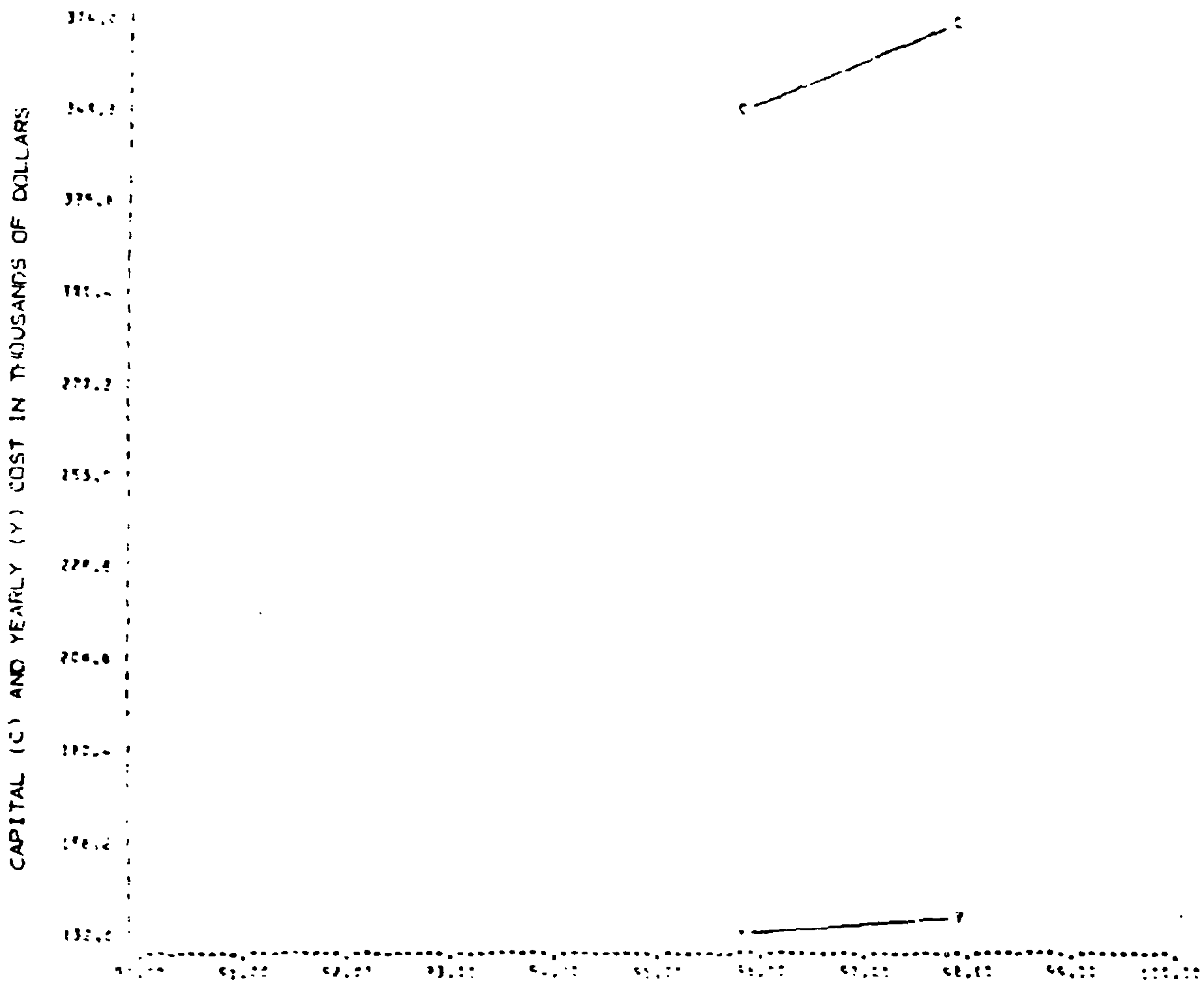


FIGURE 310

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-B-III

TABLE 304

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-B-IV (GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS

INVESTMENT COSTS:

1. CONSTRUCTION	263720.00
2. LAND	15830.00
3. ENGINEERING	26370.00
4. CONTINGENCY	26370.00
TOTAL	332290.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	19760.00
3. CHEMICALS	1860.00
4. MAINTENANCE&SUPPLIES	8920.00
TOTAL	68020.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	68020.00
2. YEARLY INVESTMENT COST RECOVERY	13290.00
3. DEPRECIATION	15820.00
TOTAL	97130.00

The model plant assumes screening of the effluent prior to discharge.

- Reduction Benefits: BOD: 95.8 percent
  SS: 92.5 percent

Alternative A 22-B-V - This alternative provides dual media filtration in addition to the treatment chain in Alternative A 22-B-IV.

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.16 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $357,500
Total yearly cost: $103,990

An itemized breakdown of costs is presented in Table 305. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 97.9 percent
SS: 96.3 percent

A cost efficiency curve is presented in Figure 311.

Alternative A 22-B-VI - This alternative replaces sand drying beds in Alternative A 22-B-IV with vacuum filtration.

The resulting BOD waste load is 0.25 kg/kkg (0.014 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $387,710
Total yearly cost: $106,650

An itemized breakdown of costs is presented in Table 306. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 95.8 percent
SS: 92.5 percent

Alternative A 22-B-VII - This alternative adds dual media filtration to Alternative A 22-B-VI.

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.16 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $412,920
Total yearly cost: $113,510

DRAFT

TABLE 305

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-B-V
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
F...AEROBIC DIGESTOR
T...SAND DRYING BEDS
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	284730.00
2. LAND	15830.00
3. ENGINEERING	28470.00
4. CONTINGENCY	28470.00
TOTAL	357500.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	24020.00
3. CHEMICALS	1860.00
4. MAINTENANCE&SUPPLIES	9250.00
TOTAL	72610.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	72610.00
2. YEARLY INVESTMENT COST RECOVERY	14300.00
3. DEPRECIATION	17080.00
TOTAL	103990.00

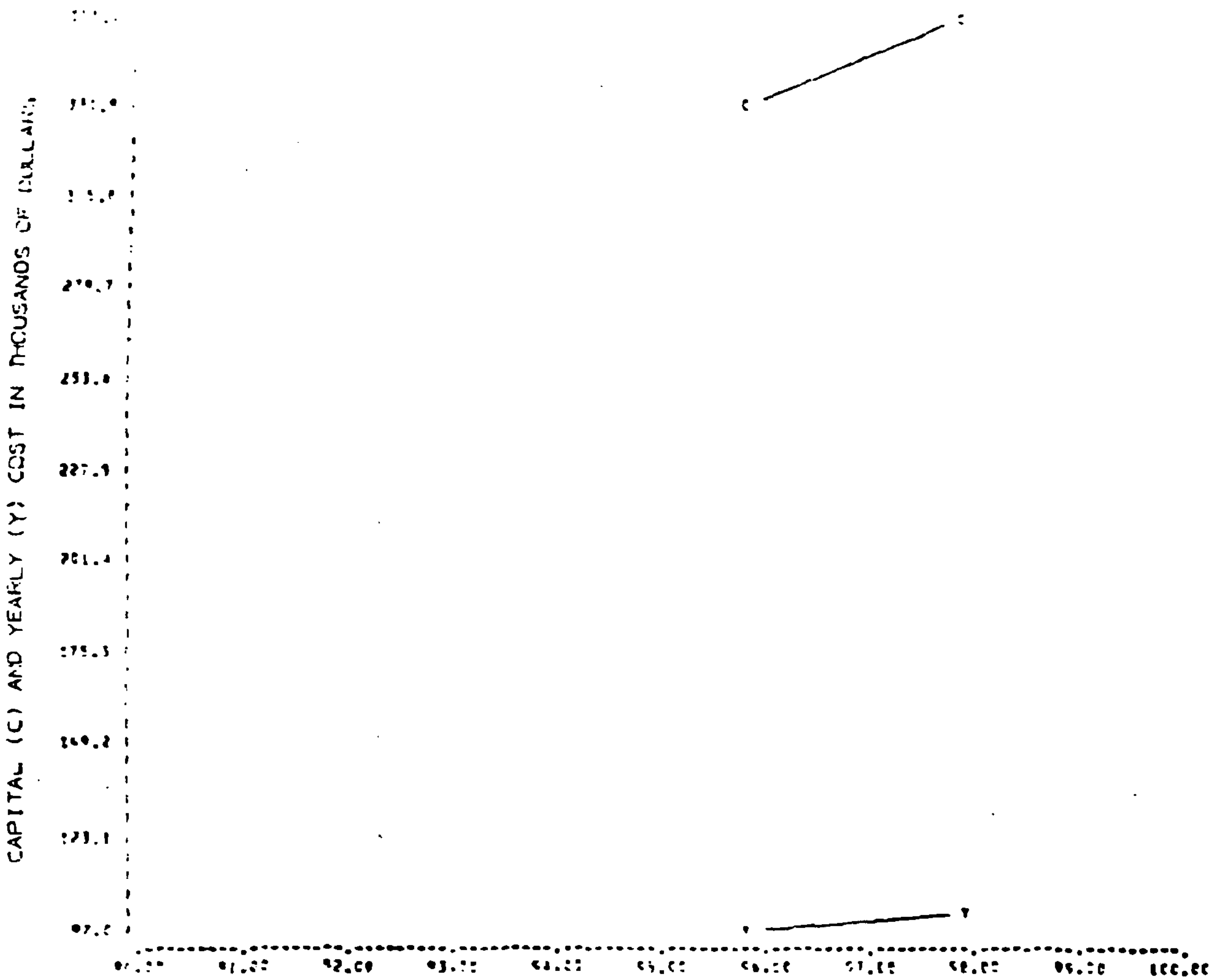


FIGURE 311

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-B-IV-V

TABLE 306

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-B-VI (GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- P...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	296720.00
2. LAND	31650.00
3. ENGINEERING	29670.00
4. CONTINGENCY	29670.00
TOTAL	387710.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	22000.00
3. CHEMICALS	4350.00
4. MAINTENANCE&SUPPLIES	9510.00
TOTAL	73340.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	73340.00
2. YEARLY INVESTMENT COST RECOVERY	15510.00
3. DEPRECIATION	17800.00
TOTAL	106650.00

An itemized breakdown of costs is presented in Table 307. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 97.9 percent
SS: 96.3 percent

A cost efficiency curve is presented in Figure 312.

Alternative A 22-B-VIII - This alternative replaces the sand drying beds in Alternative A 22-B-IV with spray irrigation.

The resulting BOD waste load is 0.25 kg/kkg (0.014 lb/bu), and the suspended solids load is 0.32 kg/kkg (0.018 lb/bu).

Costs: Total investment cost: $388,320
Total yearly cost: $102,870

An itemized breakdown of costs is presented in Table 308. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 95.8 percent
SS: 92.5 percent

Alternative A 22-B-IX - This alternative adds dual media filtration to Alternative A 22-B-VIII.

The resulting BOD waste load is 0.13 kg/kkg (0.0073 lb/bu), and the suspended solids load is 0.16 kg/kkg (0.0090 lb/bu).

Costs: Total investment cost: $404,3[illegible]0
Total yearly cost: $107,620

An itemized breakdown of costs is presented in Table 309. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

The model plant assumes screening of the effluent prior to discharge.

Reduction Benefits: BOD: 97.9 percent
SS: 96.3 percent

A cost efficiency curve is presented in Figure 313.

DRAFT

TABLE 307

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-B-VII (GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	317730.00
2. LAND	31650.00
3. ENGINEERING	31770.00
4. CONTINGENCY	31770.00
TOTAL	412920.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	26260.00
3. CHEMICALS	4350.00
4. MAINTENANCE&SUPPLIES	9840.00
TOTAL	77930.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	77930.00
2. YEARLY INVESTMENT COST RECOVERY	16520.00
3. DEPRECIATION	19060.00
TOTAL	113510.00

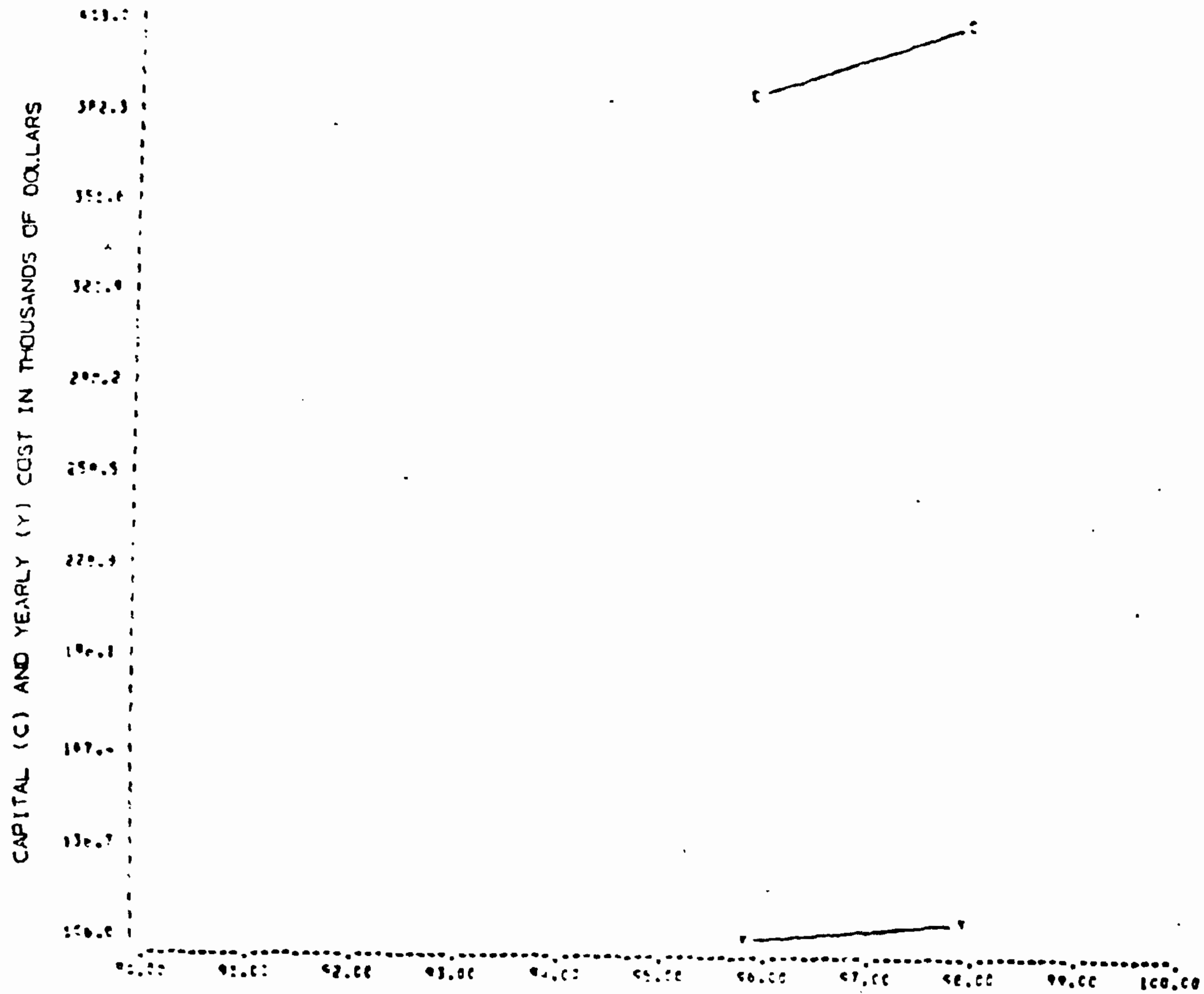


FIGURE 312

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-B-VI-VII

DRAFT

TABLE 308

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 2[illegible]-B-VIII
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

R1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
W...SLUDGE THICKENER
R...AEROBIC DIGESTER
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:

1.	CONSTRUCTION	307640.00
2.	LAND	19160.00
3.	ENGINEERING	30760.00
4.	CONTINGENCY	30760.00
TOTAL		388320.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	20600.00
3.	CHEMICALS	1860.00
4.	MAINTENANCE&SUPPLIES	8940.00
TOTAL		68880.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	68880.00
2.	YEARLY INVESTMENT COST RECOVERY	15530.00
3.	DEPRECIATION	18460.00
TOTAL		102870.00

DRAFT

TABLE 309

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 22-B-IX
(GRAIN DISTILLERS OPERATING STILLAGE RECOVERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTER
Y...HOLDING TANK
L...SPRAY IRRIGATION
P...PUMPING STATION
N...DUAL MEDIA/PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	321000.00
2.	LAND	19160.00
3.	ENGINEERING	32100.00
4.	CONTINGENCY	32100.00
	TOTAL	404360.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	22250.00
3.	CHEMICALS	1860.00
4.	MAINTENANCE&SUPPLIES	10600.00
	TOTAL	72190.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	72190.00
2.	YEARLY INVESTMENT COST RECOVERY	16170.00
3.	DEPRECIATION	19260.00
	TOTAL	107620.00

DRAFT

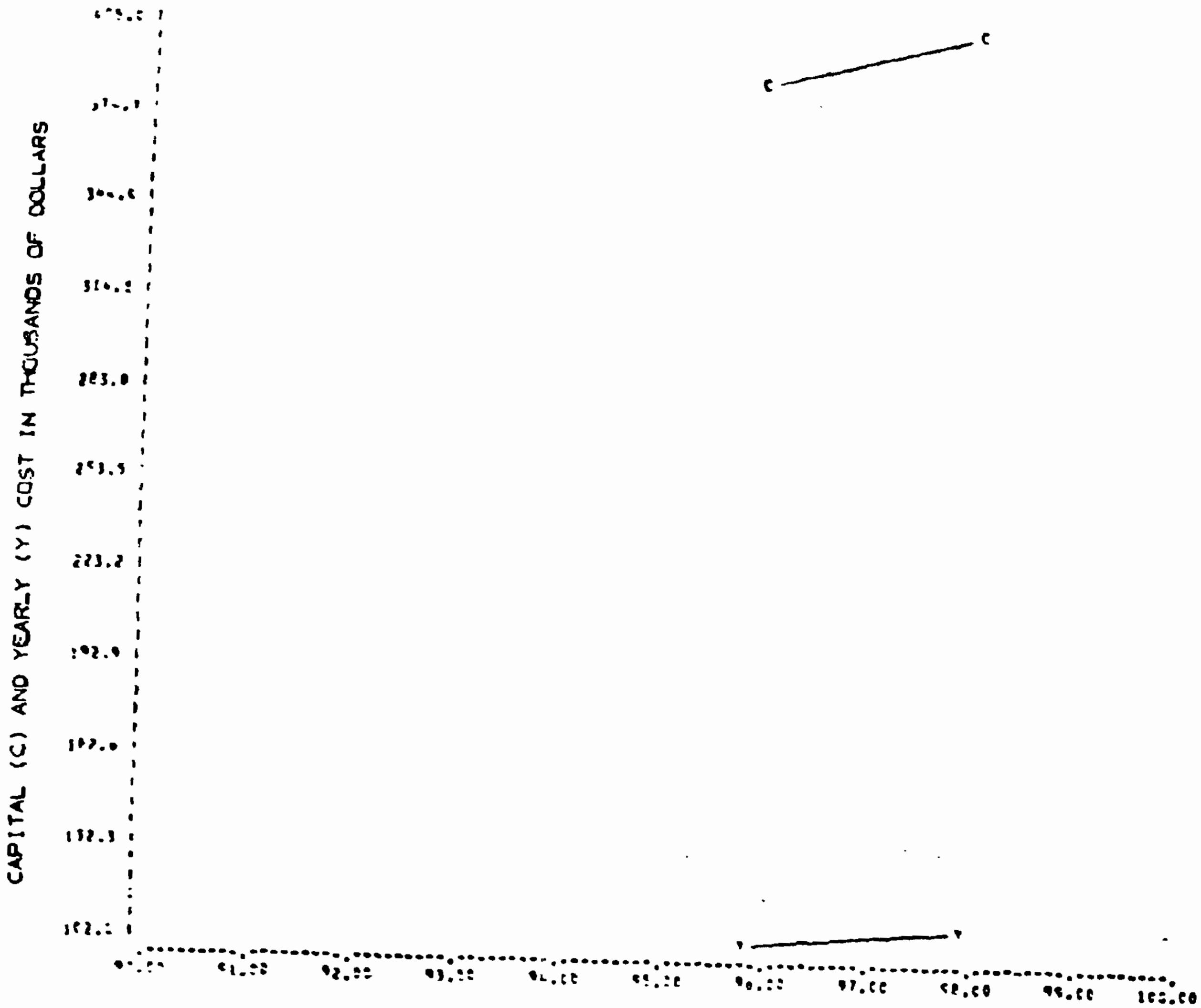


FIGURE 313

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 22-B-VII-IX

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 23 - Grain Distillers Not Operating Stills

A model plant representative of Subcategory A 23 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, five alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 50 kkg (2000 bu) per day.

Alternative A 23-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 50 kkg (2000 bu) per day plant is 91 cu m (0.024 MG) per day. The BOD waste load is 0.39 kg/kkg (0.021 lb/bu), and the suspended solids load is 0.29 kg/kkg (0.016 lb/bu).

Costs: 0
Reduction Benefits: None

Alternative A 23-II - This alternative provides a pumping station and aerated lagoon system.

The resulting BOD waste load is 0.06 kg/kkg (0.0034 lb/bu), and the suspended solids load is 0.07 kg/kkg (0.0039 lb/bu).

Costs: Total investment cost: $133,720
Total yearly cost: $ 28,200

An itemized breakdown of costs is presented in Table 310. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 85.7 percent
SS: 75.0 percent

Alternative A 23-III - This alternative provides in addition to Alternative A 23-II dual media filtration.

The resulting BOD waste load is 0.03 kg/kkg (0.0017 lb/bu), and the suspended solids load is 0.04 kg/kkg (0.0022 lb/bu).

Costs: Total investment cost: $149,750
Total yearly cost: $ 32,940

An itemized breakdown of costs is presented in Table 311. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 92.9 percent
SS: 87.5 percent

A cost efficiency curve is presented in Figure 314.

DRAFT

TABLE 310

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 23-II (GRAIN DISTILLERS NOT OPERATING STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 65.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	105670.00
2. LAND	3330.00
3. ENGINEERING	10570.00
4. CONTINGENCY	10570.00
5. PVC LINER	3580.00
TOTAL	133720.00

YEARLY OPERATING COSTS:

1. LABOR	6250.00
2. POWER	5170.00
3. CHEMICALS	60.00
4. MAINTENANCE&SUPPLIES	4790.00
5. PVC LINER	60.00
TOTAL	16330.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	16330.00
2. YEARLY INVESTMENT COST RECOVERY	5350.00
3. DEPRECIATION	6520.00
TOTAL	28200.00

DRAFT

TABLE 311

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 23-III
(GRAIN DISTILLERS NOT OPERATING STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 92.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	119040.00
2. LAND	3330.00
3. ENGINEERING	11900.00
4. CONTINGENCY	11900.00
5. PVC LINER	3580.00
TOTAL	149750.00

YEARLY OPERATING COSTS:

1. LABOR	6250.00
2. POWER	6820.00
3. CHEMICALS	60.00
4. MAINTENANCE&SUPPLIES	6440.00
5. PVC LINER	60.00
TOTAL	19630.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	19630.00
2. YEARLY INVESTMENT COST RECOVERY	5990.00
3. DEPRECIATION	7320.00
TOTAL	32940.00

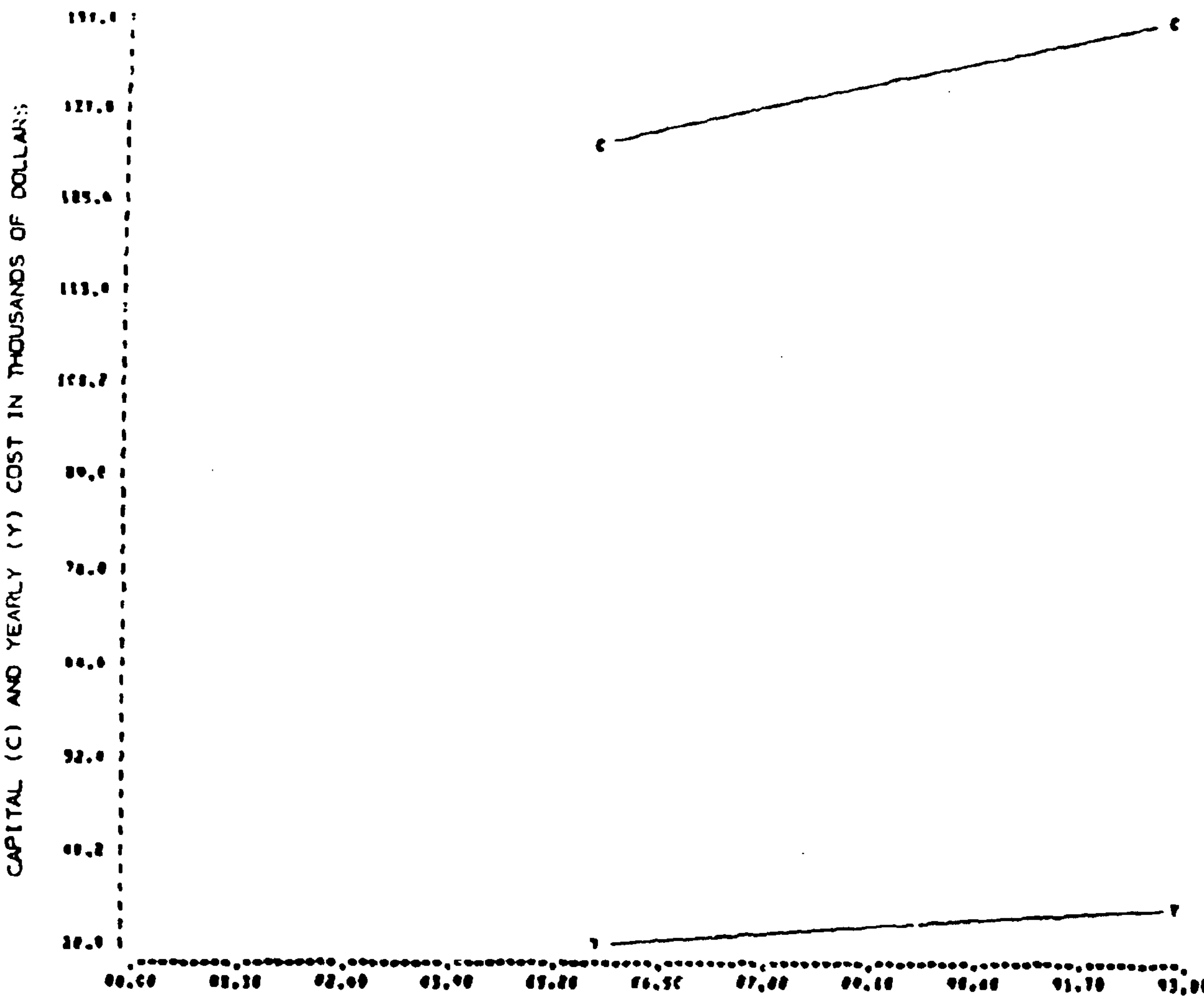


FIGURE 314

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 23-III

Alternative A 23-IV - This alternative provides in addition to Alternative A 23-II spray irrigation.

The resulting BOD waste load is zero, and the suspended solids load is zero.

Costs: Total investment cost: $224,040
Total yearly cost: $ 70,590

An itemized breakdown of costs is presented in Table 312. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

A cost efficiency curve is presented in Figure 315.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 24 - Molasses Distillers

A model plant representative of Subcategory A 24 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, nine alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 30,000 pg per day.

Alternative A 24-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 30,000 pg per day plant is 818 cu m (0.216 MG) per day. The BOD waste load is 969 kg/1000 pg (2140 lb/1000 pg), and the suspended solids load is 183 kg/1000 pg (403 lb/1000 pg).

Costs: 0
Reduction Benefits: None

Alternative A 24-II - This alternative consists of concentrating high strength molasses slops (stillage) by multi-effect evaporation, and then treating evaporator condensate and all other wastes with a treatment chain consisting of a control house, a pumping station, flow equalization, nutrient addition, a complete mix activated sludge system, sludge thickening, aerobic digestion, vacuum filtration, sludge storage and truck hauling. Evaporation is predicted to have an investment cost of $2,193,310 and a yearly cost of $609,620. Evaporation is assumed to remove 97 percent of the BOD and 99 percent of the suspended solids from high strength wastes. Two day storage of distilling slops and seven day storage of molasses by-product is provided, and all necessary pumping equipment is included.

DRAFT

TABLE 312

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 23-IV (GRAIN DISTILLERS NOT OPERATING STILLS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- L...AERATED LAGOON
- Y...HOLDING TANK
- Z...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	174270.00
2. LAND	11330.00
3. ENGINEERING	17430.00
4. CONTINGENCY	17430.00
5. PVC LINER	3580.00
TOTAL	224040.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	6130.00
3. CHEMICALS	60.00
4. MAINTENANCE&SUPPLIES	7260.00
5. PVC LINER	60.00
TOTAL	50990.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	50990.00
2. YEARLY INVESTMENT COST RECOVERY	8960.00
3. DEPRECIATION	10640.00
TOTAL	70590.00

1111

DRAFT

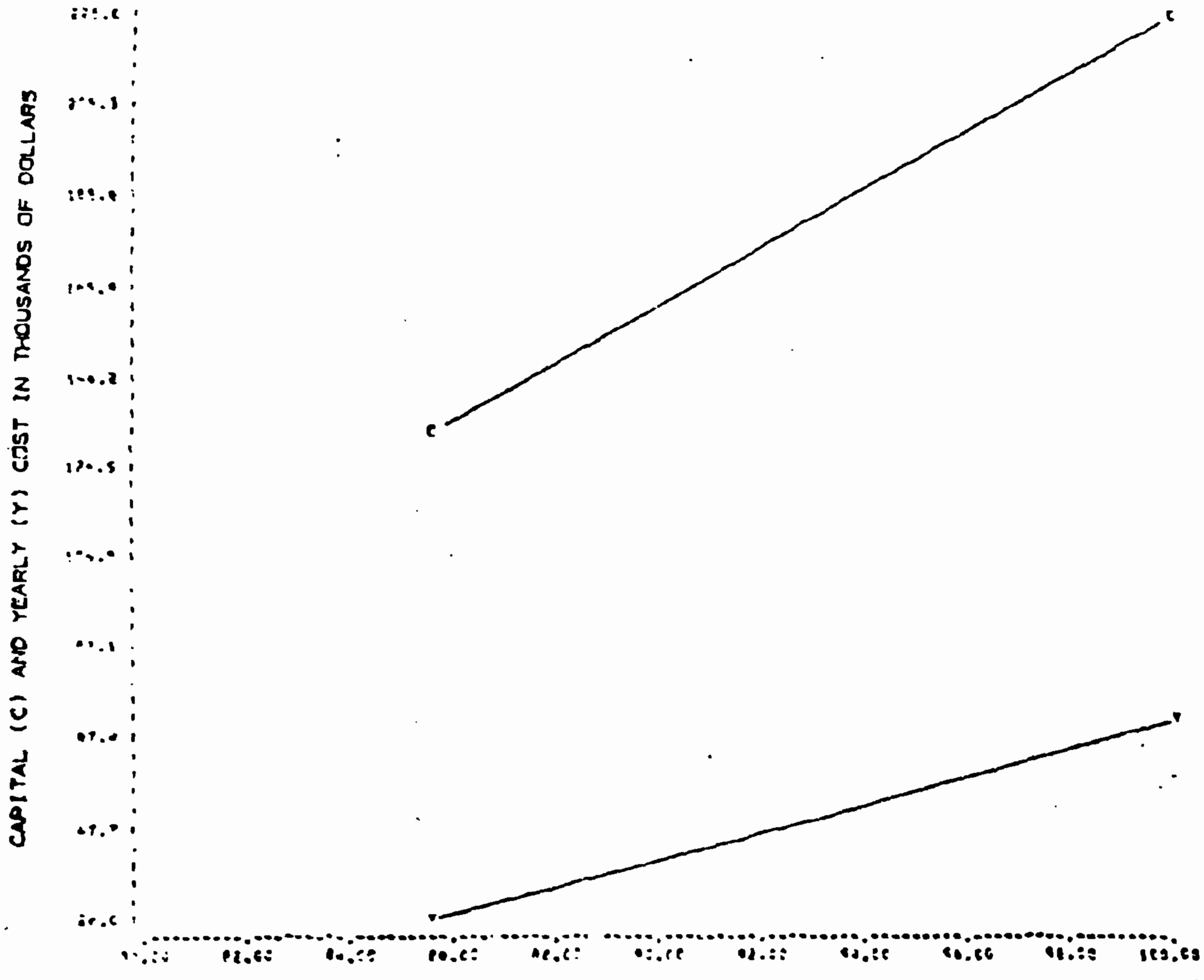


FIGURE 315

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 23-IV

The resulting BOD waste load is 1.16 kg/1000 pg (2.56 lb/1000 pg), and the suspended solids load is 0.69 kg/1000 pg (1.52 lb/1000 pg).

Costs: Total investment cost: $2,644,060
Total yearly cost: $ 698,640

An itemized breakdown of costs is presented in Table 313. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

It is recognized that, although not included in the above costs, additional boiler and cooling capacity may be required for evaporation. Cost recovery from saleable by-products is not reflected in the costs.

Reduction Benefits: BOD: 99.9 percent
SS: 99.6 percent

Alternative A 24-III - This alternative consists of adding dual media filtration to the treatment chain in Alternative A 24-II.

The resulting BOD waste load is 0.58 kg/1000 pg (1.28 lb/1000 pg), and the suspended solids load is 0.35 kg/1000 pg (0.77 lb/1000 pg).

Costs: Total investment cost: $2,671,130
Total yearly cost: $ 705,710

An itemized breakdown of costs is presented in Table 314. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.9 percent
SS: 99.8 percent

A cost efficiency curve is presented in Figure 316.

Alternative A 24-IV - This alternative replaces vacuum filtration in Alternative A 24-II with spray irrigation of sludge.

The resulting BOD waste load is 1.16 kg/1000 pg (2.56 lb/1000 pg), and the suspended solids load is 0.69 kg/1000 pg (1.52 lb/1000 pg).

Costs: Total investment cost: $2,638,610
Total yearly cost: $ 692,540

An itemized breakdown of costs is presented in Table 315. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.9 percent
SS: 99.6 percent

TABLE 313

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-II
(MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
F1..MULTIPLE EFFECT EVAPORATOR
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
1.	CONSTRUCTION	2181160.00
2.	LAND	26660.00
3.	ENGINEERING	218120.00
4.	CONTINGENCY	218120.00
TOTAL		2644060.00
YEARLY OPERATING COSTS:		
1.	LABOR	74970.00
2.	POWER	339170.00
3.	CHEMICALS	7350.00
4.	MAINTENANCE&SUPPLIES	40520.00
TOTAL		462010.00
TOTAL YEARLY COSTS:		
1.	YEARLY OPERATING COST	462010.00
2.	YEARLY INVESTMENT COST RECOVERY	105760.00
3.	DEPRECIATION	130870.00
TOTAL		698640.00

DRAFT

TABLE 314

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-III (MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

- E1..CONTROL HOUSE
- B...PUMPING STATION
- F1..MULTIPLE EFFECT EVAPORATOR
- Y...HOLDING TANK
- B...PUMPING STATION
- Y...HOLDING TANK
- B...PUMPING STATION
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	2203730.00
2.	LAND	26660.00
3.	ENGINEERING	220370.00
4.	CONTINGENCY	220370.00
TOTAL		2671130.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	343450.00
3.	CHEMICALS	7350.00
4.	MAINTENANCE&SUPPLIES	40870.00
TOTAL		466640.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	466640.00
2.	YEARLY INVESTMENT COST RECOVERY	106850.00
3.	DEPRECIATION	132220.00
TOTAL		705710.00

DRAFT

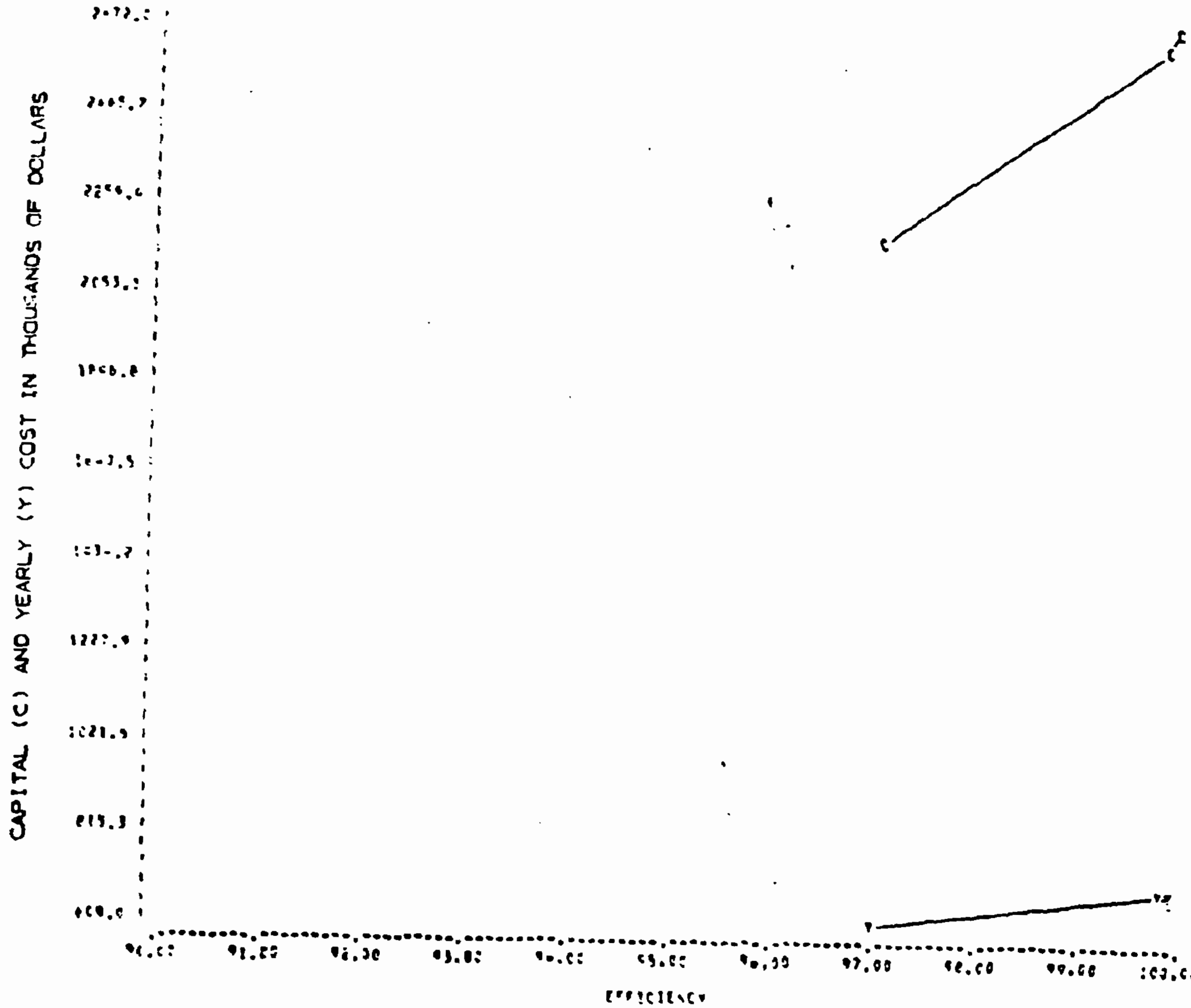


FIGURE 316

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 24-III

DRAFT

TABLE 315

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-IV
(MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
F1..MULTIPLE EFFECT EVAPORATOR
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
U...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	2183560.00
	2. LAND	18330.00
	3. ENGINEERING	218360.00
	4. CONTINGENCY	218360.00
	TOTAL	2638610.00
YEARLY OPERATING COSTS:		
	1. LABOR	74970.00
	2. POWER	337450.00
	3. CHEMICALS	4390.00
	4. MAINTENANCE&SUPPLIES	39180.00
	TOTAL	455990.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	455990.00
	2. YEARLY INVESTMENT COST RECOVERY	105540.00
	3. DEPRECIATION	131010.00
	TOTAL	692540.00

Alternative A 24-V - This alternative provides in addition to Alternative A 24-IV dual media filtration.

The resulting BOD waste load is 0.58 kb/1000 pg (1.28 lb/1000 pg), and the suspended solids load is 0.35 kg/1000 pg (0.77 lb/1000 pg).

Costs: Total investment cost: $2,665,690
Total yearly cost: $ 699,620

An itemized breakdown of costs is presented in Table 316. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.9 percent
SS: 99.8 percent

A cost efficiency curve is presented in Figure 317.

Alternative A 24-VI - This alternative replaces vacuum filtration in Alternative A 24-II with sand drying beds.

The resulting BOD waste load is 1.16 kg/1000 pg (2.56 lb/1000 pg), and the suspended solids load is 0.69 kg/1000 pg (1.52 lb/1000 pg).

Costs: Total investment cost: $2,759,100
Total yearly cost: $ 718,490

An itemized breakdown of costs is presented in Table 317. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.9 percent
SS: 99.6 percent

Alternative A 24-VII - This alternative adds dual media filtration to Alternative A 24-VI.

The resulting BOD waste load is 0.58 kg/1000 pg (1.28 lb/1000 pg), and the suspended solids load is 0.35 kg/1000 pg (0.77 lb/1000 pg).

Costs: Total investment cost: $2,786,170
Total yearly cost: $ 725,560

An itemized breakdown of costs is presented in Table 318. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.9 percent
SS: 99.8 percent

A cost efficiency curve is presented in Figure 318.

DRAFT

TABLE 316

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-V (MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
F1..MULTIPLE EFFECT EVAPORATOR
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
U...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	2206140.00
2. LAND	18330.00
3. ENGINEERING	220610.00
4. CONTINGENCY	220610.00
TOTAL	2665690.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	341730.00
3. CHEMICALS	4390.00
4. MAINTENANCE&SUPPLIES	39530.00
TOTAL	460620.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	460620.00
2. YEARLY INVESTMENT COST RECOVERY	106630.00
3. DEPRECIATION	132370.00
TOTAL	699620.00

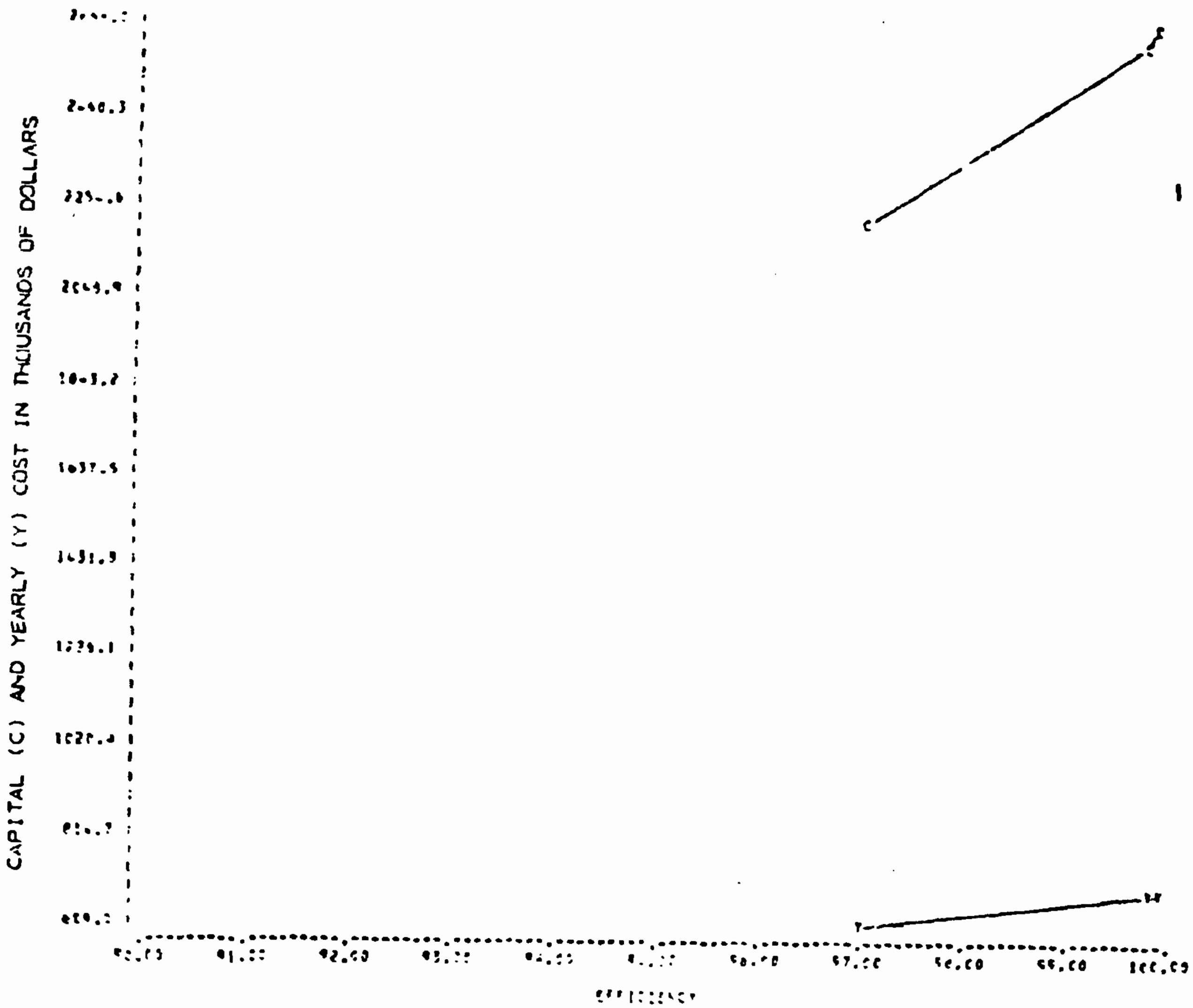


FIGURE 317

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 24-V

DRAFT

TABLE 317

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-VI (MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
F1..MULTIPLE EFFECT EVAPORATOR
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
B...PUMPING STATION
C...EQUALIZATION BASIN
M...NITROGEN ADDITION
N...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTER
T...SAND DRYING BEDS

INVESTMENT COSTS:

1. CONSTRUCTION	2280360.00
2. LAND	22660.00
3. ENGINEERING	228040.00
4. CONTINGENCY	228040.00
TOTAL	2759100.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	336600.00
3. CHEMICALS	4390.00
4. MAINTENANCE&SUPPLIES	55350.00
TOTAL	471310.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	471310.00
2. YEARLY INVESTMENT COST RECOVERY	110360.00
3. DEPRECIATION	136820.00
TOTAL	718490.00

DRAFT

TABLE 318

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-VII (MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- F1..MULTIPLE EFFECT EVAPORATOR
- Y...HOLDING TANK
- B...PUMPING STATION
- Y...HOLDING TANK
- B...PUMPING STATION
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	2302930.00
	2. LAND	22660.00
	3. ENGINEERING	230290.00
	4. CONTINGENCY	230290.00
	TOTAL	2786170.00
YEARLY OPERATING COSTS:		
	1. LABOR	74970.00
	2. POWER	340880.00
	3. CHEMICALS	4390.00
	4. MAINTENANCE&SUPPLIES	55690.00
	TOTAL	475930.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	475930.00
	2. YEARLY INVESTMENT COST RECOVERY	111450.00
	3. DEPRECIATION	138180.00
	TOTAL	725560.00

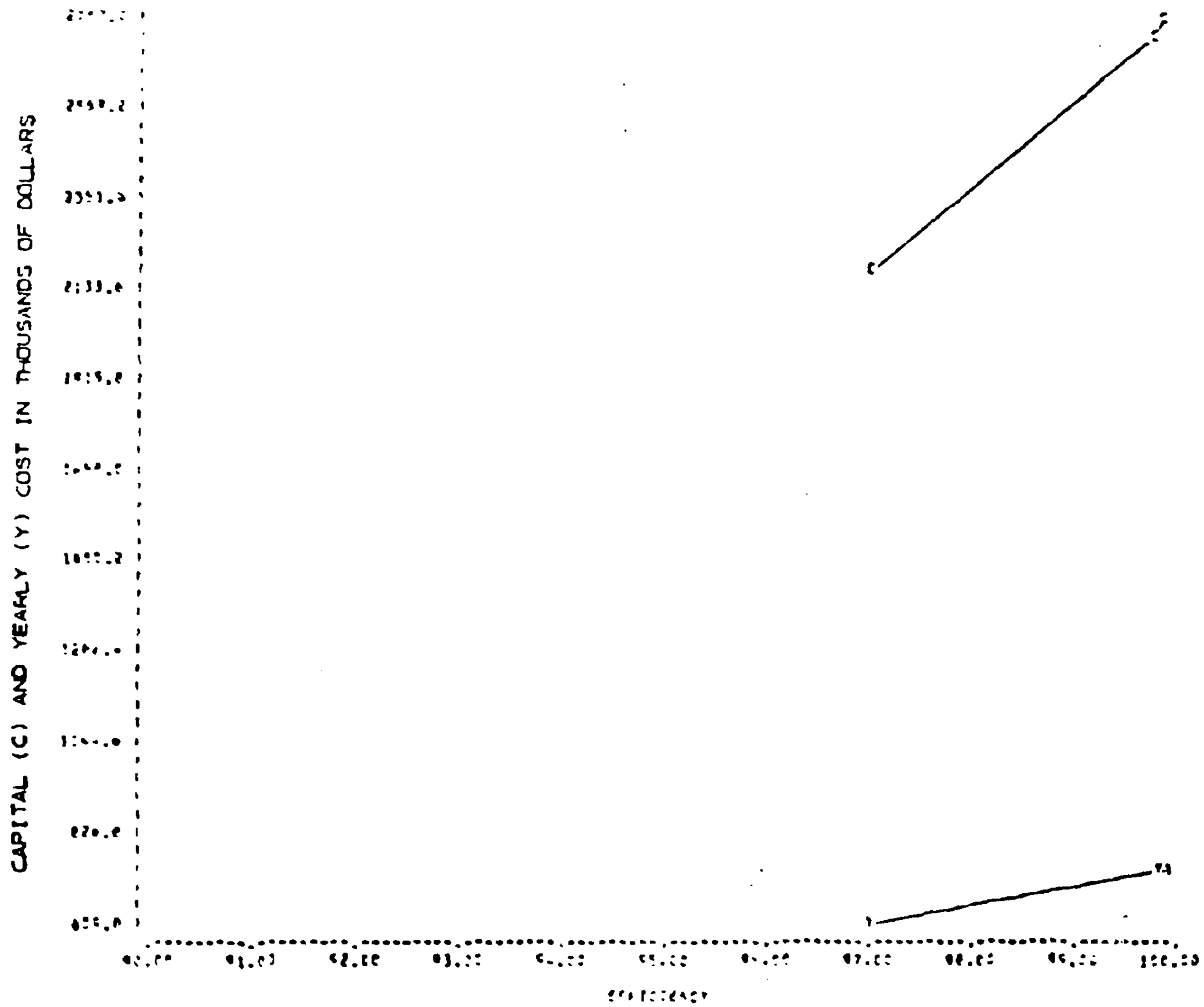


FIGURE 318

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 24-VII

DRAFT

Alternative A 24-VIII - This alternative replaces the activated sludge and sludge handling modules in Alternative A 24-II with an aerated lagoon system.

The resulting BOD waste load is 1.16 kg/1000 pg (2.56 lb/1000 pg), and the suspended solids load is 0.69 kg/1000 pg (1.52 lb/1000 pg).

Costs: Total investment cost: $2,665,800
Total yearly cost: 800,510

An itemized breakdown of costs is presented in Table 319. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.9 percent
SS: 99.6 percent

Alternative A 24-IX - This alternative provides in addition to Alternative A 24-VIII dual media filtration.

The resulting BOD waste load is 0.58 kg/1000 pg (1.28 lb/1000 pg), and the suspended solids load is 0.35 kg/1000 pg (0.77 lb/1000 pg).

Costs: Total investment cost: $2,692,880
Total yearly cost: $ 807,580

An itemized breakdown of costs is presented in Table 320. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.9 percent
SS: 99.8 percent

A cost efficiency curve is presented in Figure 319.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 25 - Bottling and Blending of Beverage Alcohol

Two model plants representative of Subcategory A 25 were developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives for each model plant. These alternatives provide for various levels of waste reductions for the model plants.

Model plant A produces a flow of 4 cu m/day (0.001 MGD).

Alternative A 25-A-I - This alternative assumes no treatment and no reduction in the waste load.

Costs: 0
Reduction Benefits: None

DRAFT

TABLE 319

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-VIII (MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

C1..CONTROL HOUSE
P...PUMPING STATION
F1..MULTIPLE EFFECT EVAPORATOR
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	2206570.00
2. LAND	5830.00
3. ENGINEERING	220660.00
4. CONTINGENCY	220660.00
5. PVC LINER	12080.00
TOTAL	2665800.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	437430.00
3. CHEMICALS	4390.00
4. MAINTENANCE&SUPPLIES	43640.00
5. PVC LINER	450.00
TOTAL	560880.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	560880.00
2. YEARLY INVESTMENT COST RECOVERY	106630.00
3. DEPRECIATION	133000.00
TOTAL	800510.00

DRAFT

TABLE 320

ITEMIZED COST SUMMARY FOR ALTERNATIVE A24-IX (MOLASSES DISTILLERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- A...PUMPING STATION
- F1..MULTIPLE EFFECT EVAPORATOR
- Y...HOLDING TANK
- B...PUMPING STATION
- Y...HOLDING TANK
- B...PUMPING STATION
- A...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- L...AERATED LAGOON
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	2229150.00
2. LAND	5830.00
3. ENGINEERING	222910.00
4. CONTINGENCY	222910.00
5. PVC LINER	12080.00
TOTAL	2692880.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	441700.00
3. CHEMICALS	4390.00
4. MAINTENANCE*SUPPLIES	44000.00
5. PVC LINER	450.00
TOTAL	565510.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	565510.00
2. YEARLY INVESTMENT COST RECOVERY	107720.00
3. DEPRECIATION	134350.00
TOTAL	807580.00

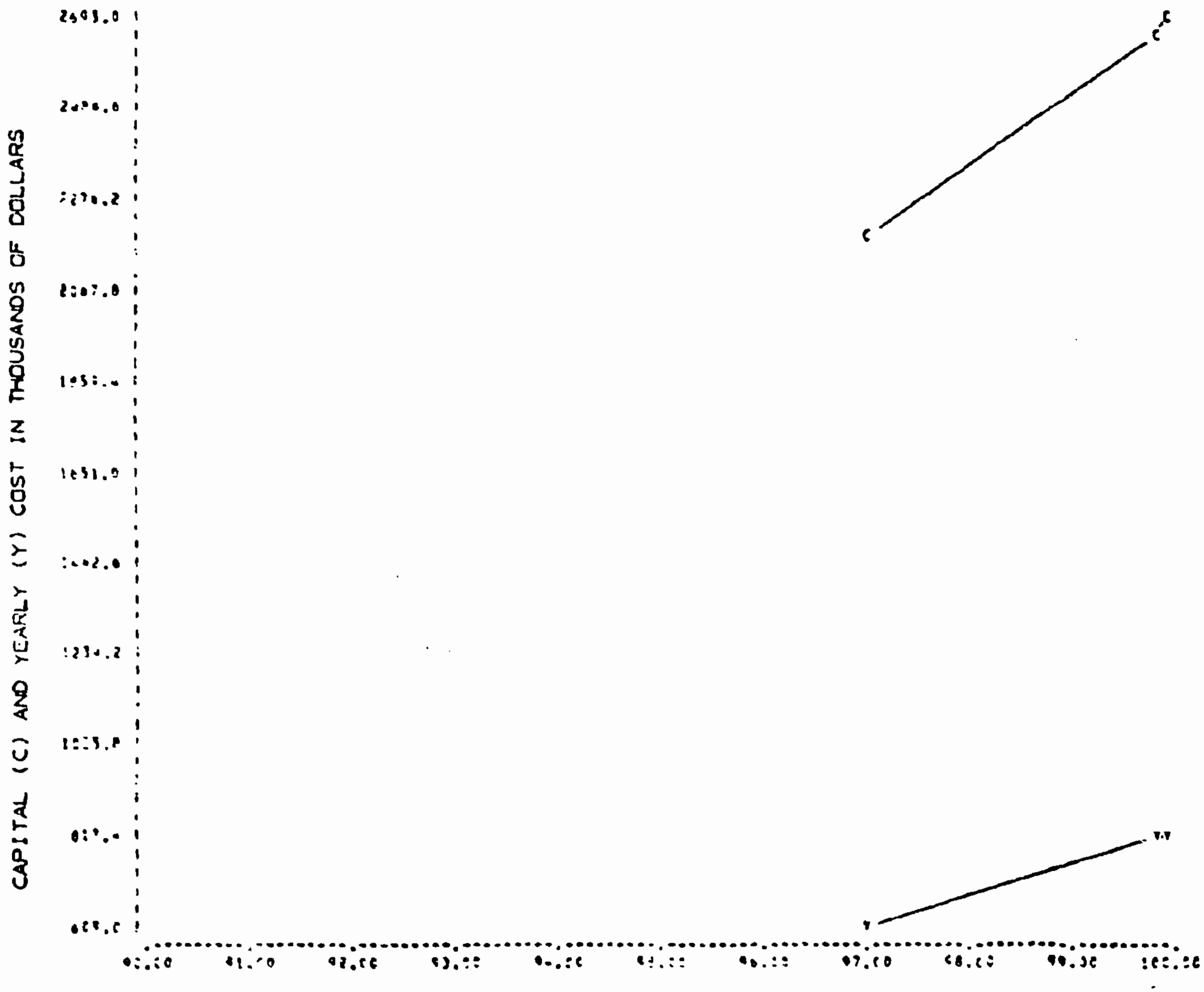


FIGURE 319

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 24-IX

Alternative A 25-A-II - This alternative provides daily truck hauling of all plant process wastes to municipal treatment facilities or approved land disposal sites. A holding tank is provided.

The resulting BOD waste load is zero, and the suspended solids load is zero.

Costs: Total investment cost: $12,860
Total yearly cost: $16,470

An itemized breakdown of costs is presented in Table 321. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Alternative A 25-A-III - This alternative provides for spray irrigation of the final effluent. A holding tank, pump, and pipelines are provided.

The resulting BOD waste load is zero, and the suspended solids load is zero.

Costs: Total investment cost: $38,270
Total yearly cost: $ 5,210

An itemized breakdown of costs is presented in Table 322. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Model p ;nt B has a flow of 40 cu m (0.01 MG) per day.

Alternative A 25-B-I - This alternative assumes no treatment and no reduction in the waste load.

Costs: 0
Reduction Benefits: None

Alternative A 25-B-II - This alternative provides daily truck hauling for all plant process wastes to municipal treatment facilities or approved land disposal sites. A holding tank is provided.

The resulting BOD waste load is zero, and the suspended solids load is zero.

Costs: Total investment cost: $ 14,670
Total yearly cost: $153,470

DRAFT

TABLE 321

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 25-A-II
(BOTTLING AND BLENDING OF BEVERAGE ALCOHOL)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
V... TRUCK HAULING

INVESTMENT COSTS:

1.	CONSTRUCTION	8490.00
2.	LAND	2670.00
3.	ENGINEERING	850.00
4.	CONTINGENCY	850.00
	TOTAL	12860.00

YEARLY OPERATING COSTS:

1.	LABOR	0.0
2.	POWER	0.0
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	15450.00
	TOTAL	15450.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	15450.00
2.	YEARLY INVESTMENT COST RECOVERY	510.00
3.	DEPRECIATION	510.00
	TOTAL	16470.00

DRAFT

TABLE 322

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 25-A-III
(BOTTLING AND BLENDING OF BEVERAGE ALCOHOL)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
U...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	29390.00
	2. LAND	3000.00
	3. ENGINEERING	2940.00
	4. CONTINGENCY	2940.00
	TOTAL	38270.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	840.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1080.00
	TOTAL	1920.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	1920.00
	2. YEARLY INVESTMENT COST RECOVERY	1530.00
	3. DEPRECIATION	1760.00
	TOTAL	5210.00

An itemized breakdown of costs is presented in Table 323. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Alternative A 25-B-III - This alternative provides truck hauling on a monthly basis for redistillation residue, bad product, and demineralizer regeneration. It is assumed these wastes are collected in holding tanks. All other process wastes are spray irrigated. A holding tank, pump, and pipeline are provided.

The resulting BOD waste load is zero, and the suspended solids load is zero.

Costs: Total investment cost: $48,860
Total yearly cost: $ 6,360

An itemized breakdown of costs is presented in Table 324. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 26 - Soft Drink Canners

A model plant representative of Subcategory A 26 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, seven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 309 cu m (81,500 gal) per day.

Alternative A 26-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 309 cu m (81,500 gal) per day plant is 229 cu m (0.0605 MG) per day. The BOD waste load is 1.02 kg/cu m (0.505 lb/1000 gal), and the suspended solids load is 0.123 kg/cu m (1.03 lb/1000 gal).

Costs: 0
Reduction Benefits: None

Alternative A 26-II - This alternative provides a control house, flow equalization, nutrient addition, a complete mix activated sludge system, sludge thickening, and spray irrigation of sludge.

The resulting BOD waste load is 0.052 kg/cu m (0.43 lb/1000 gal), and the suspended solids load is 0.030 kg/cu m (0.25 lb/1000 gal).

DRAFT

TABLE 323

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 25-B-II (BOTTLING AND BLENDING OF BEVERAGE ALCOHOL)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
V... TRUCK HAULING

INVESTMENT COSTS:		
	1. CONSTRUCTION	9940.00
	2. LAND	2750.00
	3. ENGINEERING	990.00
	4. CONTINGENCY	990.00
	TOTAL	14670.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	0.0
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	152280.00
	TOTAL	152280.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	152280.00
	2. YEARLY INVESTMENT COST RECOVERY	590.00
	3. DEPRECIATION	600.00
	TOTAL	153470.00

DRAFT

TABLE 324

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 25-B-III (BOTTLING AND BLENDING OF BEVERAGE ALCOHOL)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	37110.00
	2. LAND	4330.00
	3. ENGINEERING	3710.00
	4. CONTINGENCY	3710.00
	TOTAL	48860.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	880.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1300.00
	TOTAL	2180.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	2180.00
	2. YEARLY INVESTMENT COST RECOVERY	1950.00
	3. DEPRECIATION	2230.00
	TOTAL	6360.00

Costs: Total investment cost: $238,880
Total yearly cost: $ 49,390

An itemized breakdown of costs is presented in Table 325. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.9 percent
SS: 76.0 percent

Alternative A 26-III - This alternative provides in addition to Alternative A 26-II dual media filtration.

The resulting BOD waste load is 0.026 kg/cu m (0.22 lb/1000 gal), and the suspended solids load is 0.015 kg/cu m (0.13 lb/1000 gal).

Costs: Total investment cost: $258,070
Total yearly cost: $ 55,010

An itemized breakdown of costs is presented in Table 326. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.5 percent
SS: 88.1 percent

A cost efficiency curve is presented in Figure 320.

Alternative A 26-IV - This alternative provides a control house, flow equalization, nutrient addition, a complete mix activated sludge system, and sludge thickening.

The resulting BOD waste load is 0.052 kg/cu m (0.43 lb/1000 gal), and the suspended solids load is 0.030 kg/cu m (0.25 lb/1000 gal).

Costs: Total investment cost: $210,270
Total yearly cost: $ 47,070

An itemized breakdown of costs is presented in Table 327. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.9 percent
SS: 76.0 percent

Alternative A 26-V - This alternative provides, in addition to alternative A 26-IV dual media filtration.

The resulting BOD waste load is 0.026 kg/cu m (0.22 lb/1000 gal), and the suspended solids load is 0 015 kg/cu m (0.13 lb/1000 gal).

DRAFT

TABLE 325

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 26-II (SOFT DRINK CANNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- Y...HOLDING TANK
- U...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	185180.00
	2. LAND	15660.00
	3. ENGINEERING	18520.00
	4. CONTINGENCY	18520.00
	TOTAL	238880.00

YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	9940.00
	3. CHEMICALS	890.00
	4. MAINTENANCE&SUPPLIES	5400.00
	TOTAL	28720.00

TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	28720.00
	2. YEARLY INVESTMENT COST RECOVERY	9560.00
	3. DEPRECIATION	11110.00
	TOTAL	49390.00

DRAFT

TABLE 326

ITEMIZED COST SUMMARY FOR ALTERNATIVE . A 26-III
(SOFT DRINK CANNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
Y...HOLDING TANK
U...SPRAY IRRIGATION
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	201170.00
2. LAND	16660.00
3. ENGINEERING	20120.00
4. CONTINGENCY	20120.00
TOTAL	258070.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	12050.00
3. CHEMICALS	890.00
4. MAINTENANCE&SUPPLIES	6390.00
TOTAL	32620.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	32620.00
2. YEARLY INVESTMENT COST RECOVERY	10320.00
3. DEPRECIATION	12070.00
TOTAL	55010.00

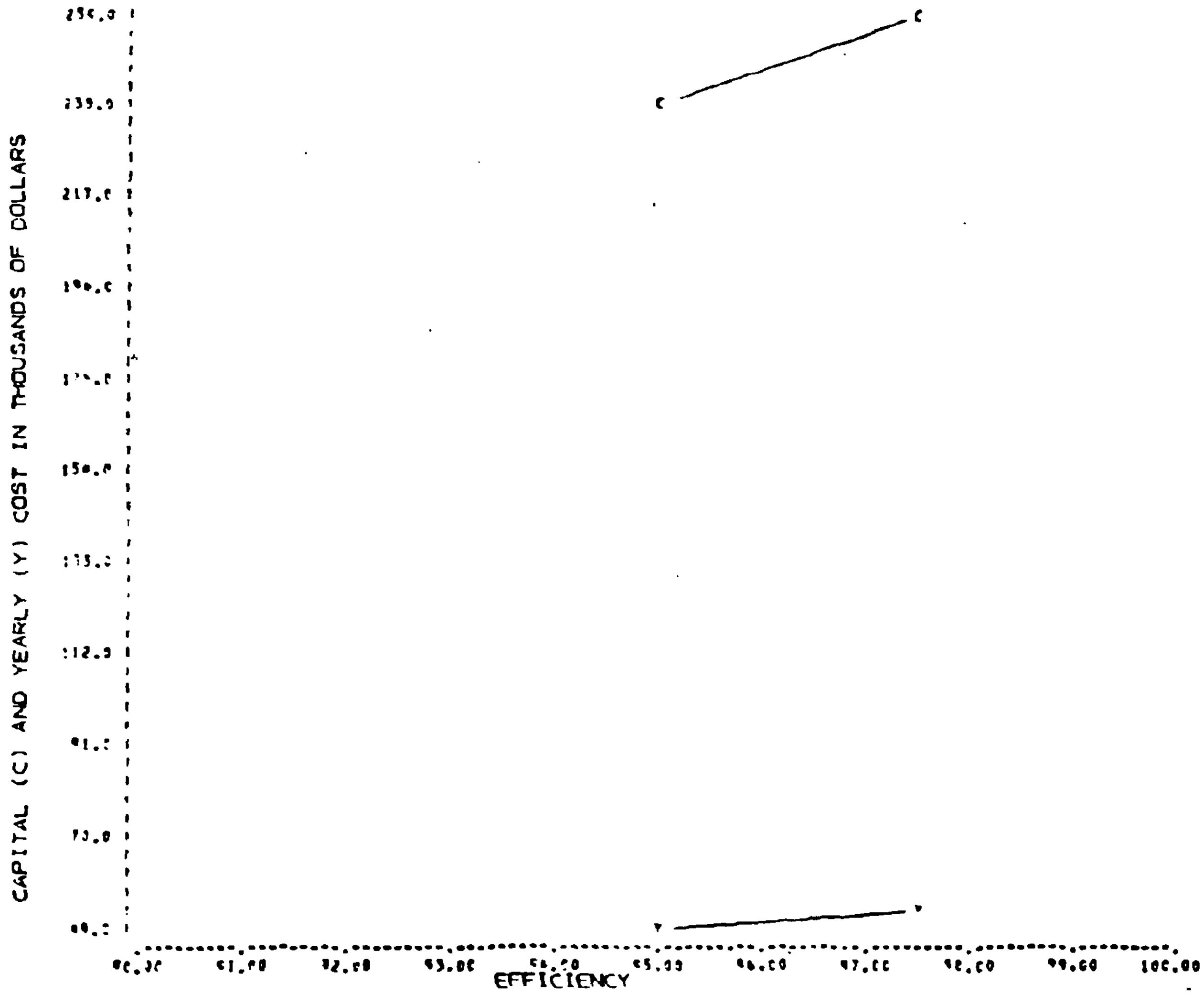


FIGURE 320

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 26, ALT. 26-II-A26-III

TABLE 327

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 26-IV
(SOFT DRINK CANNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

H1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
C...SLUDGE THICKENER
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	153010.00
	2. LAND	26660.00
	3. ENGINEERING	15300.00
	4. CONTINGENCY	15300.00
	TOTAL	210270.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	9100.00
	3. CHEMICALS	890.00
	4. MAINTENANCE&SUPPLIES	7000.00
	TOTAL	29480.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	29480.00
	2. YEARLY INVESTMENT COST RECOVERY	8410.00
	3. DEPRECIATION	9180.00
	TOTAL	47070.00

Costs: Total investment cost: $227,790
Total yearly cost: $ 52,630

An itemized breakdown of costs is presented in Table 328. It is assumed that land cost $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.5 percent
SS: 88.1 percent

A cost efficiency curve is presented in Figure 321.

Alternative A 26-VI - This alternative provides flow equalization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 0.052 kg/cu m (0.43 lb/1000 gal), and the suspended solids load is 0.030 kg/cu m (0.25 lb/1000 gal).

Costs: Total investment cost: $204,690
Total yearly cost: $ 66,240

An itemized breakdown of costs is presented in Table 329. It is assumed that land costs $4100 per hectare (1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.9 percent
SS: 76.0 percent

Alternative A 26-VII - This alternative provides in addition to Alternative A 26-VI dual media filtration.

The resulting BOD waste load is 0.026 kg/cu m (0.22 lb/1000 gal), and the suspended solids load is 0.015 kg/cu m (0.13 lb/1000 gal).

Costs: Total investment cost: $223,890
Total yearly cost: $ 71,360

An itemized breakdown of costs is presented in Table 330. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.5 percent
SS: 88.1 percent

A cost efficiency curve is presented in Figure 322.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 27 - Soft Drink Bottling or Combined Bottling/Canning Plants

A model plant representative of Subcategory A 27 was developed in Section V for the purpose of applying control and treatment alter-

DRAFT

TABLE 328

ITEMIZED COST SUMMARY FOR ALTERNATIVE A 26-V
(SOFT DRINK CANNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
Y...HOLDING TANK

N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	169000.00
	2. LAND	24990.00
	3. ENGINEERING	16900.00
	4. CONTINGENCY	16900.00
	TOTAL	227790.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	12010.00
	3. CHEMICALS	890.00
	4. MAINTENANCE&SUPPLIES	7990.00
	TOTAL	33380.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	33380.00
	2. YEARLY INVESTMENT COST RECOVERY	9110.00
	3. DEPRECIATION	10140.00
	TOTAL	52630.00

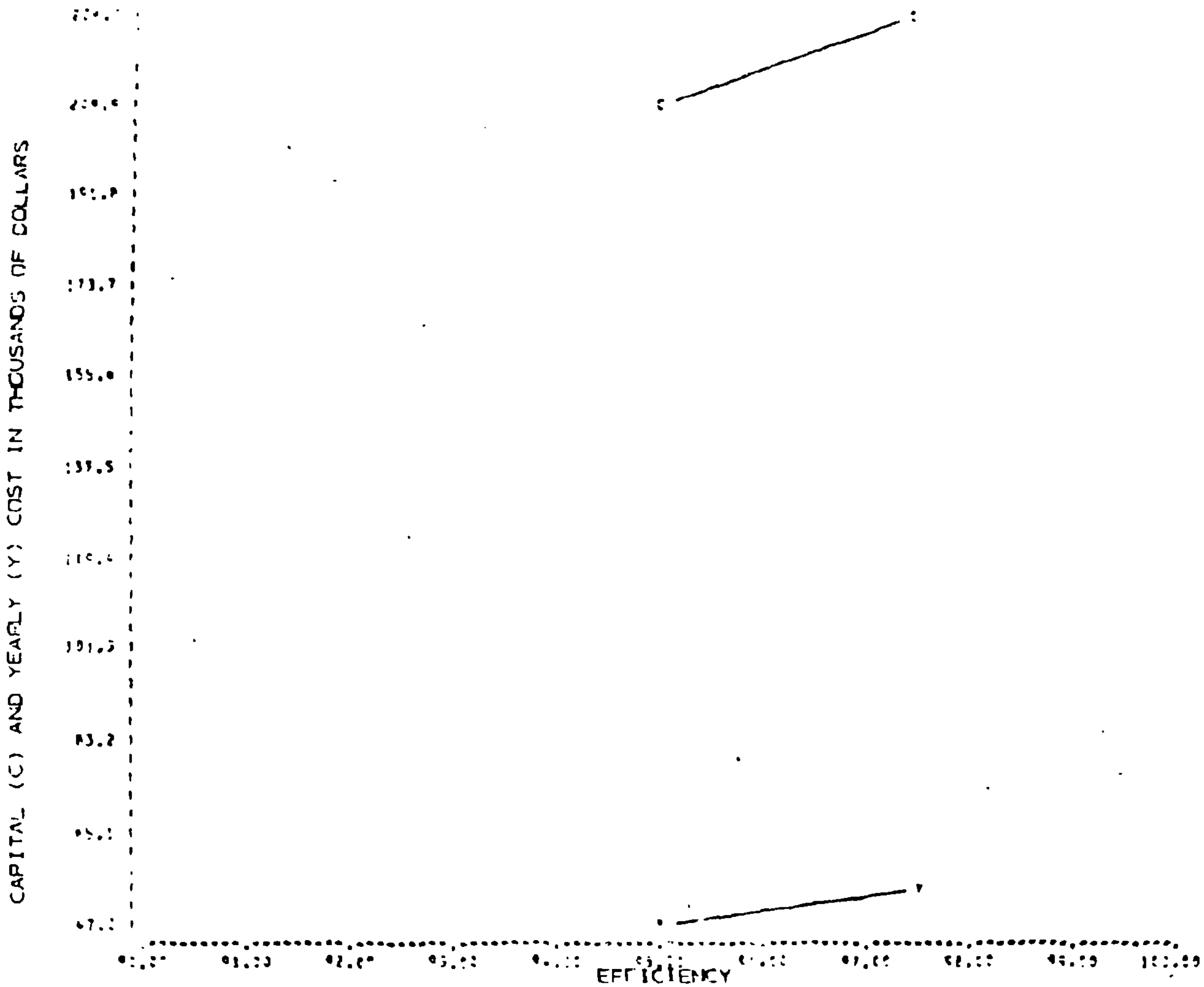


FIGURE 321

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 26-IV THROUGH A 26-V

DRAFT

TABLE 329

ITEMIZED COST SUMMARY FOR ALTERNATIVE A26-VI
(SOFT DRINK CANNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	164360.00
	2. LAND	3580.00
	3. ENGINEERING	16440.00
	4. CONTINGENCY	16440.00
	5. PVC LINER	3870.00
	TOTAL	204690.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	35480.00
	3. CHEMICALS	890.00
	4. MAINTENANCE&SUPPLIES	5210.00
	5. PVC LINER	160.00
	TOTAL	47990.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	47990.00
	2. YEARLY INVESTMENT COST RECOVERY	8190.00
	3. DEPRECIATION	10060.00
	TOTAL	66240.00

DRAFT

TABLE 330

ITEMIZED COST SUMMARY FOR ALTERNATIVE A26-VII (SOFT DRINK CANNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	160360.00
	2. LAND	3580.00
	3. ENGINEERING	18040.00
	4. CONTINGENCY	18040.00
	5. PVC LINER	3870.00
	TOTAL	223890.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	38390.00
	3. CHEMICALS	890.00
	4. MAINTENANCE&SUPPLIES	6190.00
	5. PVC LINER	160.00
	TOTAL	51880.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	51880.00
	2. YEARLY INVESTMENT COST RECOVERY	8960.00
	3. DEPRECIATION	11020.00
	TOTAL	71860.00

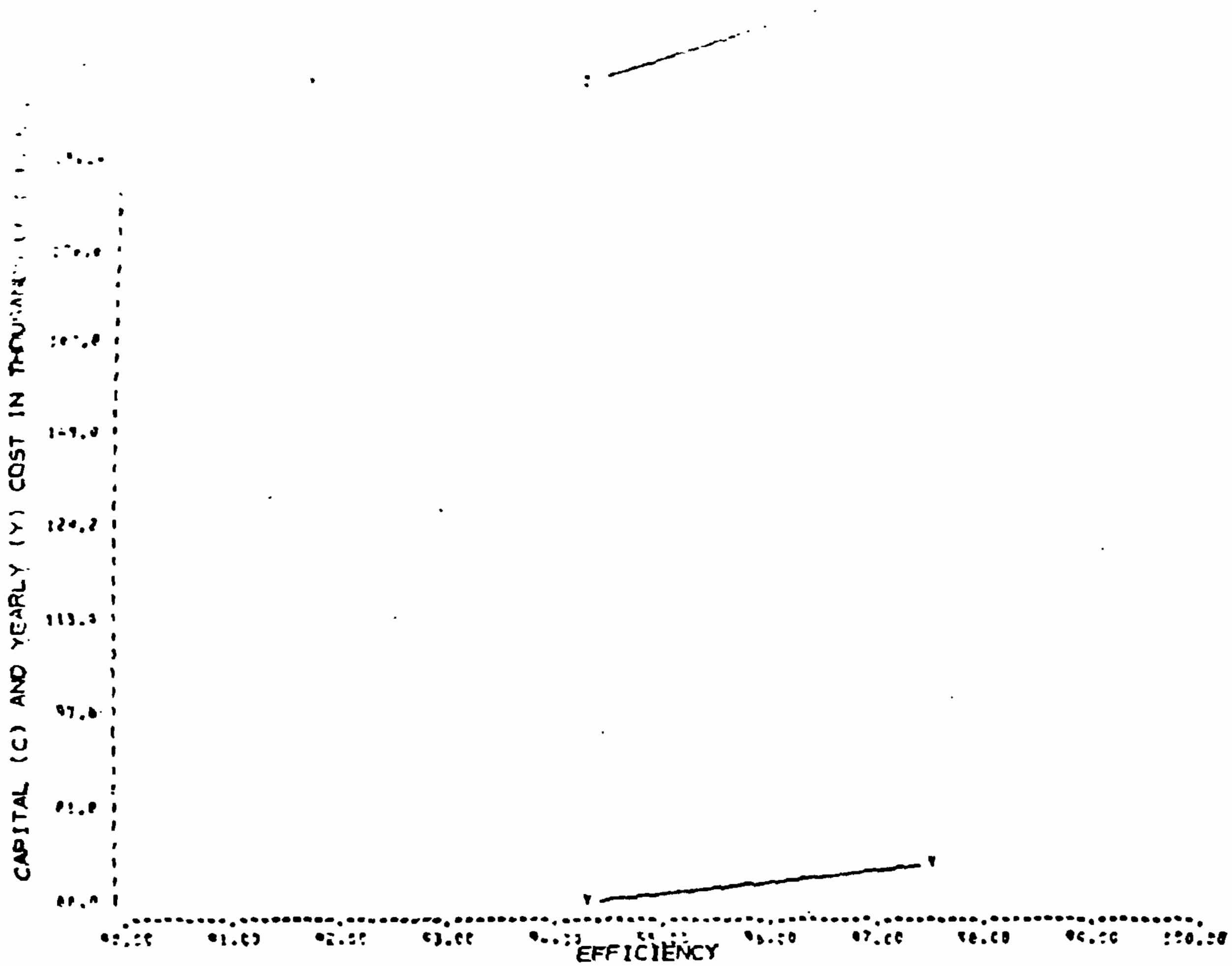


FIGURE 321

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 26, ALT. VII natives. In Section VII, seven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 136 cu m (35,900 gal) per day.

Alternative A 27-I - This alternative assumed no treatment and no reduction in the waste load. It is estimated that the effluent from a 136 cu m (35,900 gal) per day plant is 477 cu m (0.126 MG) per day. The BOD waste load is 2.30 kg/cu m (19.2 lb/1000 gal), and the suspended solids load is 0.38 kg/cu m (3.2 lb/1000 gal).

Costs: 0
Reduction Benefits: None

Alternative A 27-II - This alternative provides a control house, flow equalization, neutralization, nutrient addition, a complete mix activated sludge system, sludge thickening, and spray irrigation of sludge.

The resulting BOD waste load is 0.24 kg/cu m (2.00 lb/1000 gal), and the suspended solids load is 0.14 kg/cu m (1.17 lb/1000 gal).

Costs: Total investment cost: $289,990
Total yearly cost: $ 65,980

An itemized breakdown of costs is presented in Table 331. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 89.4 percent
SS: 63.0 percent

Alternative A 27-III - This alternative provides in addition to Alternative A 27-II dual media filtration.

The resulting BOD waste load is 0.123 kg/cu m (1.03 lb/1000 gal), and the suspended solids load is 0.07 kg/cu m (0.584 lb/1000 gal).

Costs: Total investment cost: $313,900
Total yearly cost: $ 72,700

An itemized breakdown of costs is presented in Table 332. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.7 percent
SS: 81.5 percent

A cost efficiency curve is presented in Figure 323.

Alternative A 27-IV - This alternative provides a control house, flow equalization, neutralization, nutrient addition, a complete-mix activated sludge system, and sludge thickening.

DRAFT

TABLE 331

ITEMIZED COST SUMMARY FOR ALTERNATIVE A27-II
(SOFT DRINK PLANTS EXCEPT A26)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 89.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	225690.00
2. LAND	19160.00
3. ENGINEERING	22570.00
4. CONTINGENCY	22570.00
TOTAL	289990.00

YEARLY OPERATING COSTS:

1. LABOR	18740.00
2. POWER	11580.00
3. CHEMICALS	4520.00
4. MAINTENANCE&SUPPLIES	6000.00
TOTAL	40840.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	40840.00
2. YEARLY INVESTMENT COST RECOVERY	11600.00
3. DEPRECIATION	13540.00
TOTAL	65980.00

TABLE 332

ITEMIZED COST SUMMARY FOR ALTERNATIVE A27-III (SOFT DRINK PLANTS EXCEPT A26)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
Y...HOLDING TANK
L...SPRAY IRRIGATION
P...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	245620.00
2. LAND	19160.00
3. ENGINEERING	24560.00
4. CONTINGENCY	24560.00
TOTAL	313900.00

YEARLY OPERATING COSTS:

1. LABOR	18740.00
2. POWER	15830.00
3. CHEMICALS	4520.00
4. MAINTENANCE&SUPPLIES	6310.00
TOTAL	45400.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	45400.00
2. YEARLY INVESTMENT COST RECOVERY	12560.00
3. DEPRECIATION	14740.00
TOTAL	72700.00

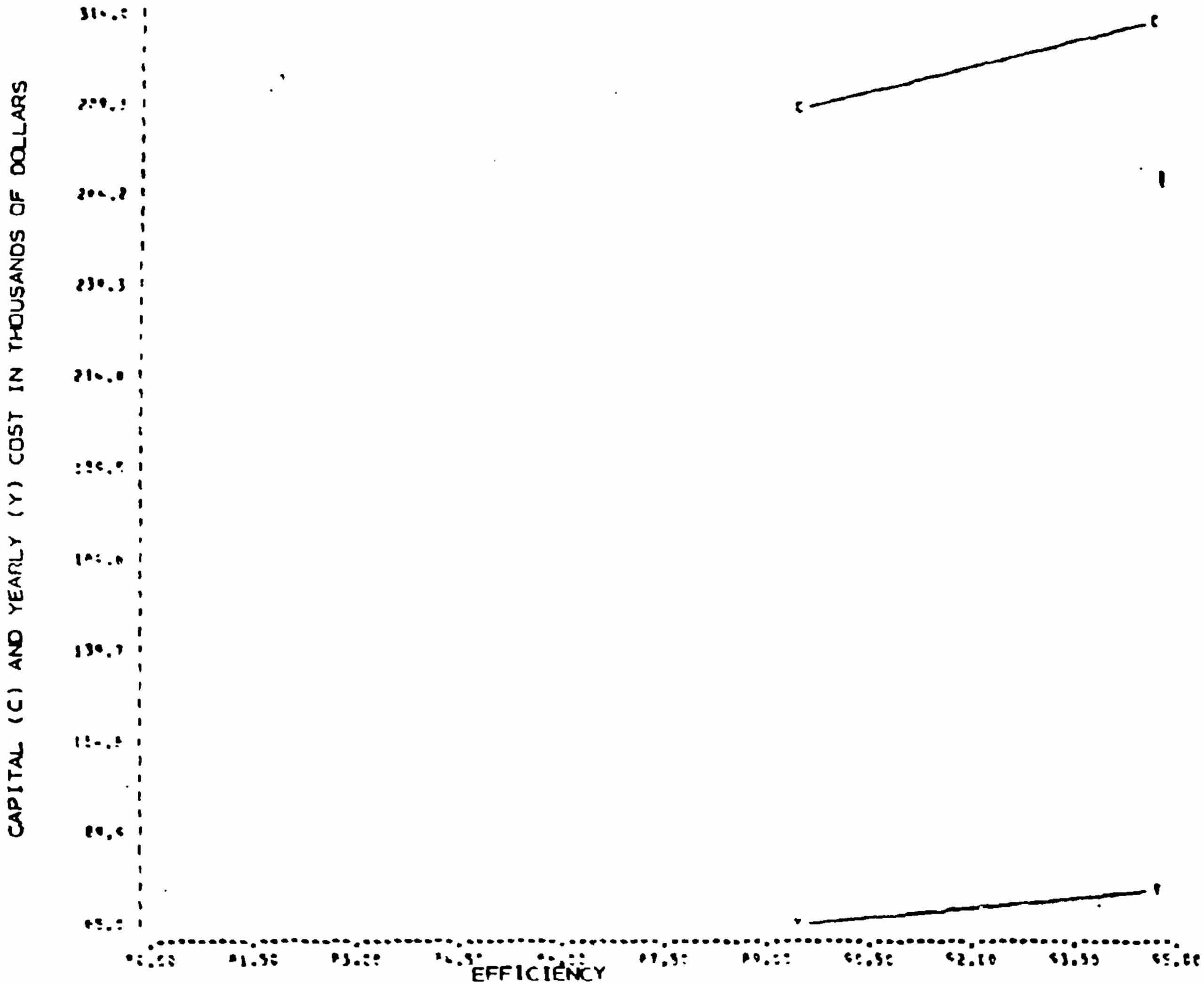


FIGURE 323

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 27, ALT. III

The resulting BOD waste load is 0.24 kg/cu m (2.00 lb/1000 gal), and the suspended solids load is 0.14 kg/cu m (1.17 lb/1000 gal).

Costs: Total investment cost: $264,650
Total yearly cost: $ 61,140

An itemized breakdown of costs is presented in Table 333. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 89.4 percent
SS: 63.0 percent

Alternative A 26-V - This alternative provides in addition to Alternative A 26-IV dual media filtration.

The resulting BOD waste load is 0.123 kg/cu m (1.03 lb/1000 gal), and the suspended solids load is 0.07 kg/cu m (0.584 lb/1000 gal).

Costs: Total investment cost: $288,560
Total yearly cost: $ 67,840

An itemized breakdown of costs is presented in Table 334. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.7 percent
SS: 81.5 percent

A cost efficiency curve is presented in Figure 324.

Alternative A 27-VI - This alternative provides flow equalization, neutralization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 0.24 kg/cu m (2.00 lb/1000 gal), and the suspended solids load is 0.14 kg/cu m (1.17 lb/1000 gal).

Costs: Total investment cost: $243,870
Total yearly cost: $ 78,820

An itemized breakdown of costs is presented in Table 335. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 89.4 percent
SS: 63.0 percent

Alternative A 27-VII - This alternative provides in addition to Alternative A 27-VI dual media filtration.

The resulting BOD waste load is 0.123 kg/cu m (1.03 lb/1000 gal), and the suspended solids load is 0.07 kg/cu m (0.584 lb/1000 gal).

DRAFT

TABLE 333

ITEMIZED COST SUMMARY FOR ALTERNATIVES A27-IV (SOFT DRINK PLANTS EXCEPT A26)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 89.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- A...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	194160.00
	2. LAND	31650.00
	3. ENGINEERING	19420.00
	4. CONTINGENCY	19420.00
	TOTAL	264650.00
YEARLY OPERATING COSTS:		
	1. LABOR	18740.00
	2. POWER	10740.00
	3. CHEMICALS	4520.00
	4. MAINTENANCE&SUPPLIES	4900.00
	TOTAL	38900.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	38900.00
	2. YEARLY INVESTMENT COST RECOVERY	10590.00
	3. DEPRECIATION	11650.00
	TOTAL	61140.00

DRAFT

TABLE 334

ITEMIZED COST SUMMARY FOR ALTERNATIVE A27-V (SOFT DRINK PLANTS EXCEPT A26)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:		
	1. CONSTRUCTION	214090.00
	2. LAND	31650.00
	3. ENGINEERING	21410.00
	4. CONTINGENCY	21410.00
	TOTAL	288560.00
YEARLY OPERATING COSTS:		
	1. LABOR	18740.00
	2. POWER	14990.00
	3. CHEMICALS	4520.00
	4. MAINTENANCE&SUPPLIES	5200.00
	TOTAL	43450.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	43450.00
	2. YEARLY INVESTMENT COST RECOVERY	11540.00
	3. DEPRECIATION	12850.00
	TOTAL	67840.00

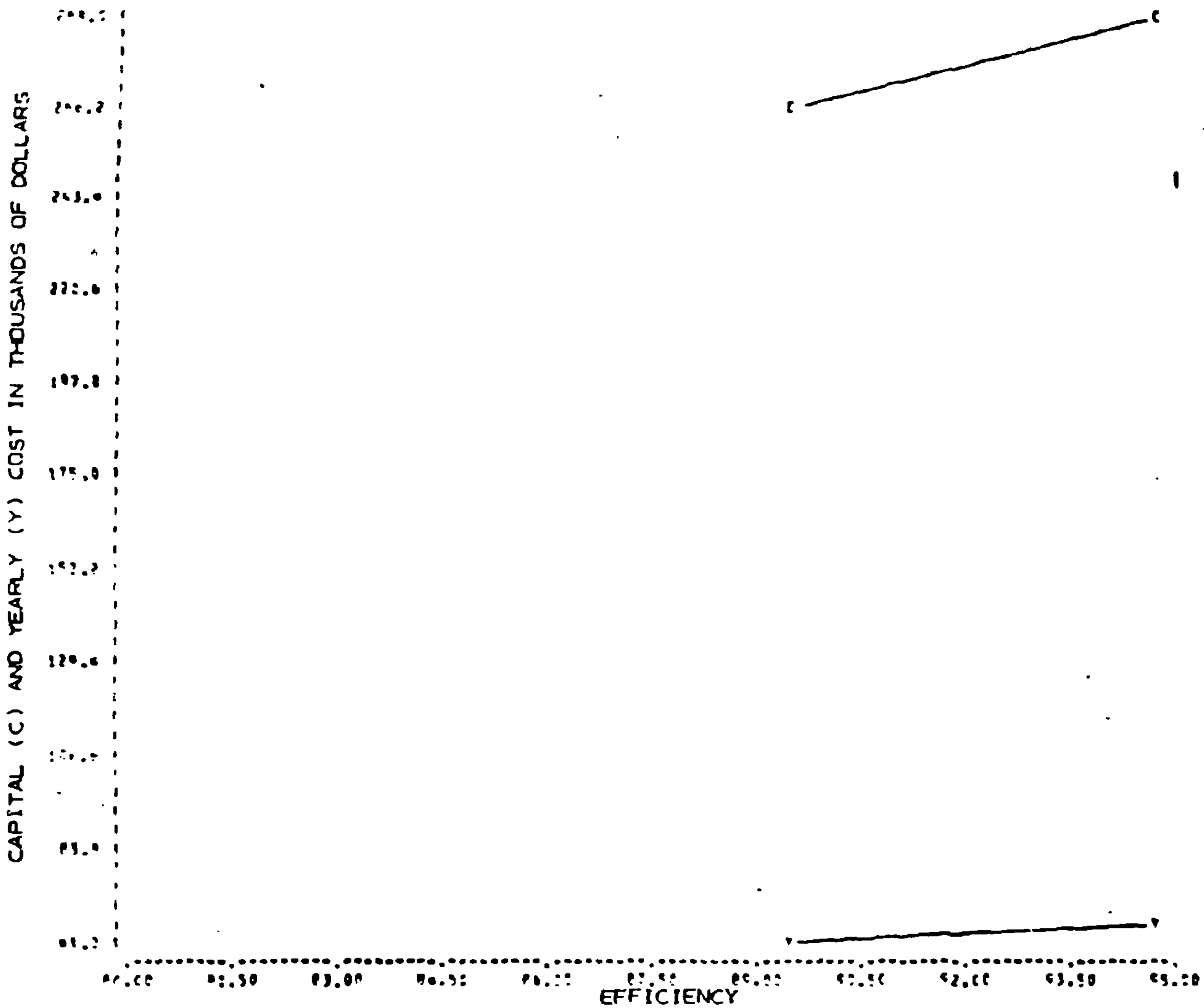


FIGURE 324

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 27, ALT. V

1151

DRAFT

DRAFT

TABLE 335

ITEMIZED COST SUMMARY FOR ALTERNATIVE A27-VI (SOFT DRINK PLANTS EXCEPT A26)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 69.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACID NEUTRALIZATION
- N...NITROGEN ADDITION
- L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	195880.00
2.	LAND	4160.00
3.	ENGINEERING	19590.00
4.	CONTINGENCY	19590.00
5.	PVC LINER	4650.00
	TOTAL	243870.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	34210.00
3.	CHEMICALS	4520.00
4.	MAINTENANCE&SUPPLIES	5540.00
5.	PVC LINER	320.00
	TOTAL	57080.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	57080.00
2.	YEARLY INVESTMENT COST RECOVERY	9750.00
3.	DEPRECIATION	11990.00
	TOTAL	78820.00

Costs: Total investment cost: $267,780
Total yearly cost: $ 85,530

An itemized breakdown of costs is presented in Table 336. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 94.7 percent
SS: 81.5 percent

A cost efficiency curve is presented in Figure 325.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 28 - Beverage Bases

A model plant representative of subcategory A 28 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, thirteen alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 379 cu m (0.10 MG) of beverage bases per day.

It is estimated that the effluent from a 379 cu m (0.10 MG) per day plant is 379 cu m (0.10 MG) per day. The BOD waste load is 0.24 kg/cu m (2.00 lb/1000 gal), and the suspended solids load is 0.05 kg/cu m (0.42 lb/1000 gal).

Alternative A 28-I - This alternative consists of a pumping station, a flow equalization tank, and an aerated lagoon.

The resulting BOD waste load is 0.010 kg/cu m (0.084 lb/1000 gal), and the suspended solids load is 0.003 kg/cu m (0.025 lb/1000 gal).

Costs: Total investment cost: $290,570
Total yearly cost: $114,720

An itemized breakdown of costs is presented in Table 337. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 95.8 percent
SS: 40.0 percent

Alternative A 28-II - This alternative consists of a pumping station, a flow equalization tank, a complete-mix activated sludge basin, a sludge thickner, an aerobic digestor, and a sludge holding tank followed by land application of the digestor sludge.

The resulting BOD waste load is 0.018 kg/cu m (0.084 lb/1000 gal), and the suspended solids load is 0.003 kg/cu m (0.025 lb/1000 gal).

DRAFT

TABLE 336

ITEMIZED COST SUMMARY FOR ALTERNATIVE A27-VII (SOFT DRINK PLANTS EXCEPT A26)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
F...ACID NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON
M...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	215810.00
	2. LAND	4160.00
	3. ENGINEERING	21580.00
	4. CONTINGENCY	21580.00
	5. PVC LINER	4650.00
	TOTAL	267780.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	38460.00
	3. CHEMICALS	4520.00
	4. MAINTENANCE&SUPPLIES	5850.00
	5. PVC LINER	320.00
	TOTAL	61640.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	61640.00
	2. YEARLY INVESTMENT COST RECOVERY	10710.00
	3. DEPRECIATION	13180.00
	TOTAL	85530.00

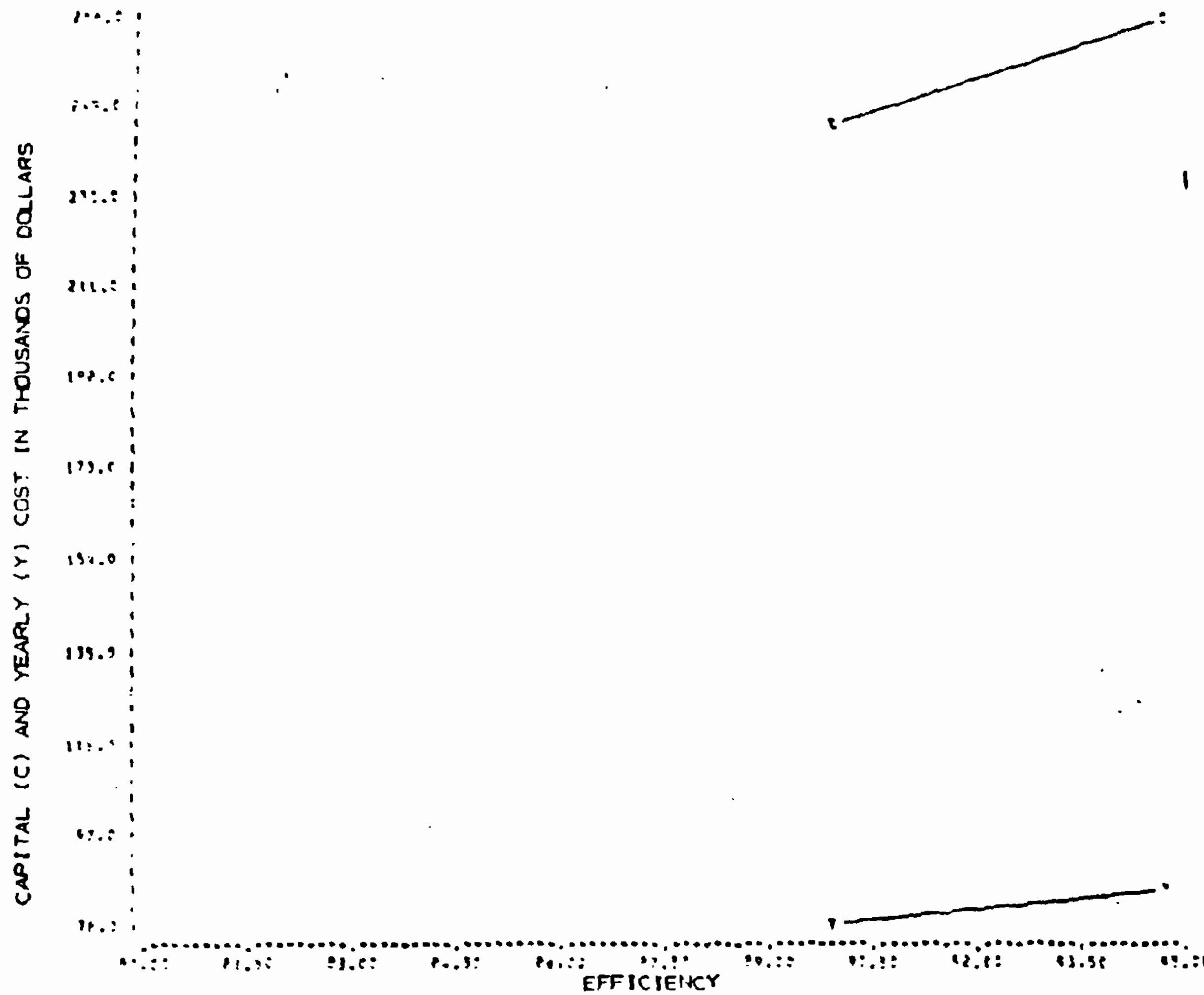


FIGURE 325

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 27, ALT. VII

DRAFT

TABLE 337

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-I (BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	233430.00
2. LAND	4160.00
3. ENGINEERING	23340.00
4. CONTINGENCY	23340.00
5. PVC LINER	6300.00
TOTAL	290570.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	70050.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	5970.00
5. PVC LINER	270.00
TOTAL	88780.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	88780.00
2. YEARLY INVESTMENT COST RECOVERY	11620.00
3. DEPRECIATION	14320.00
TOTAL	114720.00

Costs: Total investment cost: $720,590
Total yearly cost: $123,020

An itemized breakdown of costs is presented in Table 338. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 95.8 percent
SS: 40.0 percent

Alternative A 28-III - This alternative replaces the land spreading of digestor sludge in alternative A 29-II with vacuum filtration.

The resulting BOD waste load is 0.010 kg/cu m (0.084 lb/1000 gal), and the suspended solids load is 0.003 kg/cu m (0.025 lb/1000 gal).

Costs: Total investment cost: $359,350
Total yearly cost: $ 99,690

An itemized breakdown of costs is presented in Table 339. It is that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 95.8 percent
SS: 40.0 percent

Alternative A 28-IV - This alternative replaces the land spreading of digestor sludge in Alternative A 29-II with sand drying beds.

The resulting BOD waste load is 0.010 kg/cu m (0.084 lb/1000 gal), and the suspended solids load is 0.003 kg/cu m (0.025 lb/1000 gal).

Costs: Total investment cost: $545,980
Total yearly cost: $138,320

An itemized breakdown of costs is presented in Table 340. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 95.8 percent
SS: 40.0 percent

Alternative A 28-V - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 28-I

The resulting BOD waste load is 0.005 kg/cu m (0.042 lb/1000 gal), and the suspended solids load is 0.001 kg/cu m (0.0083 lb/1000 gal).

Costs: Total investment cost: $324,190
Total yearly cost: $124,150

DRAFT

TABLE 338

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-II
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
- A1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	306170.00
2. LAND	353180.00
3. ENGINEERING	30620.00
4. CONTINGENCY	30620.00
TOTAL	720590.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	27600.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	10750.00
TOTAL	75830.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	75830.00
2. YEARLY INVESTMENT COST RECOVERY	28820.00
3. DEPRECIATION	18370.00
TOTAL	123020.00

DRAFT

TABLE 339

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-III
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	277250.00
	2. LAND	20660.00
	3. ENGINEERING	27720.00
	4. CONTINGENCY	27720.00
	TOTAL	359350.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	21760.00
	3. CHEMICALS	3060.00
	4. MAINTENANCE&SUPPLIES	6390.00
	TOTAL	68690.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	68690.00
	2. YEARLY INVESTMENT COST RECOVERY	14370.00
	3. DEPRECIATION	16630.00
	TOTAL	99690.00

DRAFT

TABLE 340

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-IV
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
P...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
H...AEROBIC DIGESTOR
I...SAND DRYING BEDS
Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	451370.00
2. LAND	4330.00
3. ENGINEERING	45140.00
4. CONTINGENCY	45140.00
TOTAL	545980.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	27600.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	24320.00
TOTAL	89400.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	89400.00
2. YEARLY INVESTMENT COST RECOVERY	21840.00
3. DEPRECIATION	27080.00
TOTAL	138320.00

An itemized breakdown of costs is presented in Table 341. It is assumed that land costs $4100 per hectare ($1600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.9 percent
SS: 80.0 percent

Alternative A 28-VI - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 28-II.

The resulting BOD waste load is 0.005 kg/cu m (0.042 lb/1000 gal), and the suspended solids load is 0.001 kg/cu m (0.0083 lb/1000 gal).

Costs: Total investment cost: $754,210
Total yearly cost: $132,450

An itemized breakdown of costs is presented in Table 342. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97.9 percent
SS: 80.0 percent

Alternative A 28-VII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 28-III.

The resulting BOD waste load is 0.005 kg/cu m (0.042 lb/1000 gal), and the suspended solids load is 0.001 kg/cu m (0.0083 lb/1000 gal).

Costs: Total investment cost: $393,000
Total yearly cost: $109,130

An itemized breakdown of costs is presented in Table 343. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97.9 percent
SS: 80.0 percent

Alternative A 28-VIII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 28-IV.

The resulting BOD waste load is 0.005 kg/cu m (0.042 lb/1000 gal), and the suspended solids load is 0.001 kg/cu m (0.0083 lb/1000 gal).

Costs: Total investment cost: $579,610
Total yearly cost: $147,750

An itemized breakdown of costs is presented in Table 344. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

DRAFT

TABLE 341

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-V
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON
F...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	261450.00
2.	LAND	4160.00
3.	ENGINEERING	26140.00
4.	CONTINGENCY	26140.00
5.	PVC LINER	6300.00
	TOTAL	324190.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	75920.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	6500.00
5.	PVC LINER	270.00
	TOTAL	95180.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	95180.00
2.	YEARLY INVESTMENT COST RECOVERY	12970.00
3.	DEPRECIATION	16000.00
	TOTAL	124150.00

DRAFT

TABLE 342

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-VI
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.9 PERCENT BOD REDUCTION

TREATMENT MODULES:
B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:		
	1. CONSTRUCTION	334190.00
	2. LAND	353180.00
	3. ENGINEERING	33420.00
	4. CONTINGENCY	33420.00
	TOTAL	754210.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	33470.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	11280.00
	TOTAL	82230.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	82230.00
	2. YEARLY INVESTMENT COST RECOVERY	30170.00
	3. DEPRECIATION	20050.00
	TOTAL	132450.00

DRAFT

TABLE 343

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-VII (BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

H1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
F...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:		
	1. CONSTRUCTION	305280.00
	2. LAND	26660.00
	3. ENGINEERING	30530.00
	4. CONTINGENCY	30530.00
	TOTAL	393000.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	27620.00
	3. CHEMICALS	3060.00
	4. MAINTENANCE&SUPPLIES	6930.00
	TOTAL	75090.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	75090.00
	2. YEARLY INVESTMENT COST RECOVERY	15720.00
	3. DEPRECIATION	18320.00
	TOTAL	109130.00

TABLE 344

ITEMIZED COST SUMMARY FOR ALTERNATIVE A2B-VIII
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
F...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS
Y...HOLDING TANK
F...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	479400.00
2. LAND	4330.00
3. ENGINEERING	47940.00
4. CONTINGENCY	47940.00
TOTAL	579610.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	33470.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	24860.00
TOTAL	95810.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	95810.00
2. YEARLY INVESTMENT COST RECOVERY	23180.00
3. DEPRECIATION	28760.00
TOTAL	147750.00

DRAFT

Reduction Benefits: BOD: 97.9 percent
SS: 80.0 percent

Alternative A 28-IX - This alternative provides carbon adsorption in addition to the treatment modules of Alternative A 28-V.

The resulting BOD waste load is 0.0025 kg/cu m (0.021 lb/1000 gal), and the suspended solids load is 0.005 kg/cu m (0.0042 lb/1000 gal).

Costs: Total investment cost: $406,070
Total yearly cost: $152,030

An itemized breakdown of costs is presented in Table 345. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.9 percent
SS: 90.0 percent

A cost efficiency curve is presented in Figure 326.

Alternative A 28-X - This alternative provides carbon adsorption in addition to the treatment modules of Alternative A 28-VI.

The resulting BOD waste load is 0.0025 kg/cu m (0.021 lb/1000 gal), and the suspended solids load is 0.0005 kg/cu m (0.00042 lb/1000 gal).

Costs: Total investment cost: $836,070
Total yearly cost: $160,320

An itemized breakdown of costs is presented in Table 346. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98.9 percent
SS: 90.0 percent

A cost efficiency curve is presented in Figure 327.

Alternative A 28-XI - This alternative provides carbon adsorption in addition to the treatment modules of Alternative A 28-VII.

The resulting BOD waste load is 0.0025 kg/cu m (0.021 lb/1000 gal), and the suspended solids load is 0.0005 kg/cu m (0.0042 lb/1000 gal).

Costs: Total investment cost: $474,860
Total yearly cost: $137,000

An itemized breakdown of costs is presented in Table 347. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

DRAFT

TABLE 34[illegible]

ITEMIZED COST SUMMARY FO[illegible] [illegible]RNATIVE [illegible]
([illegible] BASE [illegible]

ITEMIZED COST [illegible] FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PER [illegible] BOD REDUCTION

TREATMENT MODULES:
[illegible]...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON
P...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:		
1.	CONSTRUCTION	329670.00
2.	LAND	4160.00
3.	ENGINEERING	32970.00
4.	CONTINGENCY	32970.00
5.	PVC LINER	6300.00
TOTAL		406070.00
YEARLY OPERATING COSTS:		
1.	LABOR	12490.00
2.	POWER	79180.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	23750.00
5.	PVC LINER	270.00
TOTAL		115690.00
TOTAL YEARLY COSTS:		
1.	YEARLY OPERATING COST	115690.00
2.	YEARLY INVESTMENT COST RECOVERY	16240.00
3.	DEPRECIATION	20100.00
TOTAL		152030.00

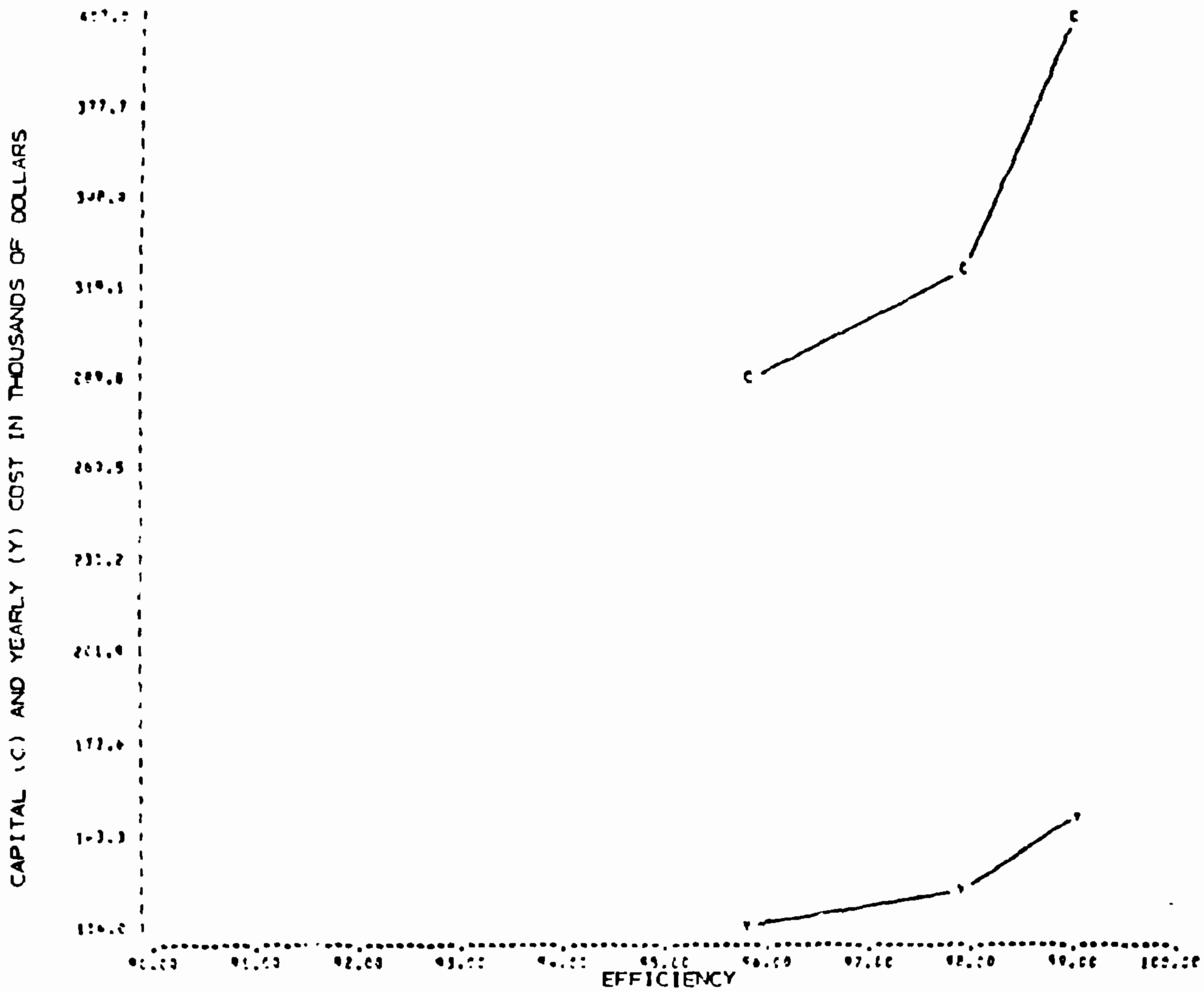


FIGURE 326

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 25, ALT. I, V, IX

DRAFT

DRAFT

TABLE 346

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-X (BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	402410.00
2. LAND	353180.00
3. ENGINEERING	40240.00
4. CONTINGENCY	40240.00
TOTAL	836070.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	36730.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	28530.00
TOTAL	102740.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	102740.00
2. YEARLY INVESTMENT COST RECOVERY	33440.00
3. DEPRECIATION	24140.00
TOTAL	160320.00

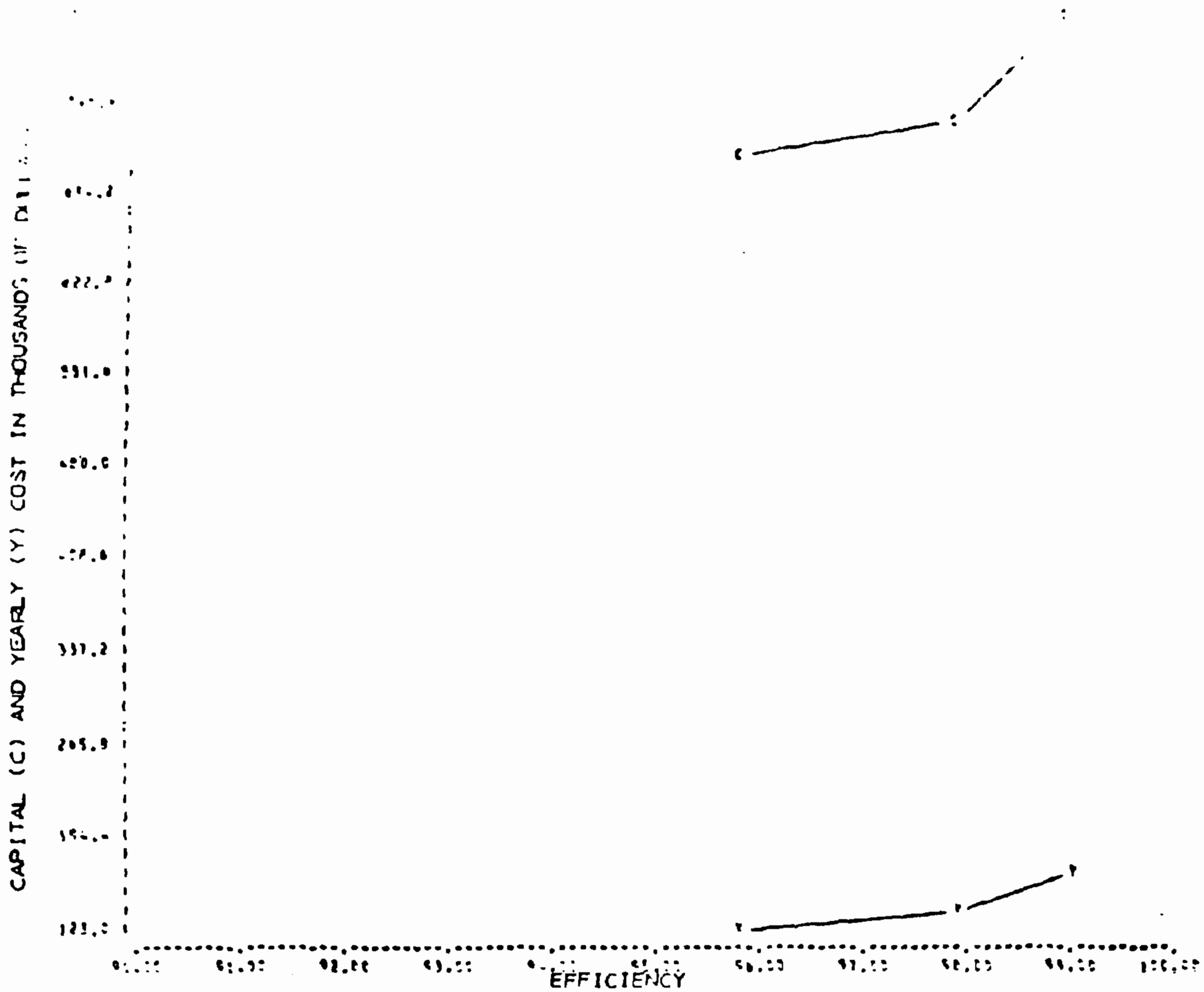


FIGURE 327

INVESTMENT AND YEARLY COSTS,FOR SUBCATEGORY A 28, ALT. II, VI, X

DRAFT

TABLE 347

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-XI (BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- E1...CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	373500.00
2. LAND	26660.00
3. ENGINEERING	37350.00
4. CONTINGENCY	37350.00
TOTAL	474860.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	30890.00
3. CHEMICALS	3060.00
4. MAINTENANCE&SUPPLIES	24170.00
TOTAL	95600.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	95600.00
2. YEARLY INVESTMENT COST RECOVERY	18990.00
3. DEPRECIATION	22410.00
TOTAL	137000.00

Reduction Benefits: BOD: 98.9 percent
SS: 90.0 percent

A cost efficiency curve is presented in Figure 328.

Alternative A 28-XII - This alternative provides carbon adsorption in addition to the treatment modules of Alternative A 28-VIII.

The resulting BOD waste load is 0.0025 kg/cu m (0.021 lb/1000 gal), and the suspended solids load is 0.005 kg/cu m (0.0042 lb/1000 gal).

Costs: Total investment cost: $661,470
Total yearly cost: $175,630

An itemized breakdown of costs is presented in Table 3[illegible]. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98.3 percent
SS: 90.0 percent

A cost efficiency curve is presented in Figure 329.

Alternative A 28-XIII - This alternative consists of a pumping station, a flow equalization tank, and spray irrigation of the raw waste effluent.

The resulting BOD waste load is 0.0 kg/cu m (0.0 lb/1000 gal), and the suspended solids load is 0.0 kg/cu m (0.0 lb/1000 gal).

Costs: Total investment cost: $192,790
Total yearly cost: $ 27,360

An itemized breakdown of costs is presented in Table 349. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 30 - Instant Tea

A model plant representative of subcategory A 30 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 9.1 kkg (10 ton) of soluble "instant" tea per day.

Alternative A 30-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 9.1 kkg (10 ton) per day plant is 454 cu m (0.12 MG) per day. The BOD waste

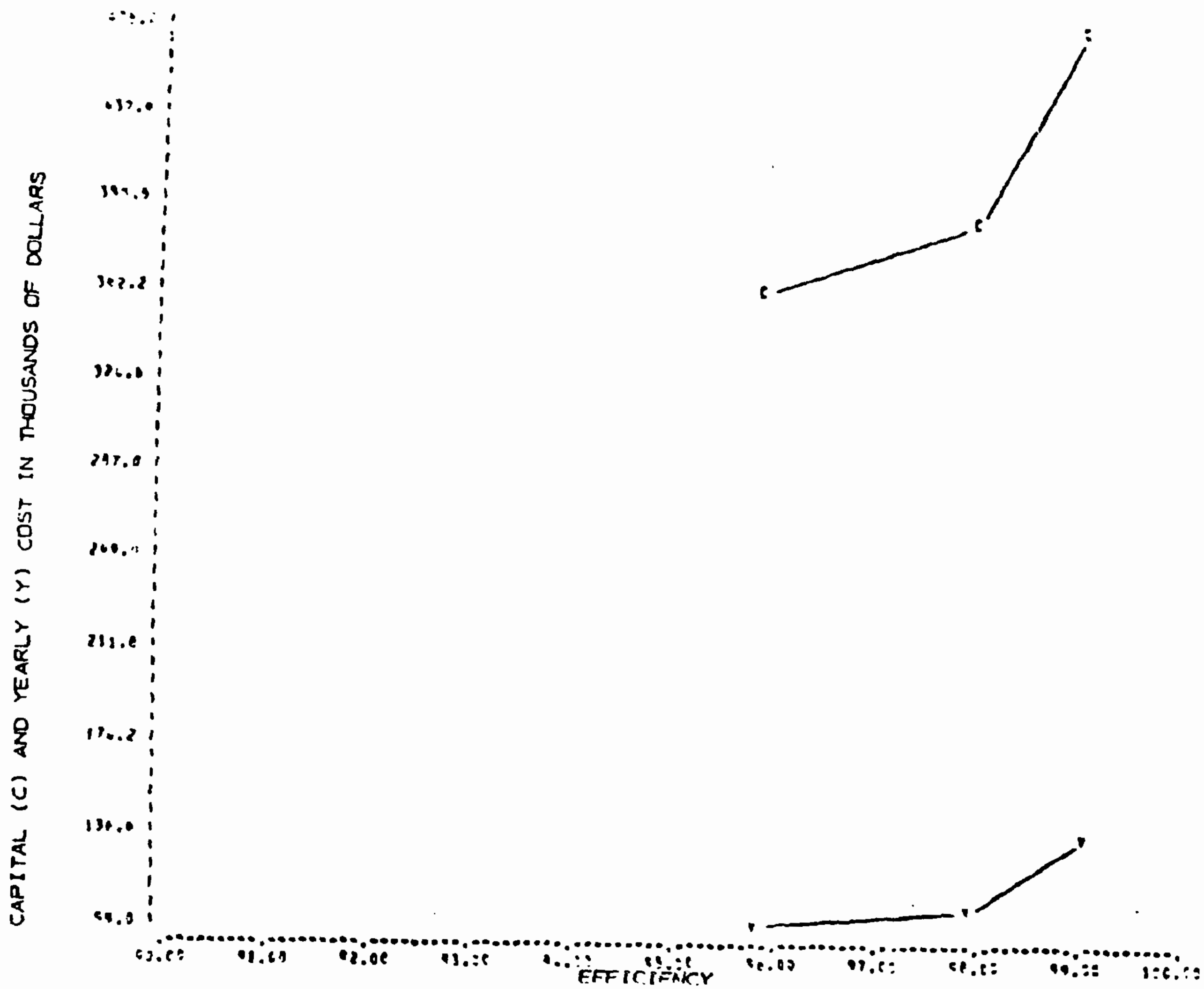


FIGURE 328

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 28, ALT. III, VI, XI

DRAFT

TABLE 348

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-XII
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
2...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	547620.00
2. LAND	4330.00
3. ENGINEERING	54760.00
4. CONTINGENCY	54760.00
TOTAL	661470.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	36730.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	42100.00
TOTAL	116310.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	116310.00
2. YEARLY INVESTMENT COST RECOVERY	26460.00
3. DEPRECIATION	32860.00
TOTAL	175630.00

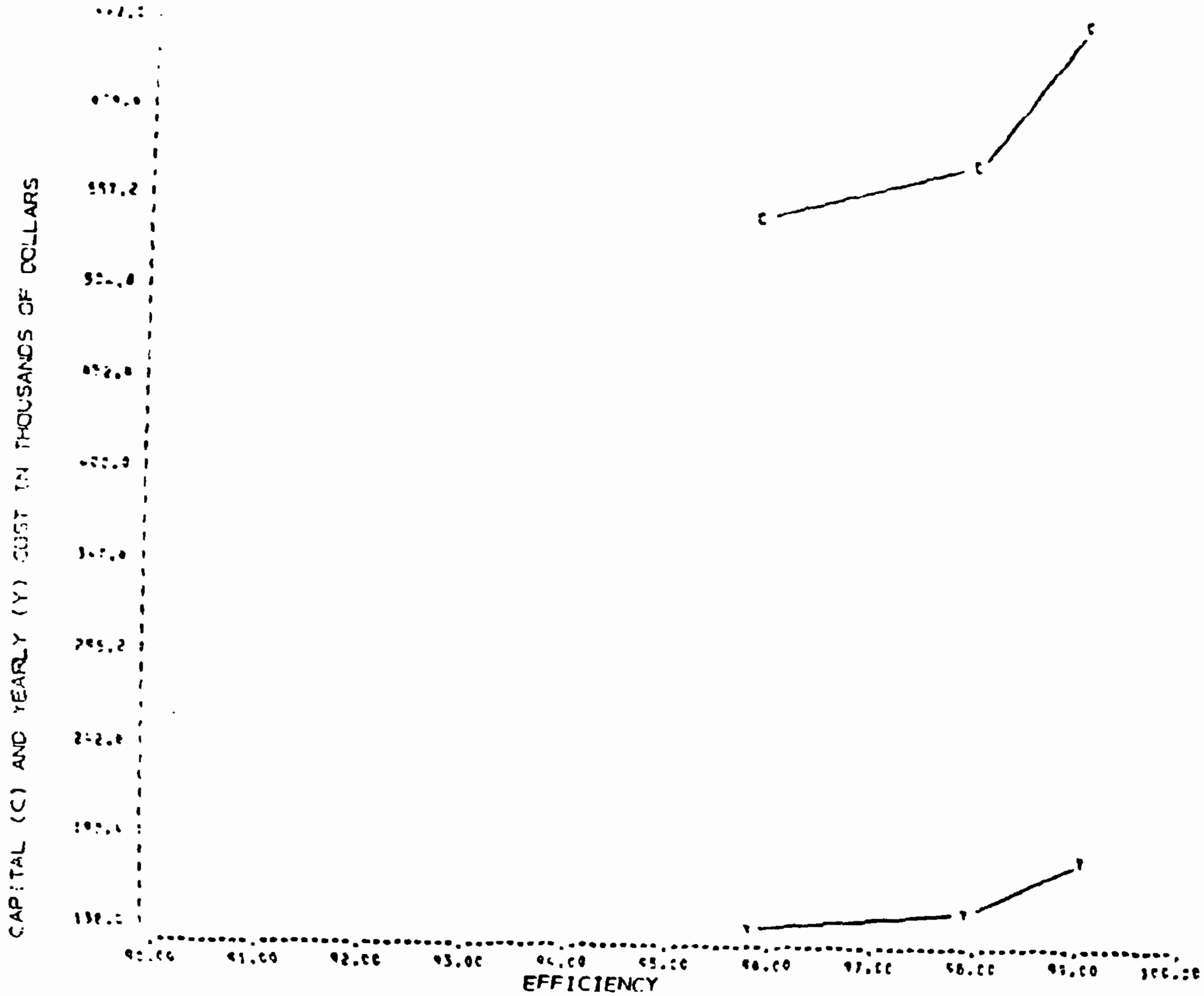


FIGURE 329

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 28, ALT. IV, VIII, XII

DRAFT

TABLE 349

ITEMIZED COST SUMMARY FOR ALTERNATIVE A28-XIII
(BEVERAGE BASE SYRUP)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

Y...HOLDING TANK
U...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	132890.00
2. LAND	33320.00
3. ENGINEERING	13290.00
4. CONTINGENCY	13290.00
TOTAL	192790.00

YEARLY OPERATING COSTS:

1. LABOR	6250.00
2. POWER	1620.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	3810.00
TOTAL	11680.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	11680.00
2. YEARLY INVESTMENT COST RECOVERY	7710.00
3. DEPRECIATION	7970.00
TOTAL	27360.00

load is 50.0 kg/kkg (100.0 lb/ton), and the suspended solids load is 37.5 kg/kkg (75.0 lb/ton).

Alternative A 30-II - This alternative consists of a pumping station, a flow equalization tank, primary clarification, a complete-mix activated sludge basin, sludge thickening, aerobic digestion and vacuum filtration.

The resulting BOD waste load is 2.00 kg/kkg (4.0 lb/ton), and the suspended solids load is 5.50 kg/kkg (11.0 lb/ton).

Costs:	Total investment cost:	$358,430
	Total yearly cost:	$ 97,010

An itemized breakdown of costs is presented in Table 350. It is that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits:	BOD:	96.0 percent
	SS:	85.3 percent

Alternative A 30-III - This alternative replaces the vacuum filtration module of alternative A 30-II with sand drying beds.

The resulting BOD waste load is 2.00 kg/kkg (4.00 lb/ton) and the suspended solids load is 5.5 kg/kkg (11.0 lb/ton).

Cost:	Total investment cost:	$402,200
	Total yearly cost:	$103,830

An itemized breakdown of costs is presented in Table 351. It is that land costs $20,510 per hectare ($8,330 per acre). It is further assumed that one operator is required.

Reduction Benefits:	BOD:	96.0 percent
	SS:	85.3 percent

Alternative A 30-IV - This alternative consists of a pumping station, a flow equalization tank and aerated lagoon.

The resulting BOD waste load is 2.0 kg/kkg (4.0 lb/ton) and the suspended solids load is 5.5 kg/kkg (11.0 lb/ton).

Costs:	Total investment cost:	$359,080
	Total yearly cost:	$140,200

An itemized breakdown of costs is presented in Table 352. It is that land costs $4,100 per hectare ($1,660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits:	BOD:	96.0 percent
	SS:	85.3 percent

DRAFT

TABLE 350

ITEMIZED COST SUMMARY FOR ALTERNATIVE A30-II (INSTANT TEA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- E...CLARIFIER
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- P...AEROBIC DIGESTER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	273700.00
2. LAND	29990.00
3. ENGINEERING	27370.00
4. CONTINGENCY	27370.00
TOTAL	358430.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	18990.00
3. CHEMICALS	2670.00
4. MAINTENANCE&SUPPLIES	7110.00
TOTAL	66250.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	66250.00
2. YEARLY INVESTMENT COST RECOVERY	14340.00
3. DEPRECIATION	16420.00
TOTAL	97010.00

DRAFT

TABLE 351

ITEMIZED COST SUMMARY FOR ALTERNATIVE A30-III (INSTANT TEA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1...CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- E...CLARIFIER
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS
- Y...HOLDING TANK

INVESTMENT COSTS:	
1. CONSTRUCTION	318580.00
2. LAND	19990.00
3. ENGINEERING	31860.00
4. CONTINGENCY	31860.00
TOTAL	402290.00
YEARLY OPERATING COSTS:	
1. LABOR	37480.00
2. POWER	16630.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	14520.00
TOTAL	68630.00
TOTAL YEARLY COSTS:	
1. YEARLY OPERATING COST	68630.00
2. YEARLY INVESTMENT COST RECOVERY	16090.00
3. DEPRECIATION	19110.00
TOTAL	103830.00

DRAFT

TABLE 352

ITEMIZED COST SUMMARY FOR ALTERNATIVE A30-IV
(INSTANT TEA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	288570.00
2. LAND	4660.00
3. ENGINEERING	28860.00
4. CONTINGENCY	28860.00
5. PVC LINER	8130.00
TOTAL	359080.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	87140.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	8180.00
5. PVC LINER	310.00
TOTAL	108120.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	108120.00
2. YEARLY INVESTMENT COST RECOVERY	14360.00
3. DEPRECIATION	17720.00
TOTAL	140200.00

Alternative A 30-V - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 30-II.

The resulting BOD waste load is 1.0 kg/kkg (2.0 lb/ton), and the suspneded solids load is 1.0 kg/kkg (2.0 lb/ton).

Costs: Total investment cost: $382,030
Total yearly cost: $103,680

An itemized breakdown of costs is presented in Table 353. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.0 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 330.

Alternative A 30-VI - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 30-III.

The resulting BOD waste load is 1.0 kg/kkg (2.0 lb/ton).

Costs: Total investment cost: $463,070
Total yearly cost: $120.500

An itemized breakdown of costs is presented in Table 354. It is assumed that land costs $20.510 per hectare ($8330 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98.0 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 331.

Alternative A 30-VII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 30-IV.

The resulting BOD waste load is 1.0 kg/kkg (2.0 lb/ton), and the suspended solids load is 1.0 kg/kkg (2.0 lb/ton).

Costs: Total investment cost: $424,650
Total yearly cost: $148,560

An itemized breakdown of costs is presented in Table 355. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 98.0 percent
SS: 97.3 percent

A cost efficiency curve is presented in Figure 332.

DRAFT

TABLE 353

ITEMIZED COST SUMMARY FOR ALTERNATIVE A30-V
(INSTANT TEA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

- H1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- E...CLARIFIER
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- F...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	293360.00
2. LAND	24990.00
3. ENGINEERING	29340.00
4. CONTINGENCY	29340.00
TOTAL	382030.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	23240.00
3. CHEMICALS	2670.00
4. MAINTENANCE&SUPPLIES	7410.00
TOTAL	70800.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	70800.00
2. YEARLY INVESTMENT COST RECOVERY	15280.00
3. DEPRECIATION	17600.00
TOTAL	103680.00

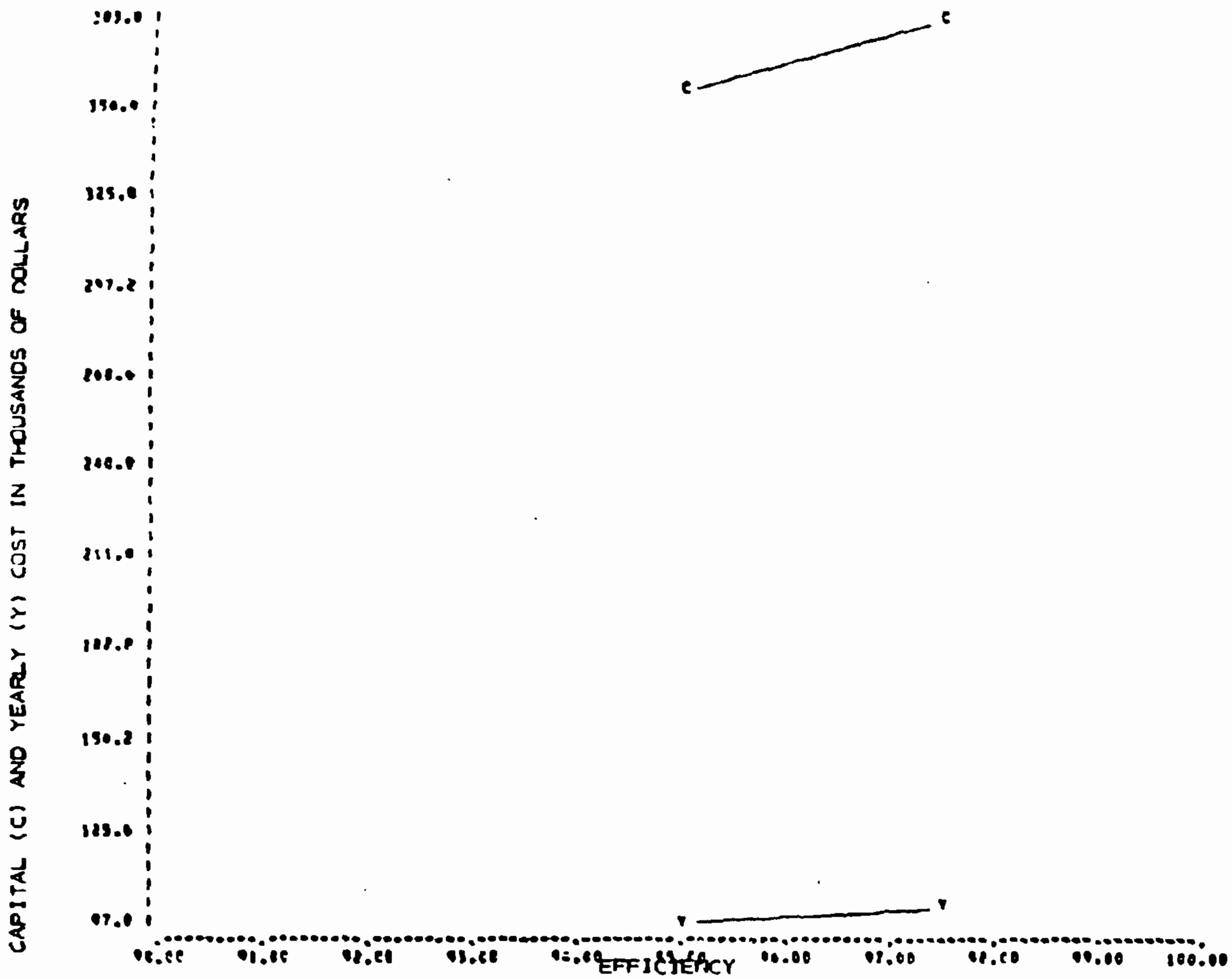


FIGURE 330

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 30, ALT. II, V

DRAFT

TABLE 354

ITEMIZED COST SUMMARY FOR ALTERNATIVE A30-VI
(INSTANT TEA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
E...CLARIFIER
F...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
I...SAND DRYING BEDS
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1.	CONSTRUCTION	338240.00
2.	LAND	19990.00
3.	ENGINEERING	33820.00
4.	CONTINGENCY	33820.00
TOTAL		425870.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	20880.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	14820.00
TOTAL		73180.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	73180.00
2.	YEARLY INVESTMENT COST RECOVERY	17030.00
3.	DEPRECIATION	20290.00
TOTAL		110500.00

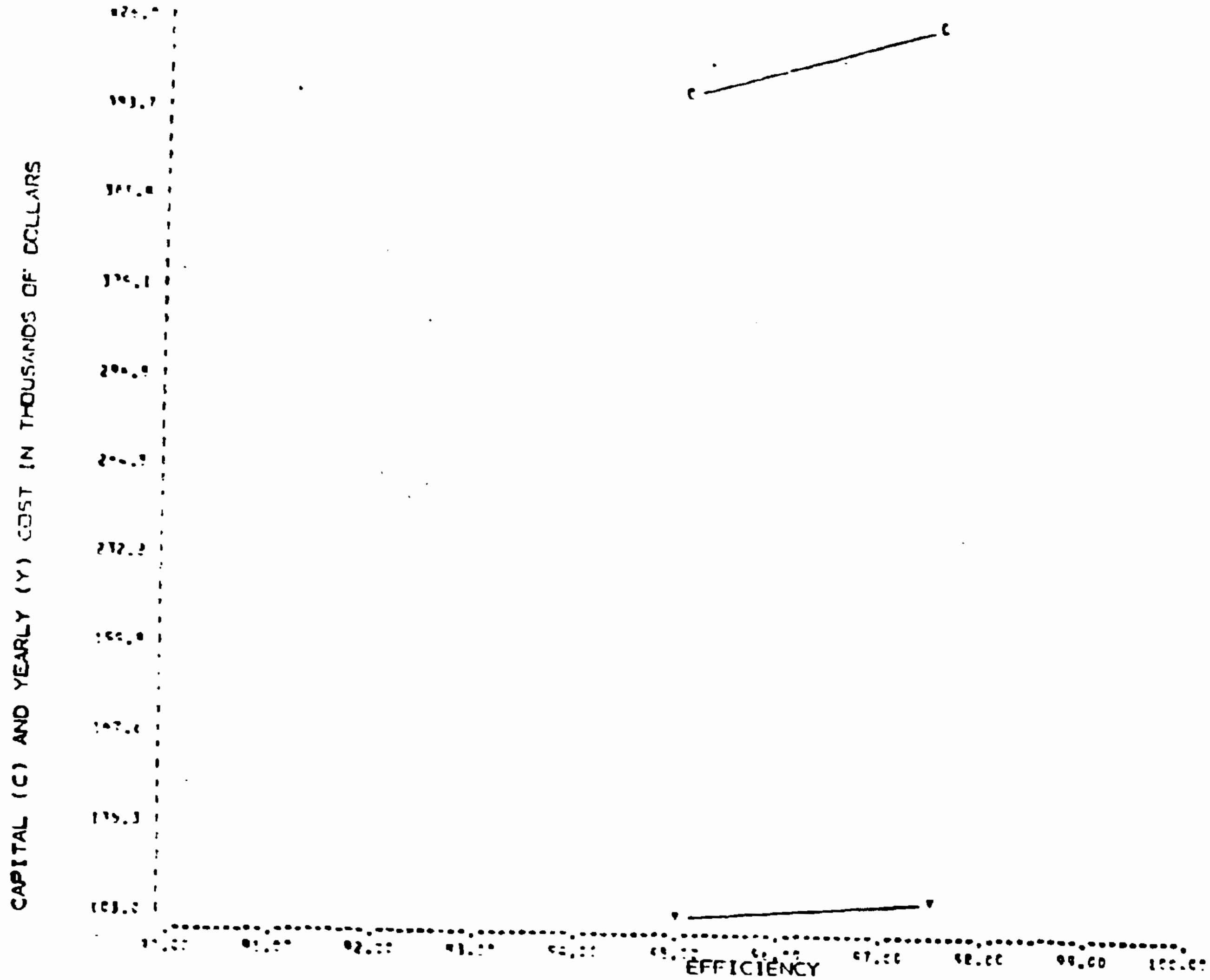


FIGURE 331

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 30, ALT. 30 III, VI

DRAFT

TABLE 355

ITEMIZED COST SUMMARY FOR ALTERNATIVE A30-VII (INSTANT TEA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON
H...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	308230.00
2. LAND	46650.00
3. ENGINEERING	30820.00
4. CONTINGENCY	30820.00
5. PVC LINER	8130.00
TOTAL	424650.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	91390.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	8480.00
5. PVC LINER	310.00
TOTAL	112670.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	112670.00
2. YEARLY INVESTMENT COST RECOVERY	16990.00
3. DEPRECIATION	18900.00
TOTAL	148560.00

DRAFT

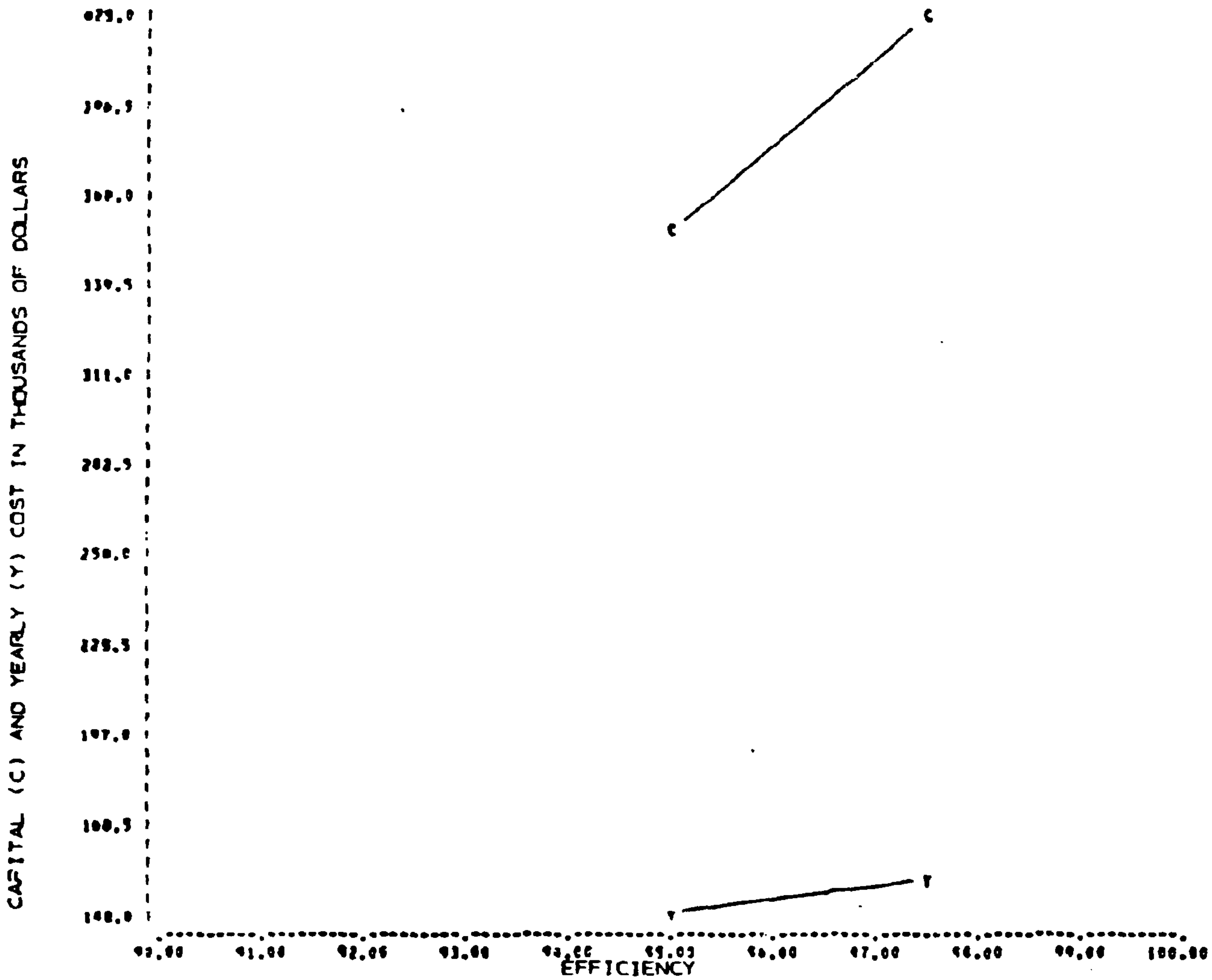


FIGURE 332

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 30, ALT. A 30 IV

Alternative A 30-VIII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 30-IV.

The resulting BOD waste load is 1.0 kg/kkg (2.0 lb/ton).

Costs: Total investment cost: $223,650
Total yearly cost: $ 30,250

An itemized breakdown of costs is presented in Table 356. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 8 - Coffee Roasting with Wet Scrubbers

A model plant representative of Subcategory C 8 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which consumes 60 kkg (65 ton) of coffee beans per day.

Alternative C 8-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 60 kkg (65 ton) per day plant is 64.3 cu m/day (0.017 MGD). The BOD concentration is 350 mg/l, and the suspended solids concentration is 200 mg/l.

Costs: 0
Reduction Benefits: None

Alternative C 8-II - This alternative consists of a pumping station, caustic neutralization, a primary clarifier, an activated sludge system, sludge thickening, vacuum filtration, and sludge storage and hauling. A control house is provided.

The resulting BOD waste load is 0.038 kg/kkg (0.076 lb/ton), and the suspended solids load is 0.066 kg/kkg (0.13 lb/ton).

Costs: Total investment cost: $181,710
Total yearly cost: $ 78,600

An itemized breakdown of costs is presented in Table 357. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 90 percent
SS: 70 percent

DRAFT

TABLE 356

ITEMIZED COST SUMMARY FOR ALTERNATIVE A30-VIII (INSTANT TEA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	150420.00
	2. LAND	43150.00
	3. ENGINEERING	15040.00
	4. CONTINGENCY	15040.00
	TOTAL	223650.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	1840.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	4190.00
	TOTAL	12280.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	12280.00
	2. YEARLY INVESTMENT COST RECOVERY	8950.00
	3. DEPRECIATION	9020.00
	TOTAL	30250.00

DRAFT

TABLE 357

ITEMIZED COST SUMMARY FOR ALTERNATIVE C8-II
(COFFEE ROASTING WITH WET SCRUBBERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...90.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
G...CAUSTIC NEUTRALIZATION
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	129210.00
	2. LAND	26660.00
	3. ENGINEERING	12920.00
	4. CONTINGENCY	12920.00
	TOTAL	181710.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	5200.00
	3. CHEMICALS	16880.00
	4. MAINTENANCE&SUPPLIES	16510.00
	TOTAL	63580.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	63580.00
	2. YEARLY INVESTMENT COST RECOVERY	7270.00
	3. DEPRECIATION	7750.00
	TOTAL	78600.00

Alternative C 8-III - This alternative consists of Alternative C 8-II with the addition of dual media filtration.

The resulting BOD waste load is 0.019 kg/kkg (0.038 lb/ton), and the suspended solids load is 0.018 kg/kkg (0.035 lb/ton).

Costs: Total investment cost: $207,430
Total yearly cost: $ 85,260

An itemized breakdown of costs is presented in Table 358. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 95 percent
SS: 92 percent

A cost efficiency curve is presented in Figure 333.

Alternative C 8-IV - This alternative consists of a pumping station, caustic neutralization, nutrient addition, and aerated lagoons.

The resulting BOD waste load is 0.038 kg/kkg (0.076 lb/ton), and the suspended solids load is 0.11 kg/kkg (0.22 lb/ton).

Costs: Total investment cost: $218,760
Total yearly cost: $ 57,090

An itemized breakdown of costs is presented in Table 359. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 90 percent
SS: 50 percent

Alternative C 8-V - This alternative consists of Alternative C 8-IV with the addition of dual media filtration.

The resulting BOD waste load is 0.019 kg/kkg (0.038 lb/ton), and the suspended solids load is 0.031 kg/kkg (0.062 lb/ton).

Costs: Total investment cost: $244,470
Total yearly cost: $ 73,750

An itemized breakdown of costs is presented in Table 360. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 95 percent
SS: 86 percent

A cost efficiency curve is presented in Figure 334.

DRAFT

TABLE 358

ITEMIZED COST SUMMARY FOR ALTERNATIVE C8-III
(COFFEE ROASTING WITH WET SCRUBBERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- G...CAUSTIC NEUTRALIZATION
- E...CLARIFIER
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	150650.00
2. LAND	26660.00
3. ENGINEERING	15060.00
4. CONTINGENCY	15060.00
TOTAL	207430.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	7530.00
3. CHEMICALS	16880.00
4. MAINTENANCE&SUPPLIES	18520.00
TOTAL	67920.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	67920.00
2. YEARLY INVESTMENT COST RECOVERY	8300.00
3. DEPRECIATION	9040.00
TOTAL	85200.00

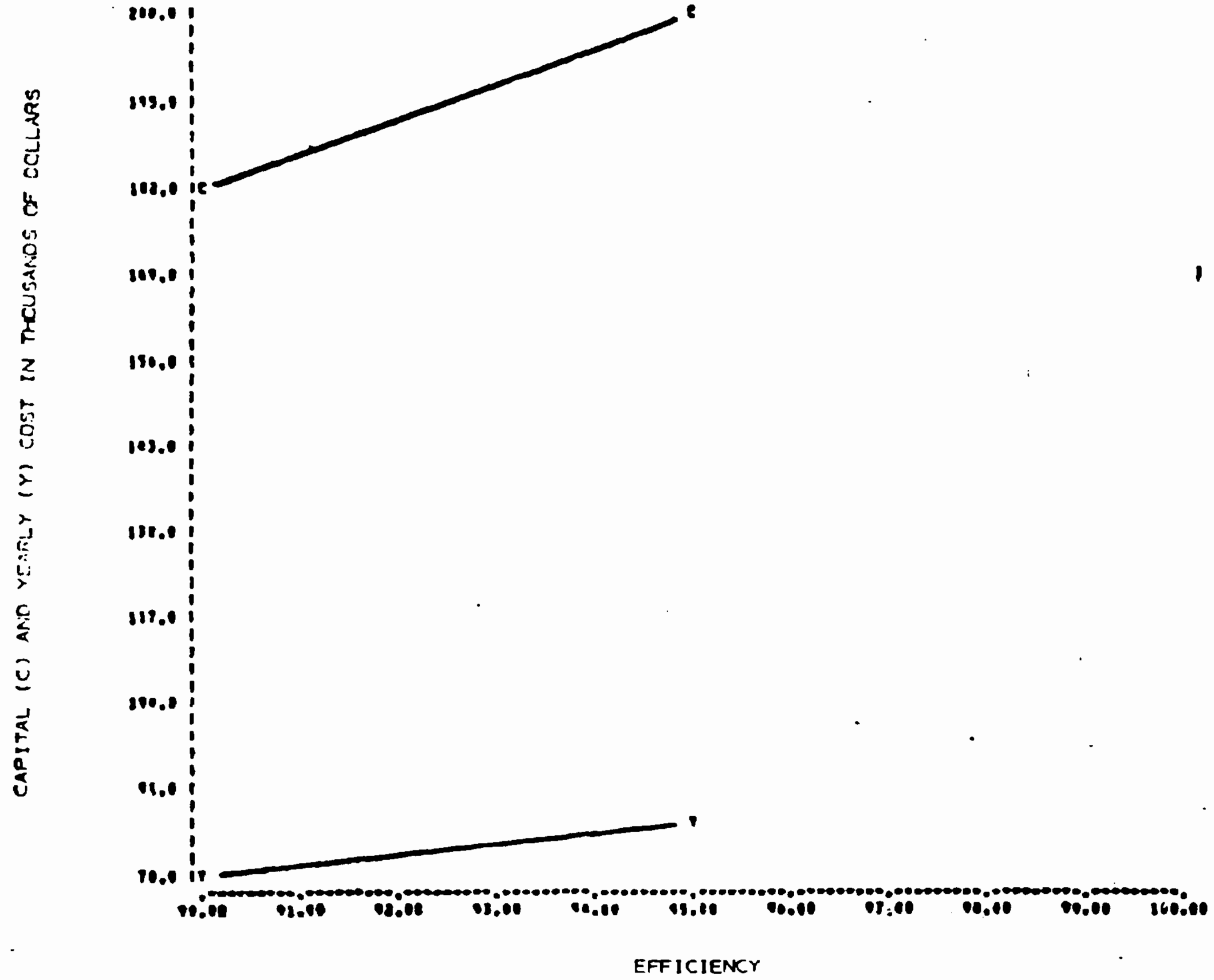


FIGURE 333

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C8, ALT. III

DRAFT

DRAFT

TABLE 359

ITEMIZED COST SUMMARY FOR ALTERNATIVE C8-IV
(COFFEE ROASTING WITH WET SCRUBBERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 90.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION

H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	154980.00
	2. LAND	28320.00
	3. ENGINEERING	15500.00
	4. CONTINGENCY	15500.00
	5. PVC LINER	4460.00
	TOTAL	218760.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	2210.00
	3. CHEMICALS	15140.00
	4. MAINTENANCE&SUPPLIES	6210.00
	5. PVC LINER	270.00
	TOTAL	48820.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	48820.00
	2. YEARLY INVESTMENT COST RECOVERY	8750.00
	3. DEPRECIATION	9520.00
	TOTAL	67090.00

DRAFT

TABLE 360

ITEMIZED COST SUMMARY FOR ALTERNATIVE C8-V
(~~EOS PROCESSING~~)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
M1...CONTROL HOUSE
F...PUMPING STATION

H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	176410.00
	2. LAND	29320.00
	3. ENGINEERING	17640.00
	4. CONTINGENCY	17640.00
	5. PVC LINER	4460.00
	TOTAL	244470.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	4540.00
	3. CHEMICALS	15140.00
	4. MAINTENANCE&SUPPLIES	8220.00
	5. PVC LINER	270.00
	TOTAL	53160.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	53160.00
	2. YEARLY INVESTMENT COST RECOVERY	9780.00
	3. DEPRECIATION	10810.00
	TOTAL	73750.00

DRAFT

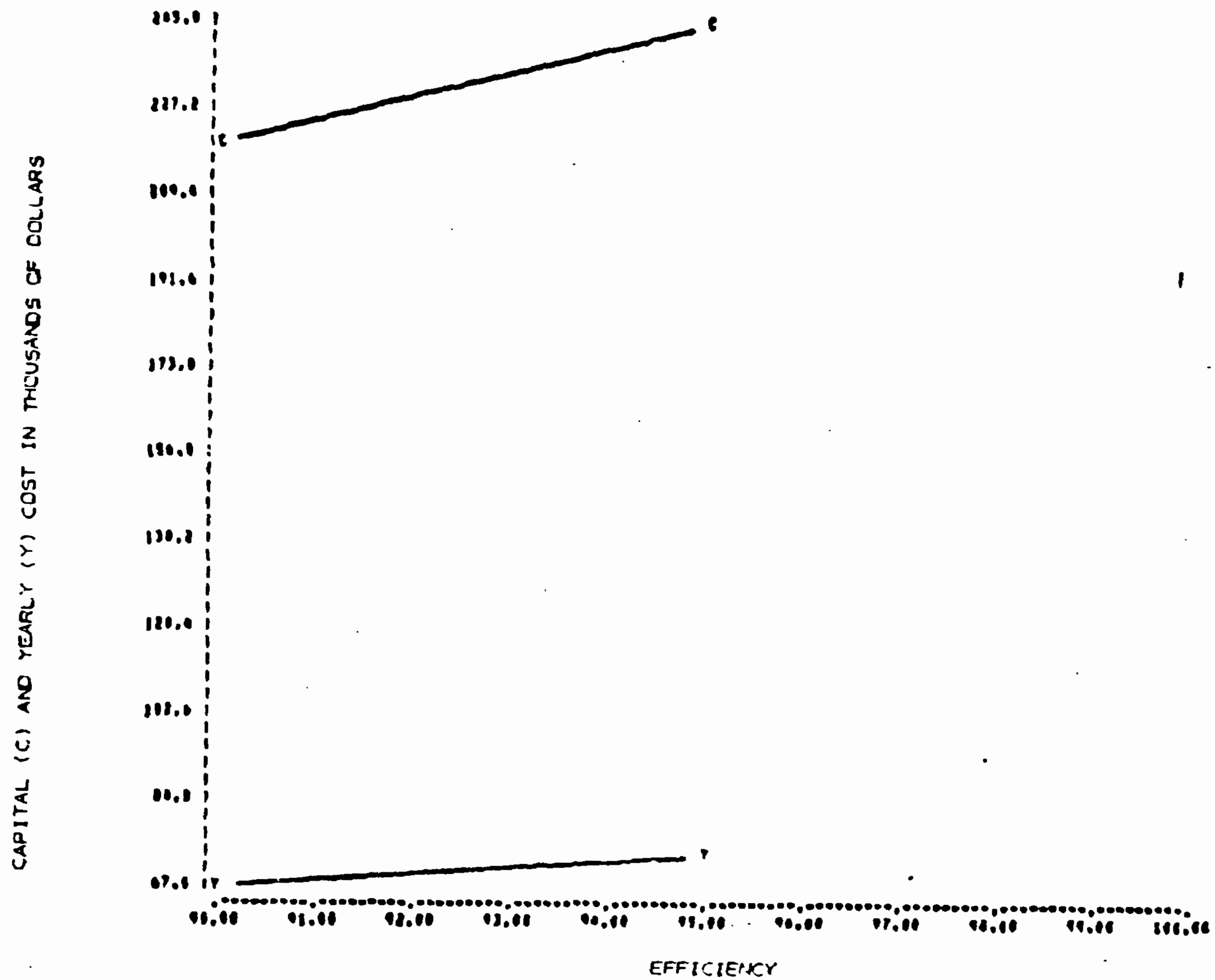


FIGURE 334

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C8, ALT. V

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 9 - Decaffination of Coffee

A model plant representative of Subcategory C 9 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which consumes 60 kkg (66 ton) of coffee beans per day.

Alternative C 9-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 60 kkg per day plant is 265 cu m/day (0.07 MGD). The BOD waste load is 3.8 kg/kkg (7.6 lb/ton), and the suspended solids load is 7.0 kg/kkg (14 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative C 9-II - This alternative consists of a pumping station, a flow equalization basin, a primary clarifier, caustic neutralization, vacuum filtration of sludge, sludge storage and hauling.

The resulting BOD waste load is 2.5 kg/kkg (5.0 lb/ton), and the suspended solids load is 2.8 kg/kkg (5.6 lb/ton).

Costs: Total investment cost: $158,350
Total yearly cost: $ 56,950

An itemized breakdown of costs is presented in Table 361. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 35 percent
SS: 60 percent

Alternative C 9-III - This alternative consists of Alternative C 9-II with the addition of an activated sludge system with nutrient addition, sludge thickening, and dual media filtration.

The resulting BOD waste load is 0.13 kg/kkg (0.26 lb/ton), and the suspended solids load is 0.35 kg/kkg (0.70 lb/ton).

Costs: Total investment cost: $319,720
Total yearly cost: $109,440

An itemized breakdown of costs is presented in Table 362. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

DRAFT

TABLE 361

ITEMIZED COST SUMMARY FOR ALTERNATIVE C9-II (COFFEE DECAFFEINATION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...35.0 PERCENT COD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- C...EQUALIZATION BASIN
- E...CLARIFIER
- G...CAUSTIC NEUTRALIZATION
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1.	CONSTRUCTION	109750.00
2.	LAND	26660.00
3.	ENGINEERING	10970.00
4.	CONTINGENCY	10970.00
TOTAL		158350.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	6520.00
3.	CHEMICALS	13180.00
4.	MAINTENANCE&SUPPLIES	11850.00
TOTAL		44040.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	44040.00
2.	YEARLY INVESTMENT COST RECOVERY	6330.00
3.	DEPRECIATION	6580.00
TOTAL		56950.00

DRAFT

TABLE 362

ITEMIZED COST SUMMARY FOR ALTERNATIVE C9-III
(COFFEE DECAFFEINATION)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...91.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
E...CLARIFIER
G...CAUSTIC NEUTRALIZATION
S...VACUUM FILTRATION
Y...HOLDING TANK
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1.	CONSTRUCTION	244220.00
2.	LAND	26660.00
3.	ENGINEERING	24420.00
4.	CONTINGENCY	24420.00
TOTAL		319720.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	18500.00
3.	CHEMICALS	17220.00
4.	MAINTENANCE&SUPPLIES	21290.00
TOTAL		82000.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	82000.00
2.	YEARLY INVESTMENT COST RECOVERY	12790.00
3.	DEPRECIATION	14650.00
TOTAL		109440.00

Reduction Benefits: BOD: 91 percent
SS: 95 percent

A cost efficiency curve is presented in Figure 335.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 10 - Soluble Coffee

A model plant representative of Subcategory C 10 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 78 kkg/day (87 ton/day) of coffee beans.

Alternative C 10-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 78 kkg (87 ton/day) plant is 680 cu m (0.18 MG) per day. The BOD waste load is 18.8 kg/kkg (37.6 lb/ton) and the suspended solids load is 12.3 kg/kkg (24.6 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative C 10-II - This alternative consists of a pumping station, flow equalization, primary clarification, multi-stage evaporation, caustic neutralization, and sludge storage.

The resulting BOD waste load is 1.9 kg/kkg (3.8 lb/ton), and the suspended solids load is 0.25 kg/kkg (0.50 lb/ton).

Costs: Total investment cost: $5,803,430
Total yearly cost: $1,291,010

An itemized breakdown of costs is presented in Table 363. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that five operators are required.

Reduction Benefits: BOD: 90 percent
SS: 99 percent

Alternative C 10-III - This alternative consists of a pumping station, flow equalization, primary clarification, caustic neutralization, nutrient addition, a complete mix activated sludge system, sludge thickening, vacuum filtration of sludge, sludge storage and hauling, and dual media filtration.

The resulting BOD waste load is 0.75 kg/kkg (1.5 lb/ton), and the suspended solids load is 0.74 kg/kkg (1.48 lb/ton).

Costs: Total investment cost: $625,620
Total yearly cost: $220,010

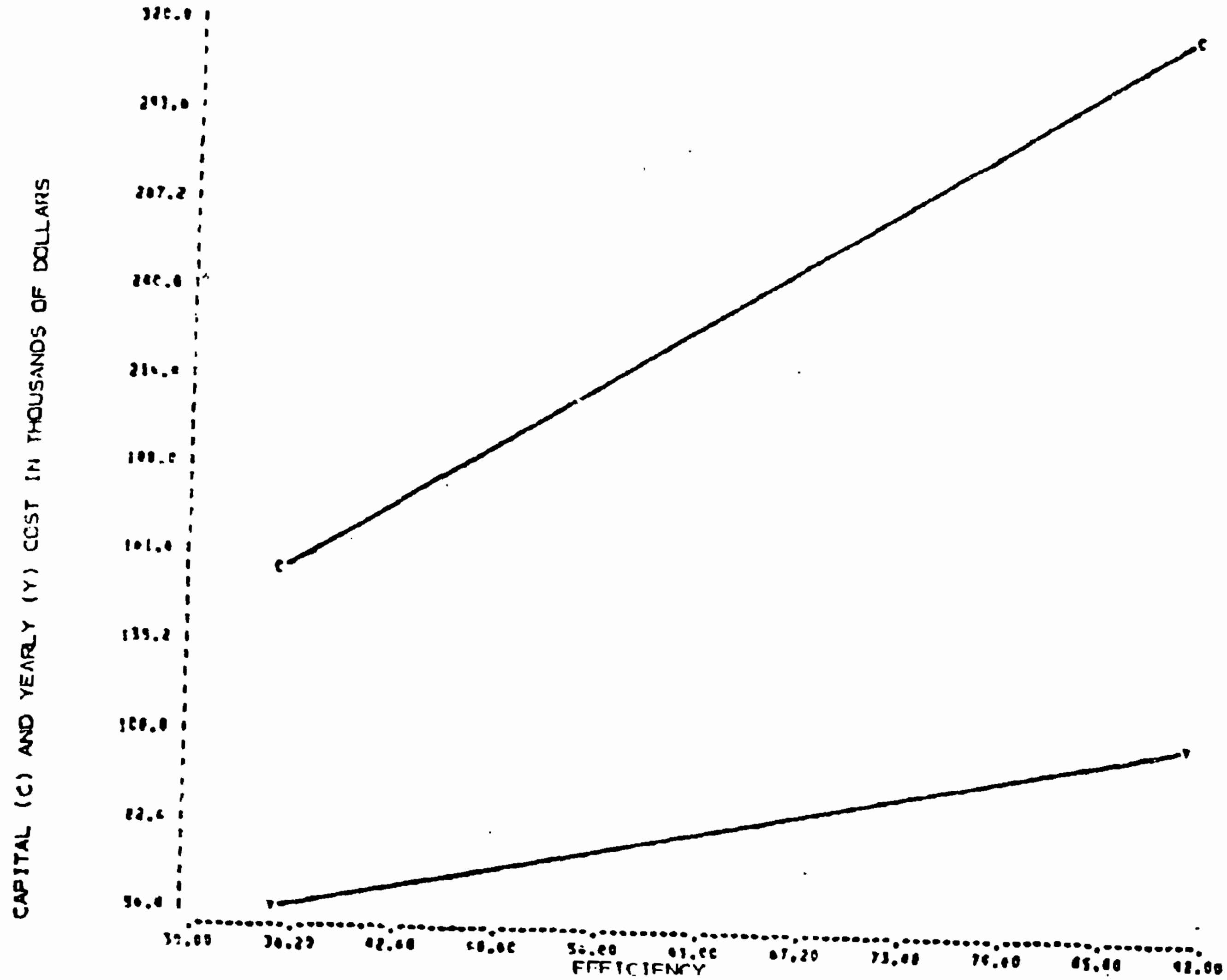


FIGURE 335

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C 9, ALT. III

DRAFT

TABLE 363

ITEMIZED COST SUMMARY FOR ALTERNATIVE C10-II (SOLUBLE COFFEE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1..CONTROL HOUSE
- F1..MULTIPLE EFFECT EVAPORATOR

INVESTMENT COSTS:		
	1. CONSTRUCTION	4808430.00
	2. LAND	33320.00
	3. ENGINEERING	480840.00
	4. CONTINGENCY	480840.00
	TOTAL	5803430.00
YEARLY OPERATING COSTS:		
	1. LABOR	58310.00
	2. POWER	109470.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	602580.00
	TOTAL	770360.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	770360.00
	2. YEARLY INVESTMENT COST RECOVERY	232140.00
	3. DEPRECIATION	268510.00
	TOTAL	1291010.00

An itemized breakdown of costs is presented in Table 364. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 96 percent
SS: 94 percent

Alternative C 10-IV - This alternative provides the addition to Alternative C 10-II complete mix activated sludge with nutrient addition, and sludge thickening, vacuum filtering, storage, and hauling.

The resulting BOD waste load is 0.2 kg/kkg (0.4 lb/ton), and the suspended solids load is negligible.

Costs: Total investment cost: $5,956,320
Total yearly cost: $1,321,270

An itemized breakdown of costs is presented in Table 365. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that five operators are required.

Reduction Benefits: BOD: 99 percent
SS: 99+ percent

A cost efficiency curve is presented in Figure 336.

BAKERY AND CONFECTIONERY PRODUCTS

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 1 - Cakes, Pies, Etc., with Pan Wash

A model plant representative of Subcategory C 1 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 136 kkg (150 ton) of product per day.

Alternative C 1-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 135 kkg per day plant is 454 cu m/day (0.12 MGD). The BOD waste load is 94.2 kg/kkg (188 lb/ton), and the suspended solids load is 16.8 kg/kkg (33.6 lb/ton), and the oil and grease load is 1.7 kg/kkg (3.4 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative C 1-II - This alternative consists of a pumping station, screening, flow equalization, chemical treatment (coagulation by ferric chloride, lime slurry, aluminum sulfate, and anionic polyelectrolyte). Solids and sludge are assumed to be trucked to landfill.

DRAFT

TABLE 364

ITEMIZED COST SUMMARY FOR ALTERNATIVE C10-III (SOLUBLE COFFEE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- A...PUMPING STATION
- C...EQUALIZATION BASIN
- F...CLARIFIER
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- G...CAUSTIC NEUTRALIZATION
- K...ACTIVATED SLUDGE
- E...CLARIFIER
- O...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	493580.00
	2. LAND	33320.00
	3. ENGINEERING	49360.00
	4. CONTINGENCY	49360.00
	TOTAL	625620.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	41810.00
	3. CHEMICALS	44410.00
	4. MAINTENANCE&SUPPLIES	54170.00
	TOTAL	165380.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	165380.00
	2. YEARLY INVESTMENT COST RECOVERY	25020.00
	3. DEPRECIATION	29610.00
	TOTAL	220010.00

DRAFT

TABLE 365

ITEMIZED COST SUMMARY FOR ALTERNATIVE C10-IV
(SOLUBLE COFFEE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
F1..MULTIPLE EFFECT EVAPORATOR
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
S...VACUUM FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	4935840.00
2. LAND	33320.00
3. ENGINEERING	493580.00
4. CONTINGENCY	493580.00
TOTAL	5956320.00

YEARLY OPERATING COSTS:

1. LABOR	58310.00
2. POWER	116270.00
3. CHEMICALS	2990.00
4. MAINTENANCE&SUPPLIES	609300.00
TOTAL	786870.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	786870.00
2. YEARLY INVESTMENT COST RECOVERY	238250.00
3. DEPRECIATION	296150.00
TOTAL	1321270.00

1206

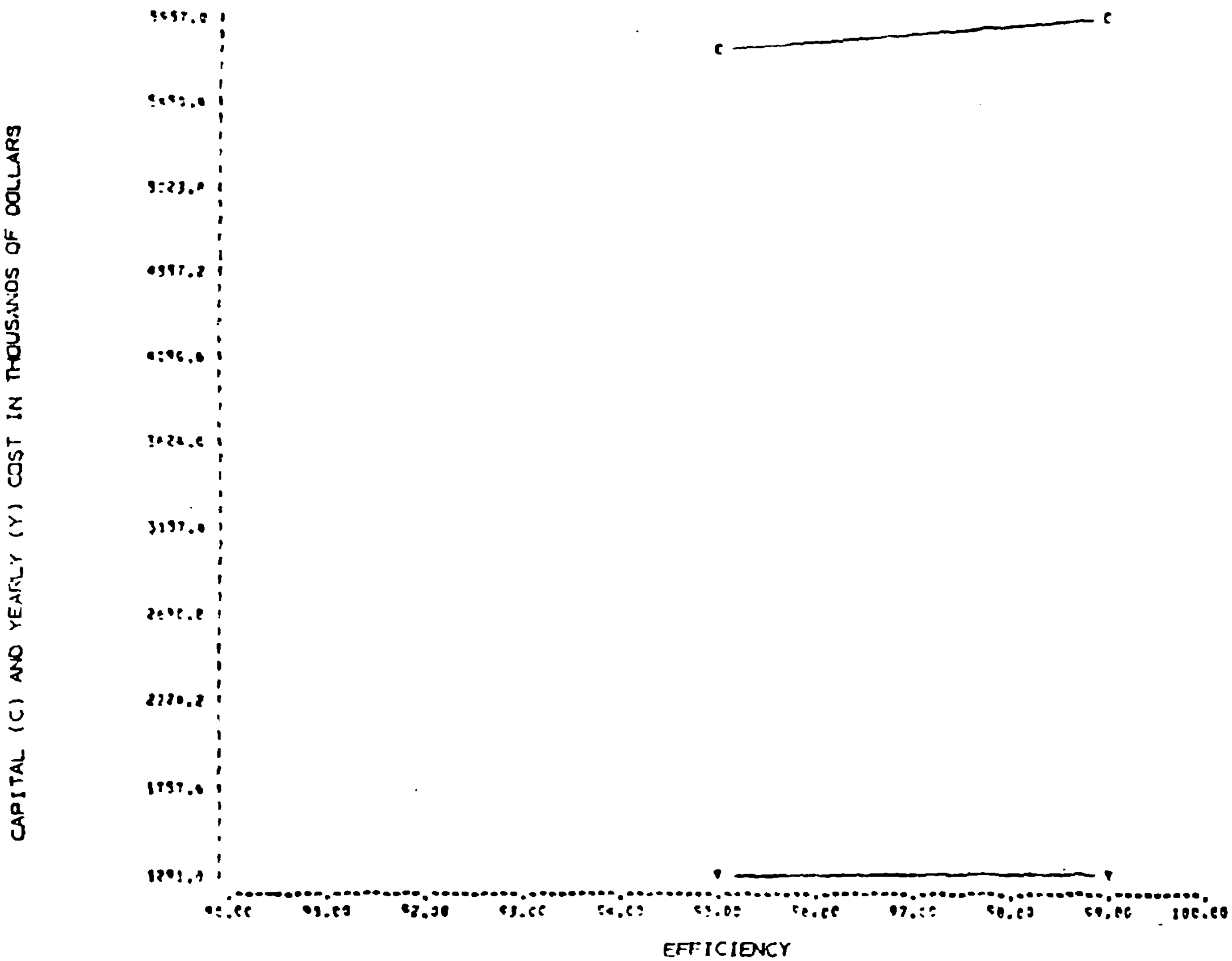


FIGURE 336

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C10, ALT. IV

DRAFT

The resulting BOD waste load is 4.7 kg/kkg (9.4 lb/ton), the suspended solids load is 0.50 kg/kkg (1.0 lb/ton), and the oil and grease load is 0.02 kg/kkg (0.04 lb/ton).

Costs: Total investment cost: $633,850
Total yearly cost: $316,170

An itemized breakdown of costs is presented in Table 366. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that seven operators are required.

Reduction Benefits: BOD: 95 percent
SS: 97 percent
O&G: 99 percent

Alternative C 1-III - This alternative consists of Alternative C 1-II with the addition of an activated sludge system, sludge thickening, vacuum filtration of sludge, and additional truck hauling.

The resulting BOD waste load is 0.94 kg/kkg (1.88 lb/ton), the suspended solids load is 0.34 kg/kkg (0.68 lb/ton), and the oil and grease load is 0.005 kg/kkg (0.01 lb/ton).

Costs: Total investment cost: $1,001,190
Total yearly cost: $ 389,640

An itemized breakdown of costs is presented in Table 367. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that seven operators are required.

Reduction Benefits: BOD: 99 percent
SS: 98 percent
O&G: 99 percent

Alternative C 1-IV - This alternative consists of Alternative C 1-III with the addition of dual media filtration.

The resulting BOD waste load is 0.94 kg/kkg (1.88 lb/ton), the suspended solids load is 0.17 kg/kkg (0.34 lb/ton), and the oil and grease load is 0.005 kg/kkg (0.01 lb/ton).

Costs: Total investment cost: $1,036,100
Total yearly cost: $ 399,420

An itemized breakdown of costs is presented in Table 368. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that seven operators are required.

Reduction Benefits: BOD: 99 percent
SS: 99 percent
O&G: 99 percent

A cost efficiency curve is presented in Figure 337.

DRAFT

TABLE 366

ITEMIZED COST SUMMARY FOR ALTERNATIVE C1-II
(CAKES, PIES, ETC. WITH PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B1..CONTROL HOUSE
C1..ENTEMANN PHYSICAL CHEMICAL

INVESTMENT COSTS:		
	1. CONSTRUCTION	514330.00
	2. LAND	16660.00
	3. ENGINEERING	51430.00
	4. CONTINGENCY	51430.00
	TOTAL	633850.00
YEARLY OPERATING COSTS:		
	1. LABOR	86630.00
	2. POWER	5020.00
	3. CHEMICALS	124950.00
	4. MAINTENANCE&SUPPLIES	43360.00
	TOTAL	259960.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	259960.00
	2. YEARLY INVESTMENT COST RECOVERY	25350.00
	3. DEPRECIATION	30860.00
	TOTAL	316170.00

DRAFT

TABLE 367

ITEMIZED COST SUMMARY FOR ALTERNATIVE C1-III
(CAKES, PIES, ETC. WITH PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C1..ENTEMANN PHYSICAL CHEMICAL
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
C...SLUDGE THICKENER
S...VACUUM FILTRATION
W...PIPELINE
Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	820450.00
2. LAND	16660.00
3. ENGINEERING	82040.00
4. CONTINGENCY	82040.00
TOTAL	1001190.00

YEARLY OPERATING COSTS:

1. LABOR	86630.00
2. POWER	23670.00
3. CHEMICALS	131760.00
4. MAINTENANCE&SUPPLIES	58300.00
TOTAL	300360.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	300360.00
2. YEARLY INVESTMENT COST RECOVERY	40050.00
3. DEPRECIATION	49230.00
TOTAL	389640.00

DRAFT

TABLE 368

ITEMIZED COST SUMMARY FOR ALTERNATIVE C1-IV
(CAKES, PIES, ETC. WITH PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...99.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C1..ENTEMANN PHYSICAL CHEMICAL
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
S...VACUUM FILTRATION
W...PIPELINE
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	849540.00
2.	LAND	16660.00
3.	ENGINEERING	84950.00
4.	CONTINGENCY	84950.00
TOTAL		1036100.00

YEARLY OPERATING COSTS:

1.	LABOR	86630.00
2.	POWER	29760.00
3.	CHEMICALS	131760.00
4.	MAINTENANCE&SUPPLIES	58860.00
TOTAL		307010.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	307010.00
2. YEARLY INVESTMENT COST RECOVERY	41440.00
3. DEPRECIATION	50970.00
TOTAL	399420.00

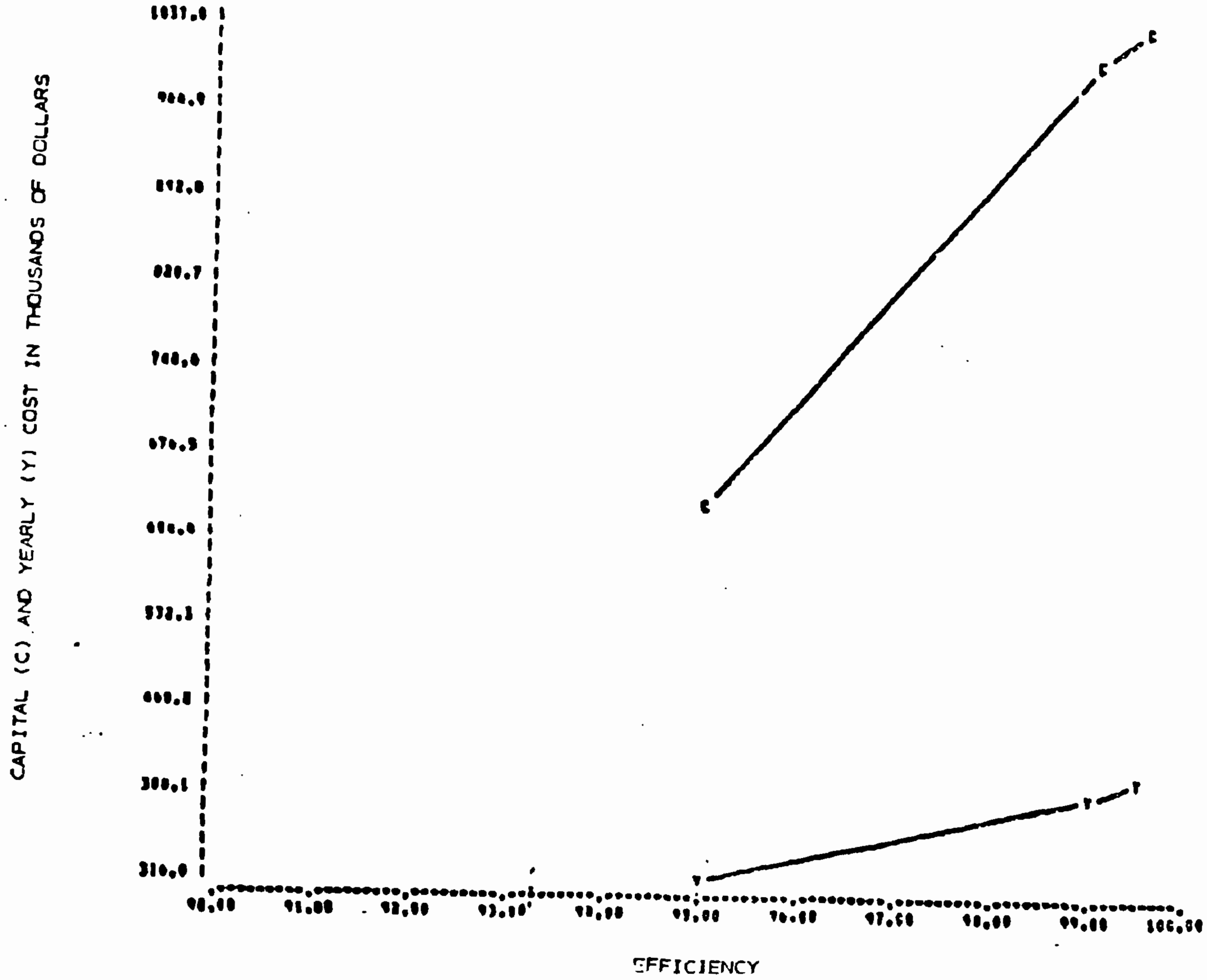


FIGURE 337

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C1 ALT. IV

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 2 - Cakes, Pies, Etc., Without Pan Wash

A model plant representative of Subcategory C 2 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 207 kkg (228 ton) of product per day.

Alternative C 2-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 207 kkg per day plant is 189 cu m/day (0.05 MGD). The BOD waste load is 2.0 kg/kkg (4.0 lb/ton), the suspended solids load is 0.94 kg/kkg (1.88 lb/ton), and the oil and grease load is 0.63 kg/kkg (1.26 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative C 2-II - This alternative consists of a pumping station, a flow equalization basin, a dissolved air flotation unit, a vacuum filter for sludge, and truck hauling of sludge.

The resulting BOD waste load is 1.0 kg/kkg (2.0 lb/ton), the suspended solids load is 0.28 kg/kkg (0.56 lb/ton), and the oil and grease load is 0.19 kg/kkg (0.38 lb/ton).

Costs: Total investment cost: $138,830
Total yearly cost: $ 37,390

An itemized breakdown of costs is presented in Table 369. It is assumed that costs $41,000 per hectare ($16,600 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 50 percent
SS: 70 percent
O&G: 70 percent

Alternative C 2-III - This alternative consists of Alternative C 2-II with the addition of a plastic media roughing filter with nutrient addition.

The resulting BOD waste load is 0.50 kg/kkg (1.0 lb/ton), the suspended solids load is 0.14 kg/kkg (0.28 lb/ton), and the oil and grease load is 0.085 kg/kkg (0.17 lb/ton).

Costs: Total investment cost: $165,420
Total yearly cost: $ 41,690

DRAFT

TABLE 369

ITEMIZED COST SUMMARY FOR ALTERNATIVE C2-II
(CAKES, PIES, ETC. WITHOUT PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...50.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
S...VACUUM FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	93470.00
	2. LAND	26660.00
	3. ENGINEERING	9350.00
	4. CONTINGENCY	9350.00
	TOTAL	138830.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	3990.00
	3. CHEMICALS	1800.00
	4. MAINTENANCE&SUPPLIES	14190.00
	TOTAL	26230.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	26230.00
	2. YEARLY INVESTMENT COST RECOVERY	5550.00
	3. DEPRECIATION	5610.00
	TOTAL	37390.00

An itemized breakdown of costs is presented in Table 370. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one half-time operator is required.

Reduction Benefits: BOD: 75 percent
SS: 85 percent
O&G: 85 percent

Alternative C 2-IV - This alternative consists of Alternative C 2-III with the addition of an activated sludge system, sludge thickening, and additional capacity for vacuum filtration of sludge.

The resulting BOD waste load is 0.050 kg/kkg (0.10 lb/ton), the suspended solids load is 0.042 kg/kkg (0.084 lb/ton), and the oil and grease load is 0.026 kg/kkg (0.052 lb/ton).

Costs: Total investment cost: $262,420
Total yearly cost: $ 69,300

An itemized breakdown of costs is presented in Table 371. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required full time and one is required half-time

Reduction Benefits: BOD: 97 percent
SS: 95 percent
O&G: 95 percent

Alternative C 2-V - This alternative consists of Alternative C 2-IV with the addition of dual media filtration.

The resulting BOD waste load is 0.025 kg/kkg (0.05 lb/ton), the suspended solids load is 0.011 kg/kkg (0.022 lb/ton), and the oil and grease load is 0.013 kg/kkg (0.026 lb/ton).

Costs: Total investment cost: $291,510
Total yearly cost: $ 76,970

An itemized breakdown of costs is presented in Table 372. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required full time and one half-time.

Reduction Benefits: BOD: 99 percent
SS: 99 percent
O&G: 98 percent

A cost efficiency curve is presented in Figure 338.

DRAFT

TABLE 370

ITEMIZED COST SUMMARY FOR ALTERNATIVE C2-III
(CAKES, PIES, ETC. WITHOUT PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...75.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
S...VACUUM FILTRATION
M...NITROGEN ADDITION
X...ROUGHING FILTER

INVESTMENT COSTS:

1.	CONSTRUCTION	115640.00
2.	LAND	26660.00
3.	ENGINEERING	11560.00
4.	CONTINGENCY	11560.00
TOTAL		165420.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	4000.00
3.	CHEMICALS	2180.00
4.	MAINTENANCE&SUPPLIES	15700.00
TOTAL		28130.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	28130.00
2.	YEARLY INVESTMENT COST RECOVERY	6620.00
3.	DEPRECIATION	6940.00
TOTAL		41690.00

DRAFT

TABLE 371

ITEMIZED COST SUMMARY FOR ALTERNATIVE C2-IV
(CAKES, PIES, ETC. WITHOUT PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
S...VACUUM FILTRATION
H...NITROGEN ADDITION
X...ROUGHING FILTER
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
B1../CONTROL HOUSE

INVESTMENT COSTS:

1.	CONSTRUCTION	196460.00
2.	LAND	26660.00
3.	ENGINEERING	19650.00
4.	CONTINGENCY	19650.00
TOTAL		262420.00

YEARLY OPERATING COSTS:

1.	LABOR	18740.00
2.	POWER	9030.00
3.	CHEMICALS	2180.00
4.	MAINTENANCE&SUPPLIES	17060.00
TOTAL		47010.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	47010.00
2. YEARLY INVESTMENT COST RECOVERY	10500.00
3. DEPRECIATION	11790.00
TOTAL	69300.00

DRAFT

TABLE 372

ITEMIZED COST SUMMARY FOR ALTERNATIVE C2-V
(CAKES, PIES, ETC. WITHOUT PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
S...VACUUM FILTRATION
H...NITROGEN ADDITION
X...ROUGHING FILTER
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
B1..CONTROL HOUSE
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	220710.00
2. LAND	26660.00
3. ENGINEERING	22070.00
4. CONTINGENCY	22070.00
TOTAL	291510.00

YEARLY OPERATING COSTS:

1. LABOR	18740.00
2. POWER	12650.00
3. CHEMICALS	2180.00
4. MAINTENANCE&SUPPLIES	18500.00
TOTAL	52070.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	52070.00
2. YEARLY INVESTMENT COST RECOVERY	11660.00
3. DEPRECIATION	13240.00
TOTAL	76970.00

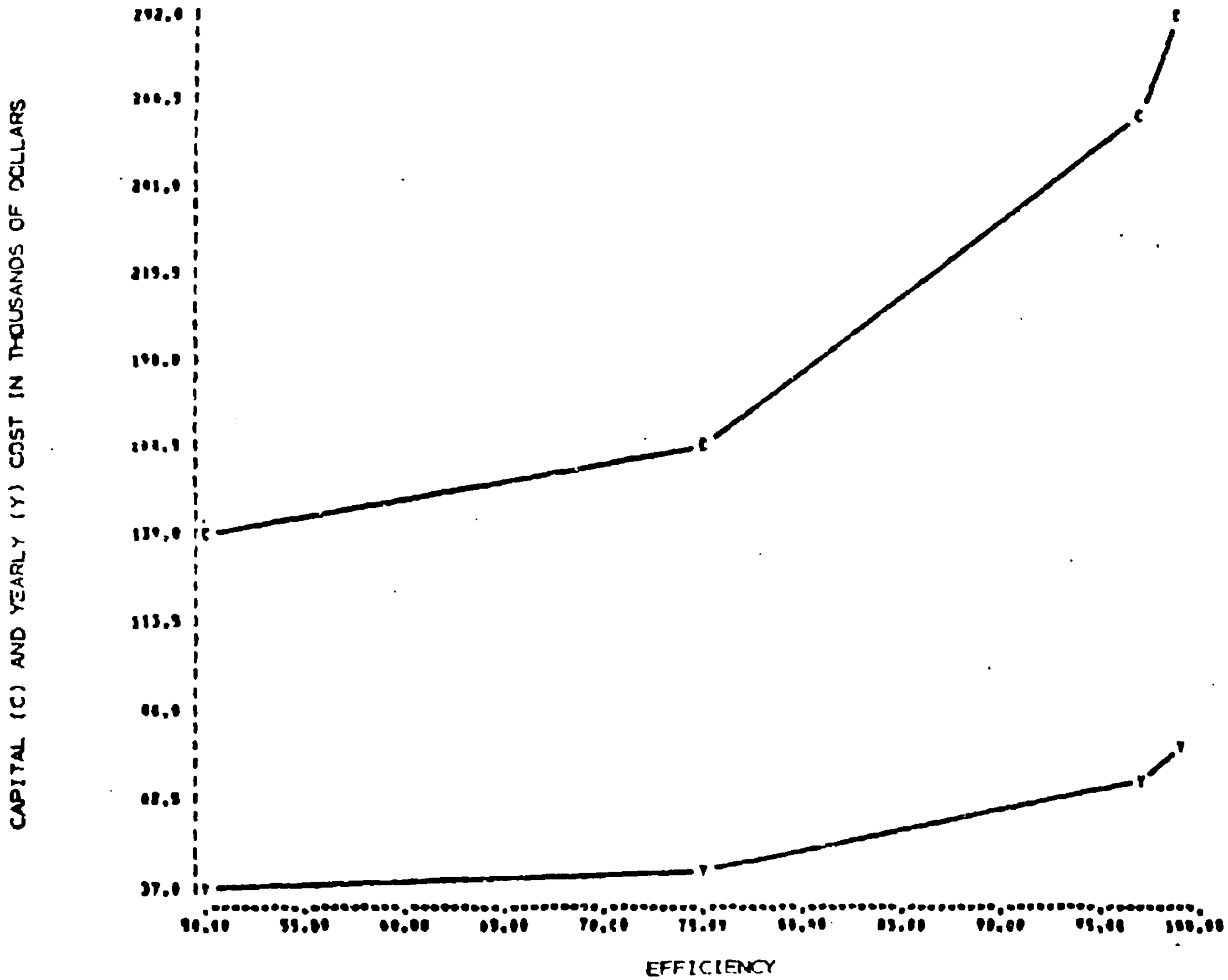


FIGURE 338

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C2, ALT. V

DRAFT

Alternative C 2-VI - This alternative consists of Alternative C 2-V with the addition of two aerobic stabilization ponds and the deletion of the dual media filtration.

The resulting BOD waste load is 0.025 kg/kkg (0.05 lb/ton), the suspended solids load is 0.022 kg/kkg (0.044 lb/ton), and the oil and grease load is 0.013 kg/kkg (0.026 lb/ton).

Costs: Total investment cost: $297,900
Total yearly cost: $ 73,650

An itemized breakdown of costs is presented in Table 373. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that one operator is required full time and one half-time.

Reduction Benefits: BOD: 99 percent
SS: 98 percent
O&G: 98 percent

A cost efficiency curve is presented in Figure 339.

Alternative C 2-VII - This alternative consists of caustic neutralization, nitrogen addition, and an aerated lagoon system.

The resulting BOD waste load is 0.20 kg/kkg (0.40 lb/ton), the suspended solids load is 0.28 kg/kkg (0.56 lb/ton), and the oil and grease load is 0.19 kg/kkg (0.38 lb/ton).

Costs: Total investment cost: $174,000
Total yearly cost: $ 50,350

An itemized breakdown of costs is presented in Table 374. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 90 percent
SS: 70 percent
O&G: 70 percent

Alternative C 2-VIII - This alternative is the same as Alternative C 2-VII with the addition of spray irrigation of the final effluent. It is assumed that an additional pumping station is required and that the spray field is 300 m (1000 ft) from the treatment plant.

Costs: Total investment cost: $256,720
Total yearly cost: $ 72,220

An itemized breakdown of costs is presented in Table 375. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required full time and one-half time.

DRAFT

TABLE 373

ITEMIZED COST SUMMARY FOR ALTERNATIVE C2-VI
(CAKES, PIES, ETC. WITHOUT PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
S...VACUUM FILTRATION
H...NITROGEN ADDITION
X...ROUGHING FILTER
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
B1..CONTROL HOUSE
M...SETTLING POND

INVESTMENT COSTS:

1.	CONSTRUCTION	232340.00
2.	LAND	16660.00
3.	ENGINEERING	23230.00
4.	CONTINGENCY	23230.00
5.	PVC LINER	2440.00
TOTAL		297900.00

YEARLY OPERATING COSTS:

1.	LABOR	18740.00
2.	POWER	9030.00
3.	CHEMICALS	2180.00
4.	MAINTENANCE&SUPPLIES	17230.00
5.	PVC LINER	490.00
TOTAL		47670.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	47670.00
2.	YEARLY INVESTMENT COST RECOVERY	11920.00
3.	DEPRECIATION	14060.00
TOTAL		73650.00

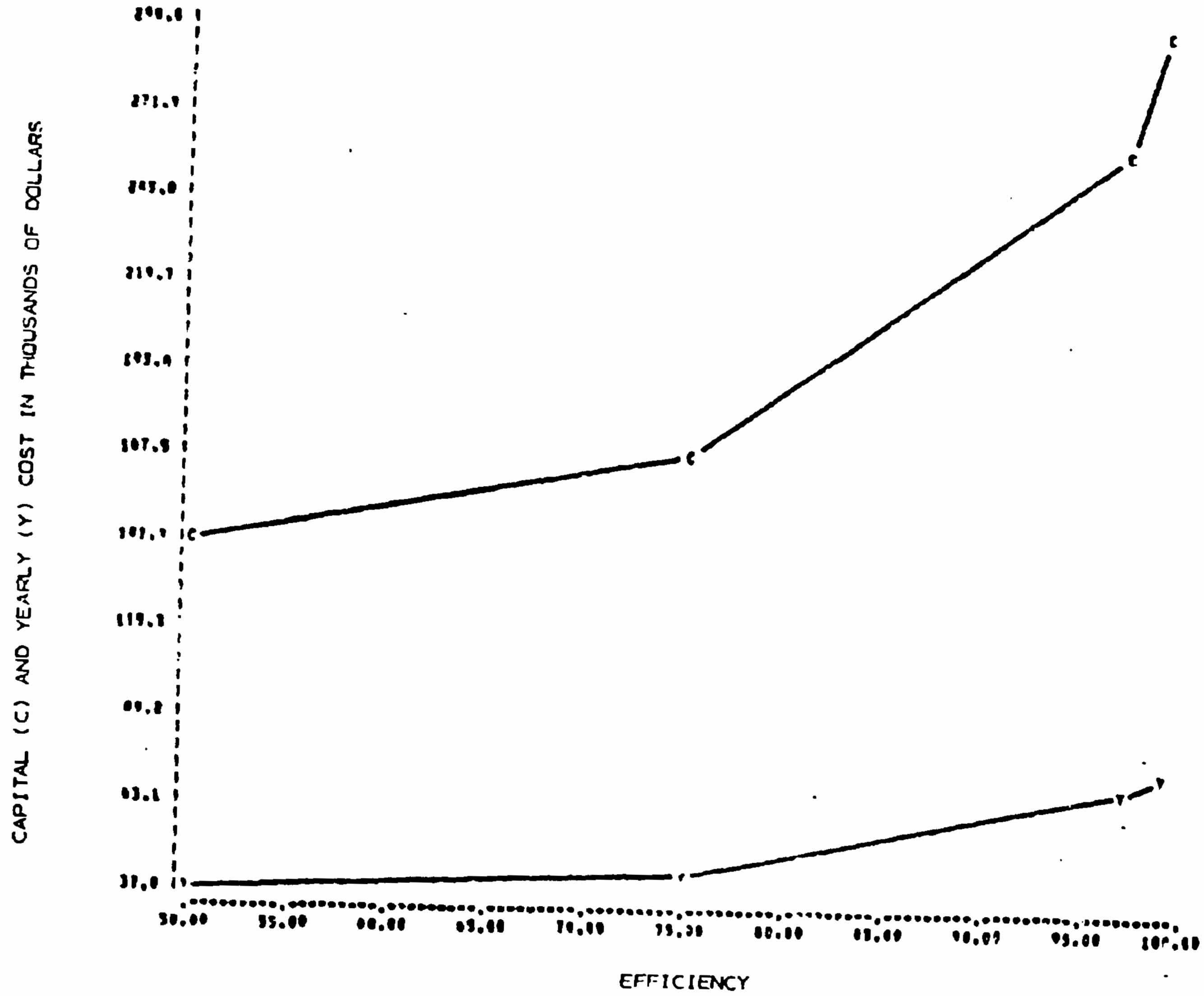


FIGURE 339

INVESTMENT AND YEARLY COST FOR SUBCATEGORY C2, ALT. VI

TABLE 374

ITEMIZED COST SUMMARY FOR ALTERNATIVE C2-VII (CAKES, PIES, ETC. WITHOUT PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 90.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- G...CAUSTIC NEUTRALIZATION
- H...NITROGEN ADDITION
- L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	139080.00
2.	LAND	3330.00
3.	ENGINEERING	13910.00
4.	CONTINGENCY	13910.00
5.	PVC LINER	3770.00
	TOTAL	174000.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	9660.00
3.	CHEMICALS	15790.00
4.	MAINTENANCE&SUPPLIES	3020.00
5.	PVC LINER	140.00
	TOTAL	34660.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	34860.00
2.	YEARLY INVESTMENT COST RECOVERY	6960.00
3.	DEPRECIATION	8530.00
	TOTAL	50350.00

DRAFT

TABLE 375

ITEMIZED COST SUMMARY FOR ALTERNATIVE C2-VIII
(CAKES, PIES, ETC. WITHOUT PAN WASH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- G...CAUSTIC NEUTRALIZATION
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- U...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	194140.00
	2. LAND	19990.00
	3. ENGINEERING	19410.00
	4. CONTINGENCY	19410.00
	5. PVC LINER	3770.00
	TOTAL	256720.00
YEARLY OPERATING COSTS:		
	1. LABOR	18740.00
	2. POWER	10740.00
	3. CHEMICALS	15790.00
	4. MAINTENANCE&SUPPLIES	4700.00
	5. PVC LINER	140.00
	TOTAL	50110.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	50110.00
	2. YEARLY INVESTMENT COST RECOVERY	10270.00
	3. DEPRECIATION	11840.00
	TOTAL	72220.00

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

A cost efficiency curve is presented in Figure 340.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 3 - Bread and Buns

A model plant representative of Subcategory C 3 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 41 kkg (45 ton) of product per day.

Alternative C 3-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 41 kkg per day plant is 100 cu m (0.026 MG) per day. The BOD waste load is 0.88 kg/kkg (1.76 lb/ton), the suspended solids load is 0.46 kg/kkg (0.92 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative C 3-II - This alternative provides a pumping station, flow equalization, primary clarification, complete mix activated sludge with nutrient addition, sludge thickening, vacuum filtration of sludge, and sludge storage and hauling.

The resulting BOD waste load is 0.07 kg/kkg (0.14 lb/ton), and the suspended solids load is 0.12 kg/kkg (0.24 lb/ton).

Costs: Total investment cost: $195,350
Total yearly cost: $ 52,510

An itemized breakdown of costs is presented in Table 376. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required full time and one-half time.

Reduction Benefits: BOD: 92 percent
SS: 75 percent

Alternative C 3-III - This alternative provides the addition to Alternative C 3-II of a dual media filtration unit.

The resulting BOD waste load is 0.035 kg/kkg (0.070 lb/ton), and the suspended solids load is 0.03 kg/kkg (0.06 lb/ton).

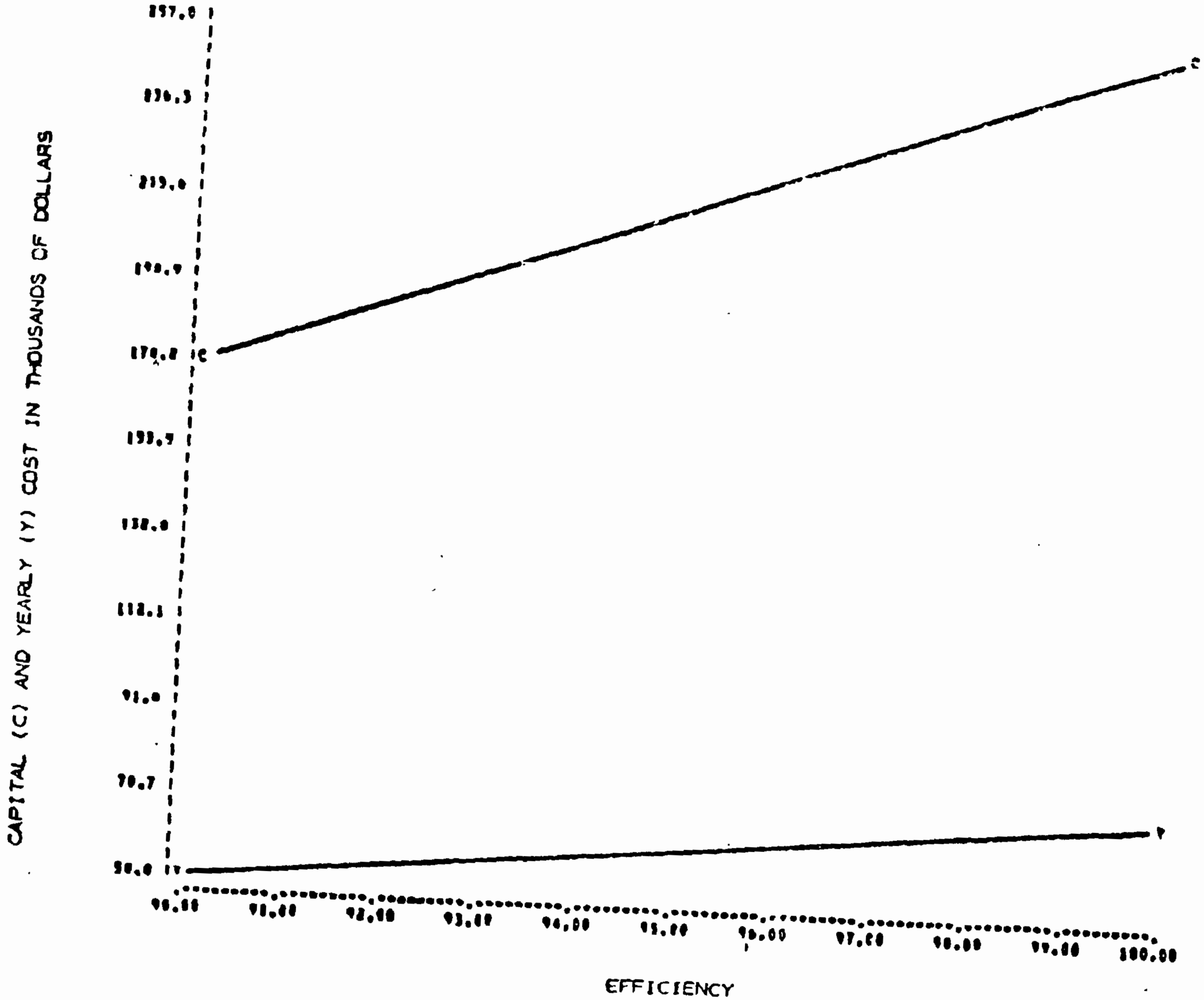


FIGURE 340

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C2, ALT. VIII

DRAFT

DRAFT

TABLE 376

ITEMIZED COST SUMMARY FOR ALTERNATIVE C3-II
(BREAD AND BREAD RELATED PRODUCTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 92.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	140570.00
2. LAND	26660.00
3. ENGINEERING	14060.00
4. CONTINGENCY	14060.00
TOTAL	195350.00

YEARLY OPERATING COSTS:

1. LABOR	18740.00
2. POWER	6790.00
3. CHEMICALS	1990.00
4. MAINTENANCE&SUPPLIES	8750.00
TOTAL	36270.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	36270.00
2. YEARLY INVESTMENT COST RECOVERY	7810.00
3. DEPRECIATION	8430.00
TOTAL	52510.00

Costs: Total investment cost: $211,550
Total yearly cost: $ 57,310

An itemized breakdown of costs is presented in Table 377. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required full time and one-half time.

Reduction Benefits: BOD: 96 percent
SS: 93 percent

A cost efficiency curve is presented in Figure 341.

Alternative C 3-IV - This alternative replaces the activated sludge system of Alternative C 3-III with an aerated lagoon.

The resulting BOD waste load is 0.44 kg/kkg (0.88 lb/ton), and the suspended solids load is 0.054 kg/kkg (0.11 lb/ton).

Costs: Total investment cost: $205,550
Total yearly cost: $ 43,070

An itemized breakdown of costs is presented in Table 378. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 95 percent
SS: 88 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 7 - Cookie and Cracker Manufacturing

A model plant representative of Subcategory C 7 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, six alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 204 kkg (224 ton) of product per day.

Alternative C 7-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 204 kkg (224 ton) per day plant is 341 cu m/day (0.09 MGD). The BOD waste load is 2.0 kg/kkg (4.0 lb/ton), the suspended solids load is 1.5 kg/kkg (3.0 lb/ton), and the oil and grease load is 0.85 kg/kkg (1.7 lb/ton).

Costs: 0
Reduction Benefits: None

DRAFT

TABLE 377

ITEMIZED COST SUMMARY FOR ALTERNATIVE CD-III
(BREAD AND BREAD RELATED PRODUCTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
A...PUMPING STATION
C...EQUALIZATION BASIN
E...CLARIFIER
F...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	154070.00
2.	LAND	26660.00
3.	ENGINEERING	15410.00
4.	CONTINGENCY	15410.00
TOTAL		211550.00

YEARLY OPERATING COSTS:

1.	LABOR	18740.00
2.	POWER	8510.00
3.	CHEMICALS	1990.00
4.	MAINTENANCE&SUPPLIES	10370.00
TOTAL		39610.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	39610.00
2.	YEARLY INVESTMENT COST RECOVERY	8460.00
3.	DEPRECIATION	9240.00
TOTAL		57310.00

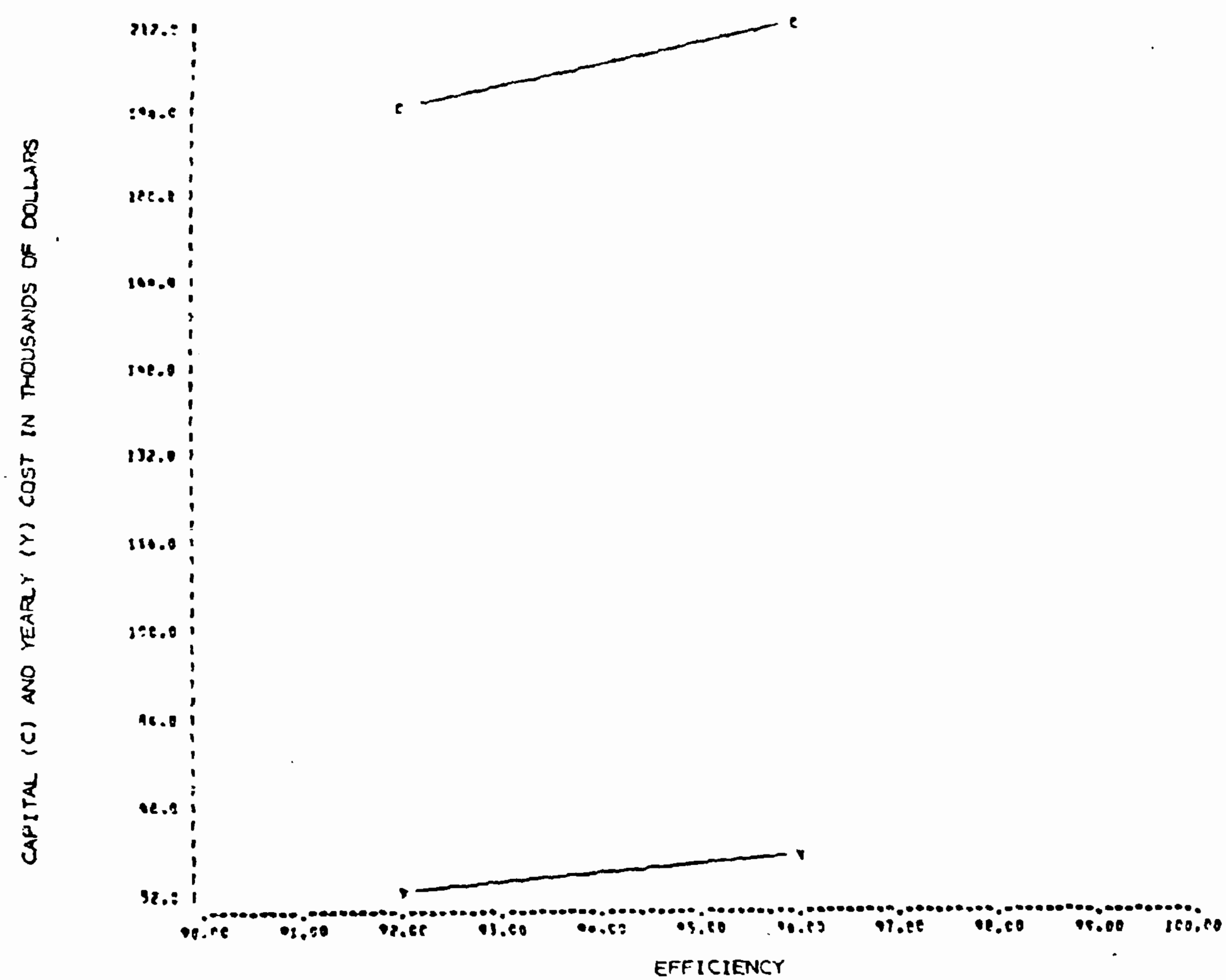


FIGURE 341

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C3, ALT. III

DRAFT

DRAFT

TABLE 378

ITEMIZED COST SUMMARY FOR ALTERNATIVE C3-IV
(BREAD AND BREAD RELATED PRODUCTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES;

B...PUMPING STATION
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	143970.00
2. LAND	28320.00
3. ENGINEERING	14400.00
4. CONTINGENCY	14400.00
5. PVC LINER	4460.00
TOTAL	205550.00

YEARLY OPERATING COSTS;

1. LABOR	12490.00
2. POWER	4900.00
3. CHEMICALS	270.00
4. MAINTENANCE&SUPPLIES	8060.00
5. PVC LINER	270.00
TOTAL	25990.00

TOTAL YEARLY COSTS;

1. YEARLY OPERATING COST	25990.00
2. YEARLY INVESTMENT COST RECOVERY	8220.00
3. DEPRECIATION	8860.00
TOTAL	43070.00

Alternative C 7-II - This alternative consists of flow equalization, air flotation, and storage and truck hauling of soldis and sludge. It is assumed that the separated solids are hauled to a rendering company at no cost to the bakery.

The resulting BOD waste load is 0.8 kg/kkg (1.6 lb/ton), the suspended solids load is 0.45 kg/kkg (0.9 lb/ton), and the oil and grease load is 0.3 kg/kkg (0.6 lb/ton).

Costs: Total investment cost: $110,030
Total yearly cost: $ 40,490

An itemized breakdown of costs is presented in Table 379. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed tnat one operator is required.

Reduction Benefits: BOD: 60 percent
SS: 70 percent
O&G: 65 percent

Alternative C 7-III - This alternative is the same as Alternative C 7-II with the addition of an aerated lagoon system.

The resulting BOD waste load is 0.1 kg/kkg (0.2 lb/ton), the suspended solids load is 0.15 kg/kkg (0.3 lb/ton), and the oil and grease load is 0.09 kg/kkg (0.18 lb/ton).

Costs: Total investment cost: $230,060
Total yearly cost: $ 59,260

An itemized treadkown of costs is presented in Table 380. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 95 percent
SS: 90 percent
O&G: 90 percent

Alternative C 7-IV - This alternative adds dual media filtration to Alternative C 7-III.

The resulting BOD waste load is 0.04 kg/kkg (0.08 lb/ton), the suspended solids load is 0.06 kg/kkg (0.12 lb/ton), and the oil and grease load is 0.05 kg/kkg (0.10 lb/ton).

Costs: Total investment cost: $262,730
Total yearly cost: $ 68,340

An itemized breakdown of costs is presented in Table 381. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

DRAFT

TABLE 379

ITEMIZED COST SUMMARY FOR ALTERNATIVE C7-II (COOKIE AND CRACKER MANUFACTURING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...60.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
J...AIR FLOTATION
B...PUMPING STATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	88230.00
	2. LAND	4160.00
	3. ENGINEERING	8820.00
	4. CONTINGENCY	8820.00
	TOTAL	110030.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	2210.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	16100.00
	TOTAL	30800.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	30800.00
	2. YEARLY INVESTMENT COST RECOVERY	4400.00
	3. DEPRECIATION	5290.00
	TOTAL	40490.00

DRAFT

TABLE 380

ITEMIZED COST SUMMARY FOR ALTERNATIVE C7-III
(COOKIE AND CRACKER MANUFACTURING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
J...AIR FLOTATION
B...PUMPING STATION
Y...HOLDING TANK
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	184410.00
2.	LAND	5000.00
3.	ENGINEERING	18440.00
4.	CONTINGENCY	18440.00
5.	PVC LINER	3770.00
	TOTAL	230060.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	8740.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	17440.00
5.	PVC LINER	140.00
	TOTAL	38810.00

TOTAL YEARLY COSTS:

1. YEARL OPERATING COST	38810.00
2. YEARLY INVESTMENT COST RECOVERY	9200.00
3. DEPRECIATION	11250.00
TOTAL	59260.00

DRAFT

TABLE 381

ITEMIZED COST SUMMARY FOR ALTERNATIVE C7-IV
(COOKIE AND CRACKER MANUFACTURING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
J...AIR FLOTATION
B...PUMPING STATION
Y...HOLDING TANK
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	211680.00
2. LAND	5000.00
3. ENGINEERING	21170.00
4. CONTINGENCY	21170.00
5. PVC LINER	3770.00
TOTAL	262790.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	14150.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	18160.00
5. PVC LINER	140.00
TOTAL	44940.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	44940.00
2. YEARLY INVESTMENT COST RECOVERY	10510.00
3. DEPRECIATION	12890.00
TOTAL	68340.00

Reduction Benefits: BOD: 98.0 percent
SS: 96 percent
O&G: 94 percent

A cost efficiency curve is presented in Figure 342.

Alternative C 7-V - This alternative replaces the aerated lagoon of Alternative C 7-IV with activated sludge and adds sludge vacuum filtration and sludge thickening. The dual media filter is deleted.

The resulting BOD waste load is 0.1 kg/kkg (0.2 lb/ton), the suspended solids load is 0.15 kg/kkg (0.30 lb/ton), and the oil and grease load is 0.085 kg/kkg (0.17 lb/ton).

Costs: Total investment cost: $281,170
Total yearly cost: $101,490

An itemized breakdown of costs is presented in Table 382. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 95 percent
SS: 90 percent
O&G: 90 percent

Alternative C 7-VI - This alternative adds dual media filtration to Alternative V.

The resulting BOD waste load is 0.04 kg/kkg (0.08 lb/ton), the suspended solids load is 0.06 kg/kkg (0.12 lb/ton), and the oil and grease load is 0.05 kg/kkg (0.10 lb/ton).

Costs: Total investment cost: $313,890
Total yearly cost: $110,570

An itemized breakdown of costs is presented in Table 383. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.0 percent
SS: 96 percent
O&G: 94 percent

A cost efficiency curve is presented in Figure 343.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory D 1 - Candy and Confectionery

A model plant representative of Subcategory D 1 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, six alternatives were selected as being

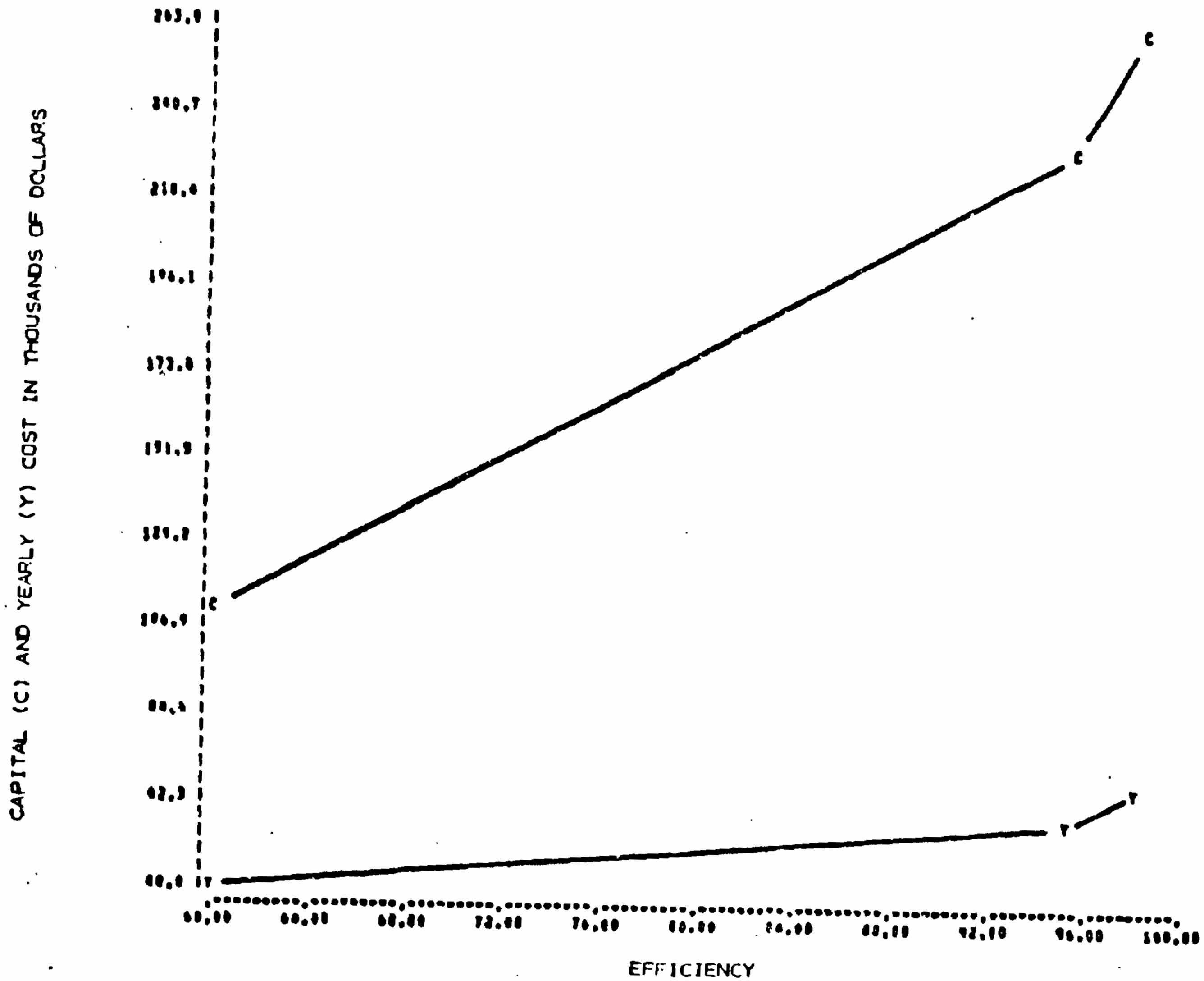


FIGURE 342

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C7, ALT. IV

DRAFT

DRAFT

TABLE 382

ITEMIZED COST SUMMARY FOR ALTERNATIVE C7-V
(COOKIE AND CRACKER MANUFACTURING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
C...EQUALIZATION BASIN
J...AIR FLOTATION
D...PUMPING STATION
Y...HOLDING TANK
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
S...VACUUM FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	230650.00
	2. LAND	4160.00
	3. ENGINEERING	23080.00
	4. CONTINGENCY	23080.00
	TOTAL	281170.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	13170.00
	3. CHEMICALS	2440.00
	4. MAINTENANCE&SUPPLIES	48290.00
	TOTAL	76390.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	76390.00
	2. YEARLY INVESTMENT COST RECOVERY	11250.00
	3. DEPRECIATION	13850.00
	TOTAL	101490.00

DRAFT

TABLE 383

ITEMIZED COST SUMMARY FOR ALTERNATIVE C7-VI
(COOKIE AND CRACKER MANUFACTURING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
J...AIR FLOTATION
B...PUMPING STATION
Y...HOLDING TANK
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
S...VACUUM FILTRATION
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	258110.00
2. LAND	4160.00
3. ENGINEERING	25810.00
4. CONTINGENCY	25810.00
TOTAL	313890.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	18590.00
3. CHEMICALS	2440.00
4. MAINTENANCE&SUPPLIES	49000.00
TOTAL	82520.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	82520.00
2. YEARLY INVESTMENT COST RECOVERY	12560.00
3. DEPRECIATION	15490.00
TOTAL	110570.00

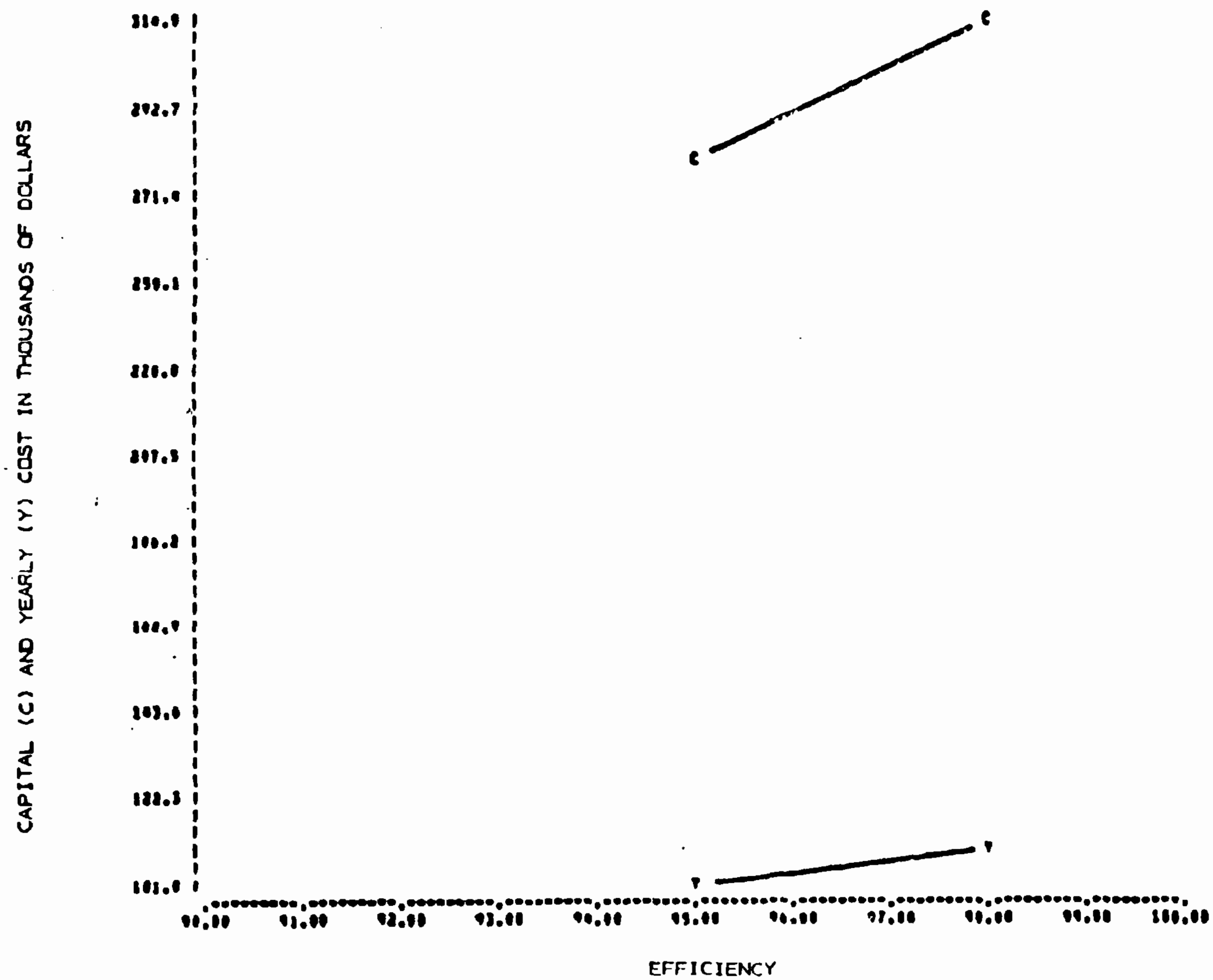


FIGURE 343

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C7, ALT. VI applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 97 kkg (107 ton) of finished product per day.

Alternative D 1-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 97 kkg (107 ton) per day plant is 375 cu m (0.099 MG) per day. The BOD waste load is 6.94 kg/kkg (13.9 lb/ton), and the suspended solids load is 0.65 kg/kkg (1.31 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative D 1-II - This alternative provides a pumping station, flow equalization, nitrogen addition, and an aerated lagoon.

The resulting BOD waste load is 0.35 kg/kkg (0.70 lb/ton), and the suspended solids load is 0.12 kg/kkg (0.24 lb/ton).

Costs: Total investment cost: $242,450
Total yearly cost: $ 70,230

An itemized breakdown of costs is presented in Table 384. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 95 percent
SS: 82 percent

Alternative D 1-III - This alternative replaces the aerobic lagoon of Alternative D 1-II with activated sludge and provides sludge thickening, aerobic digestion, and truck hauling of sludge.

The resulting BOD waste load is 0.21 kg/kkg (0.42 lb/ton), and the suspended solids load is 0.078 kg/kkg (0.15 lb/ton).

Costs: Total investment cost: $299,400
Total yearly cost: $105,840

An itemized breakdown of costs is presented in Table 385. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97 percent
SS: 88 percent

Alternative D 1-IV - This alternative adds sand drying beds to Alternative D 1-III.

The resulting BOD waste load is 0.21 kg/kkg (0.42 lb/ton), and the suspended solids load is 0.078 kg/kkg (0.15 lb/ton).

TABLE 384

ITEMIZED COST SUMMARY FOR ALTERNATIVE D1-II
(CANDY AND CONFECTIONERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	194380.00
	2. LAND	4000.00
	3. ENGINEERING	19440.00
	4. CONTINGENCY	19440.00
	5. PVC LINER	5200.00
	TOTAL	242460.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	3060.00
	3. CHEMICALS	7920.00
	4. MAINTENANCE&SUPPLIES	31110.00
	5. PVC LINER	270.00
	TOTAL	48610.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	48610.00
	2. YEARLY INVESTMENT COST RECOVERY	9700.00
	3. DEPRECIATION	11920.00
	TOTAL	70230.00

DRAFT

TABLE 385

ITEMIZED COST SUMMARY FOR ALTERNATIVE D1-III
(CANDY AND CONFECTIONERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR

INVESTMENT COSTS:		
	1. CONSTRUCTION	224510.00
	2. LAND	29990.00
	3. ENGINEERING	22450.00
	4. CONTINGENCY	22450.00
	TOTAL	299400.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	14740.00
	3. CHEMICALS	7920.00
	4. MAINTENANCE&SUPPLIES	20250.00
	TOTAL	80390.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	80390.00
	2. YEARLY INVESTMENT COST RECOVERY	11980.00
	3. DEPRECIATION	13470.00
	TOTAL	105840.00

Costs: Total investment cost: $425,670
Total yearly cost: $116,120

An itemized breakdown of costs is presented in Table 386. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97 percent
SS: 88 percent

Alternative D 1-V - This alternative adds dual media filtration to Alternative D 1-IV.

The resulting BOD waste load is 0.10 kg/kkg (0.20 lb/ton), and the suspended solids load is 0.039 kg/kkg (0.078 lb/ton).

Costs: Total investment cost: $459,300
Total yearly cost: $125,540

An itemized breakdown of costs is presented in Table 387. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98.5 percent
SS: 94 percent

A cost efficiency curve is presented in Figure 344.

Alternative D 1-VI- This alternative adds dual media filtration to Alternative D 1-II.

The resulting BOD waste load is 0.14 kg/kkg (0.28 lb/ton), and the suspended solids load is 0.039 kg/kkg (0.078 lb/ton).

Costs: Total investment cost: $276,080
Total yearly cost: $ 79,650

An itemized breakdown of costs is presented in Table 388. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 98 percent
SS: 94 percent

A cost efficiency curve is presented in Figure 345.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory D 2 - Chewing Gum

A model plant representative of Subcategory D 2 was developed in Section V for the purpose of applying control and treatment alternatives.

DRAFT

TABLE 386

ITEMIZED COST SUMMARY FOR ALTERNATIVE D1-IV (CANDY AND CONFECTIONERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- S...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS

INVESTMENT COSTS:		
	1. CONSTRUCTION	335290.00
	2. LAND	23320.00
	3. ENGINEERING	33530.00
	4. CONTINGENCY	33530.00
	TOTAL	425670.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	14740.00
	3. CHEMICALS	7920.00
	4. MAINTENANCE&SUPPLIES	18830.00
	TOTAL	78970.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	78970.00
	2. YEARLY INVESTMENT COST RECOVERY	17030.00
	3. DEPRECIATION	20120.00
	TOTAL	116120.00

DRAFT

TABLE 387

ITEMIZED COST SUMMARY FOR ALTERNATIVE D1-V
(CANDY AND CONFECTIONERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTER
T...SAND DRYING BEDS
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	363320.00
2. LAND	23320.00
3. ENGINEERING	36330.00
4. CONTINGENCY	36330.00
TOTAL	459300.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	20600.00
3. CHEMICALS	7920.00
4. MAINTENANCE&SUPPLIES	19370.00
TOTAL	85370.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	85370.00
2. YEARLY INVESTMENT COST RECOVERY	18370.00
3. DEPRECIATION	21800.00
TOTAL	125540.00

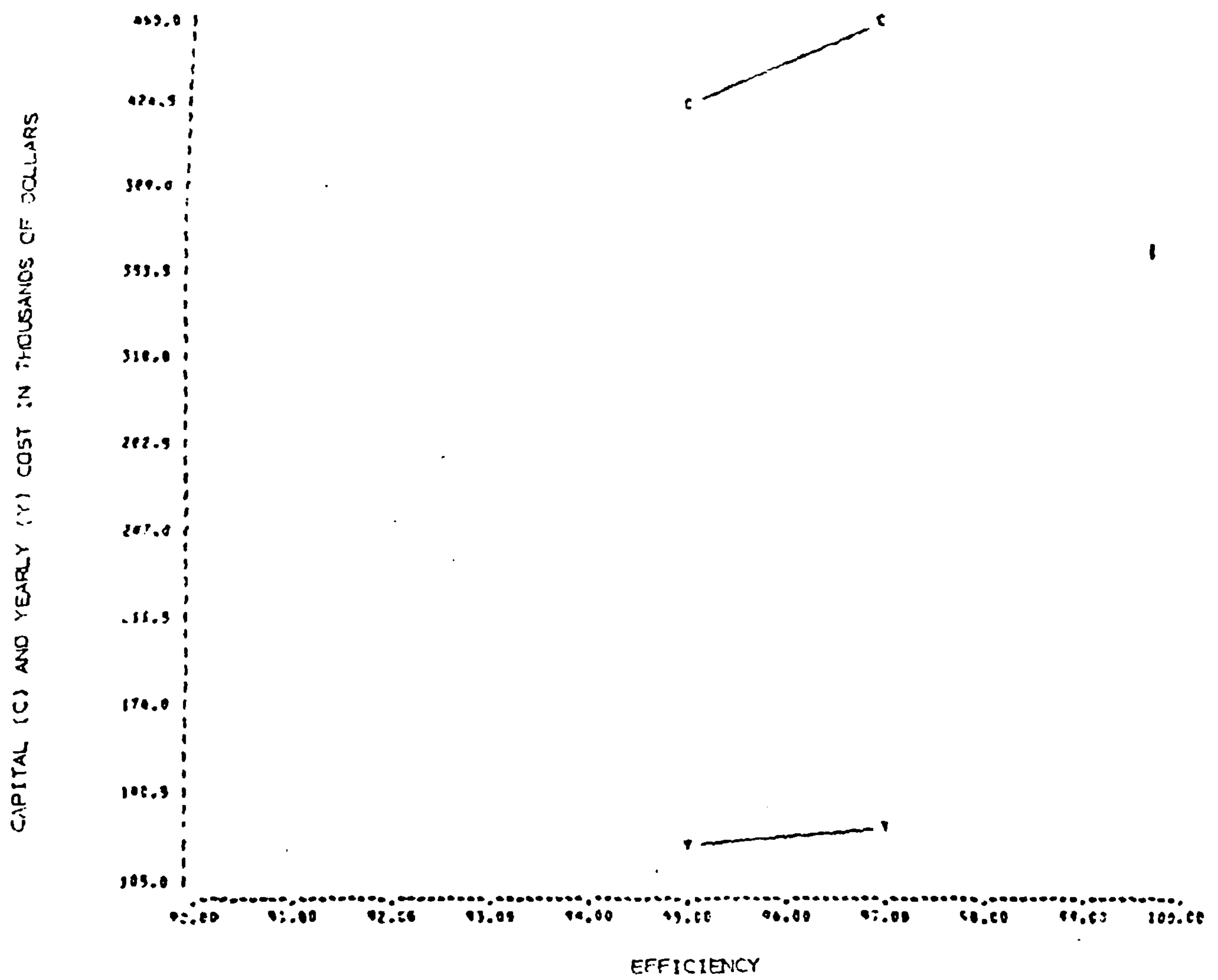

CAPITAL (C) AND YEARLY (Y) COST IN THOUSANDS OF DOLLARS
EFFICIENCY

FIGURE 344

DRAFT

TABLE 38C

ITEMIZED COST SUMMARY FOR ALTERNATIVE D1-VI
(CANDY AND CONFECTIONERY)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON
B...PUMPING STATION
K...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	222400.00
	2. LAND	4000.00
	3. ENGINEERING	22240.00
	4. CONTINGENCY	22240.00
	5. PVC LINER	5200.00
	TOTAL	276080.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	8920.00
	3. CHEMICALS	7920.00
	4. MAINTENANCE&SUPPLIES	31650.00
	5. PVC LINER	270.00
	TOTAL	55010.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	55010.00
	2. YEARLY INVESTMENT COST RECOVERY	11040.00
	3. DEPRECIATION	13600.00
	TOTAL	79650.00

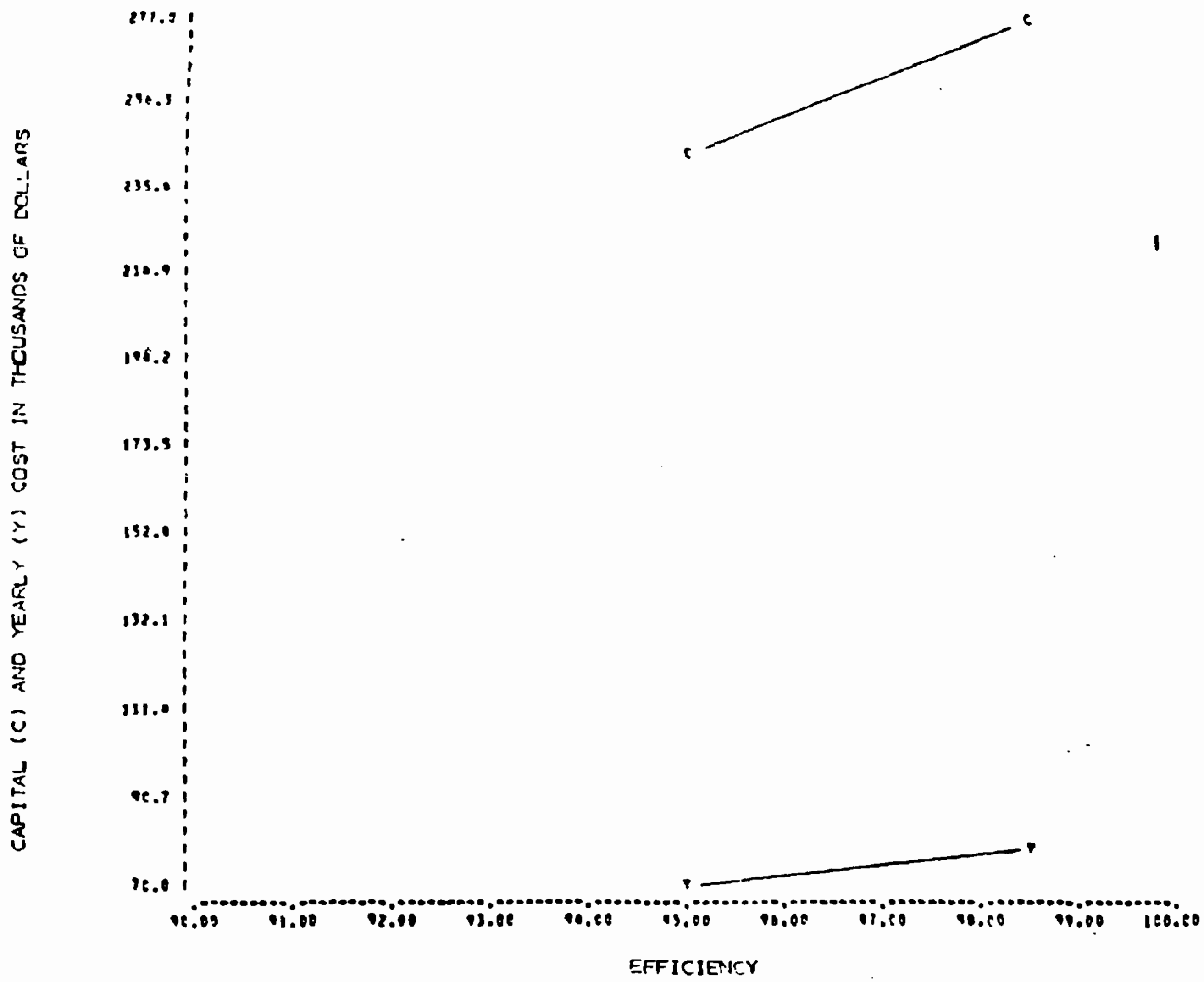


FIGURE 345

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D1, ALT. VI

In Section VII, seven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 70.9 kkg (78.2 ton) of chewing gum per day.

Alternative D 2-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 70.9 kkg (78.2 ton) per day plant is 322 cu m (0.085 MG) per day. The BOD waste load is 3.17 kg/kkg (6.34 lb/ton), and the suspended solids load is 0.43 kg/kkg (0.86 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative D 2-II - This alternative proivdes a pumping station, flow equalization, nitrogen addition, and an aerated lagoon.

The resulting BOD waste load is 0.16 kg/kkg (0.32 lb/ton), and the suspended solids load is 0.14 kg/kkg (0.28 lb/ton).

Costs: Total investment cost: $345,260
Total yearly cost: $ 99,860

An itemized breakdown of costs is presented in Table 389. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 95 percent
SS: 68 percent

Alternative D 2-III - This alternative replaces the aerated lagoon of Alternative D 2-II with activated sludge and provides sludge thickening and aerobic digestion.

The resulting BOD waste load is 0.095 kg/kkg (0.19 lb/ton), and the suspended solids load is 0.09 kg/kkg (0.18 lb/ton).

Costs: Total investment cost: $246,210
Total yearly cost: $ 86,780

An itemized breakdown of costs is presented in Table 390. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97 percent
SS: 79 percent

Alternative D 2-IV - This alternative adds sand drying beds to Alternative D 2-III.

DRAFT

TABLE 389

ITEMIZED COST SUMMARY FOR ALTERNATIVE D2-II
(CHEWING GUM)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

E...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	271290.00
2.	LAND	6330.00
3.	ENGINEERING	27130.00
4.	CONTINGENCY	27130.00
5.	PVC LINER	13380.00
TOTAL		345260.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	49830.00
3.	CHEMICALS	4690.00
4.	MAINTENANCE&SUPPLIES	6270.00
5.	PVC LINER	2060.00
TOTAL		69100.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	69100.00
2.	YEARLY INVESTMENT COST RECOVERY	13810.00
3.	DEPRECIATION	16950.00
TOTAL		99860.00

DRAFT

TABLE 390

ITEMIZED COST SUMMARY FOR ALTERNATIVE D2-III (CHEWING GUM)

ITEMIZED COST SUMMARY FOR WAS[illegible] TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 REDUC[illegible] [illegible]ION

TREATMENT MODULES:

- D... [illegible]
- B... [illegible]
- C... [illegible] [illegible]ASIN
- H... [illegible] ADDITION
- K... [illegible] SLUDGE
- C... [illegible] THICKENER
- [illegible] [illegible]CR

INVESTMENT COSTS:

1.	CO[illegible]	[illegible]
2.	LA[illegible]	[illegible]
3.	ENGI[illegible]	[illegible]
4.	CONTINGENCY	[illegible]
	TOTAL	2[illegible]210.0[illegible]

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	10480.00
3.	CHEMICALS	4690.00
4.	MAINTENANCE&SUPPLIES	13430.00
	TOTAL	66080.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	66080.00
2.	YEARLY INVESTMENT COST RECOVERY	9850.00
3.	DEPRECIATION	10850.00
	TOTAL	86780.00

The resulting BOD waste load is 0.093 kg/kkg (0.19 lb/ton), and the suspended solids load is 0.09 kg/kkg (0.18 lb/ton).

Costs: Total investment cost: $319,750
Total yearly cost: $101,670

An itemized breakdown of costs is presented in Table 391. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97 percent
SS: 79 percent

Alternative D 2-V - This alternative adds dual media filtration to Alternative D 2-IV.

The resulting BOD waste load is 0.063 kg/kkg (0.12 lb/ton), and the suspended solids load is 0.056 kg/kkg (0.11 lb/ton).

Costs: Total investment cost: $352,020
Total yearly cost: $102,230

An itemized breakdown of costs is presented in Table 392. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98 percent
SS: 89 percent

A cost efficiency curve is presented in Figure 346.

Alternative D 2-VI - This alternative adds a pumping station, a pipeline, and a spray irrigation field to Alternative D 2-III. This alternative provides for no discharge of polluted wastewater.

Costs: Total investment cost: $465,530
Total yearly cost: $113,250

An itemized breakdown of costs is presented in Table 393. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

A cost efficiency curve is presented in Figure 347.

Alternative D 2-VII - This alternative adds a pumping station, a pipeline, and a spray irrigation field to Alternative D 2-III. This alternative provides for no discharge of polluted wastewater.

DRAFT

TABLE 391

ITEMIZED COST SUMMARY FOR ALTERNATIVE D2-IV
(CHEWING GUM)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTER
T...SAND DRYING BEDS

INVESTMENT COSTS:

1.	CONSTRUCTION	250850.00
2.	LAND	18740.00
3.	ENGINEERING	25080.00
4.	CONTINGENCY	25080.00
TOTAL		319750.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	10480.00
3.	CHEMICALS	4690.00
4.	MAINTENANCE&SUPPLIES	21180.00
TOTAL		73830.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	73830.00
2.	YEARLY INVESTMENT COST RECOVERY	12790.00
3.	DEPRECIATION	15050.00
TOTAL		101670.00

DRAFT

TABLE 392

ITEMIZED COST SUMMARY FOR ALTERNATIVE D2-V
(CHEWING GUM)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1...CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	277740.00
2.	LAND	18740.00
3.	ENGINEERING	27770.00
4.	CONTINGENCY	27770.00
TOTAL		352020.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	15670.00
3.	CHEMICALS	4690.00
4.	MAINTENANCE&SUPPLIES	13650.00
TOTAL		71490.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	71490.00
2.	YEARLY INVESTMENT COST RECOVERY	14080.00
3.	DEPRECIATION	16660.00
TOTAL		102230.00

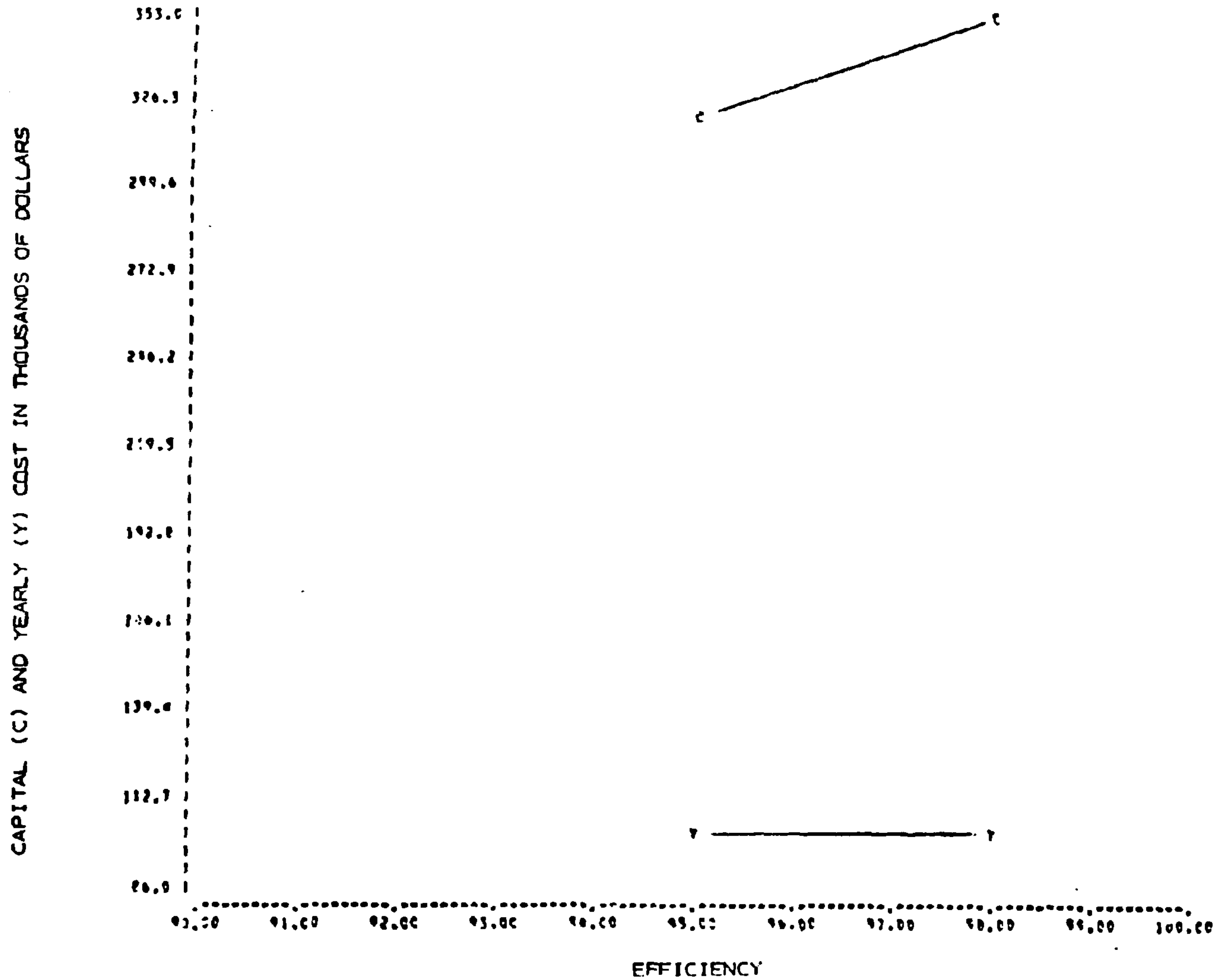


FIGURE 346

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D2, ALT. V

TABLE 393

ITEMIZED COST SUMMARY FOR ALTERNATIVE D2-VI
(CHEWING GUM)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON
L...SPRAY IRRIGATION

INVESTMENT COSTS:

1.	CONSTRUCTION	350420.00
2.	LAND	34650.00
3.	ENGINEERING	35040.00
4.	CONTINGENCY	35040.00
5.	PVC LINER	13380.00
	TOTAL	468530.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	51290.00
3.	CHEMICALS	4690.00
4.	MAINTENANCE&SUPPLIES	8530.00
5.	PVC LINER	2060.00
	TOTAL	72820.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	72820.00
2.	YEARLY INVESTMENT COST RECOVERY	18740.00
3.	DEPRECIATION	21690.00
	TOTAL	113250.00

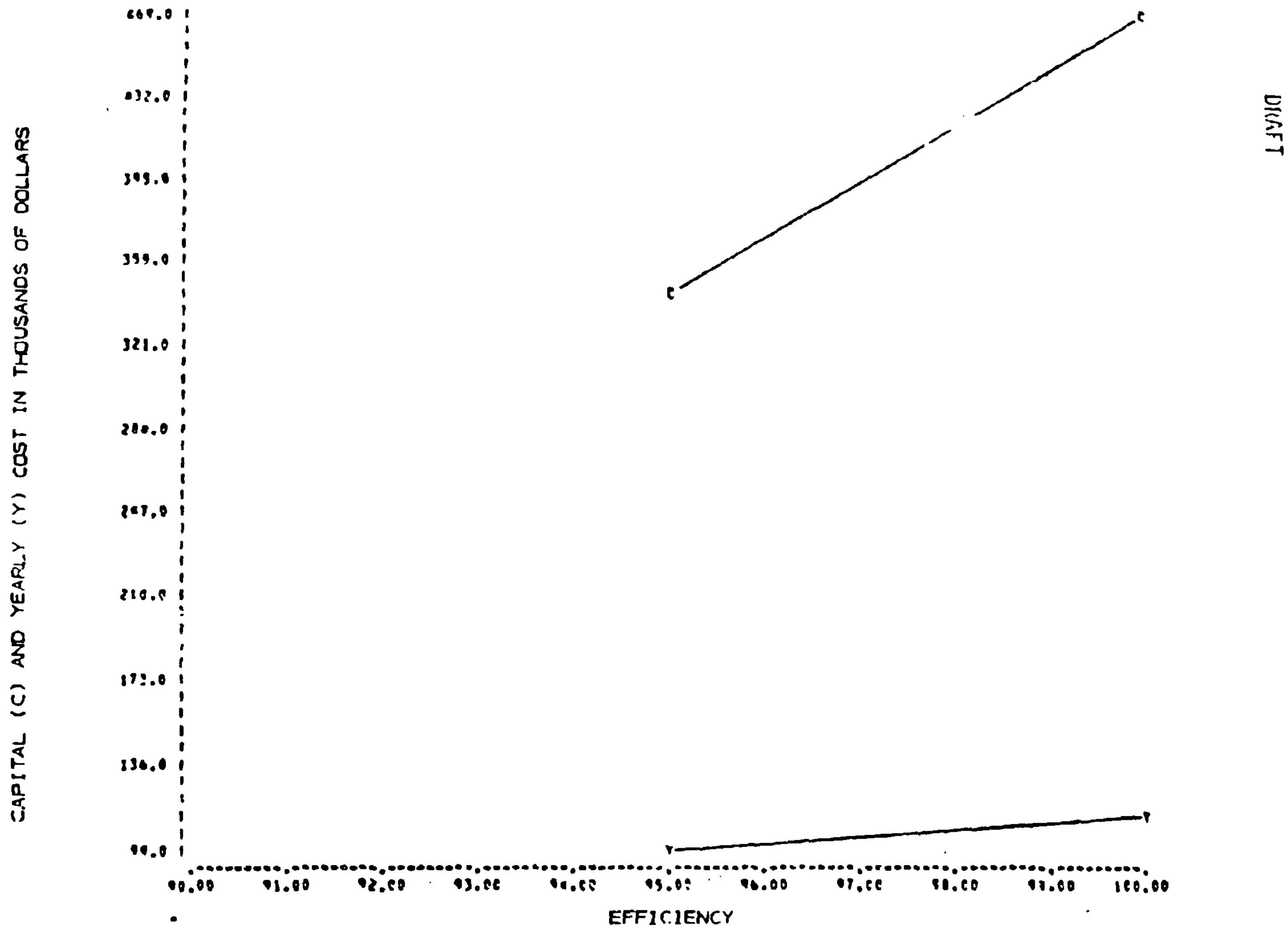


FIGURE 347

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D2, ALT. VI

Costs: Total investment cost: $346,650
Total yearly cost: $ 89,970

An itemized breakdown of costs is presented in Table 394. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

A cost efficiency curve is presented in Figure 348.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory D 3 - Gum Base

A model plant representative of Subcategory D 3 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, six alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 105 kkg (116 ton) of gum base per day.

Alternative D 3-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 105 kkg per day plant is 356 cu m (0.094 MG) per day. The BOD waste load is 1.45 kg/kkg (2.91 lb/ton), and the suspended solids load is 0.39 kg/kkg (0.78 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative D 3-II - This alternative provides a pumping station, flow equalization, nitrogen addition, and an aerated lagoon.

The resulting BOD waste load is 0.10 kg/kkg (0.20 lb/ton), and the suspended solids load is 0.03 kg/kkg (0.06 lb/ton).

Costs: Total investment cost: $242,420
Total yearly cost: $ 74,610

An itemized breakdown of costs is presented in Table 395. It is assumed that land costs $4100 per hectare ($1660 per acre). It is fuother assumed that one operator is required one-half time.

Reduction Benefits: BOD: 93 percent
SS: 92 percent

Alternative D 3-III - This alternative replaces the aerobic lagoon of Alternative D 3-II with activated sludge and provides sludge thickening and aerobic digestion.

DRAFT

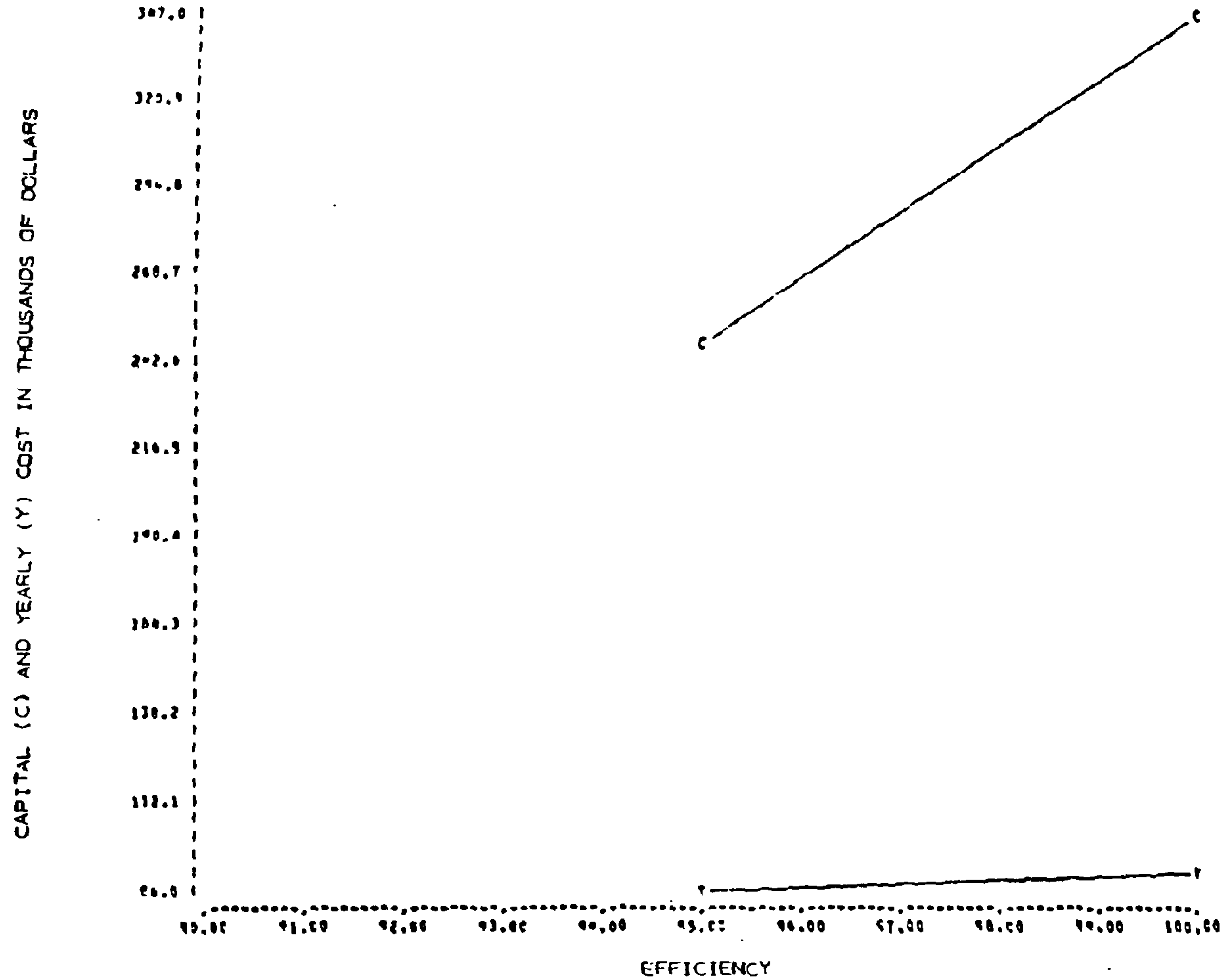
TABLE 394

ITEMIZED COST SUMMARY FOR ALTERNATIVE D2-VII
(CHEWING GUM)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTER
L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	260000.00
	2. LAND	34650.00
	3. ENGINEERING	26000.00
	4. CONTINGENCY	26000.00
	TOTAL	346650.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	11940.00
	3. CHEMICALS	4690.00
	4. MAINTENANCE&SUPPLIES	6390.00
	TOTAL	60500.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	60500.00
	2. YEARLY INVESTMENT COST RECOVERY	13870.00
	3. DEPRECIATION	15600.00
	TOTAL	89970.00



DRAFT

FIGURE 348

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D2, ALT. VII

DRAFT

TABLE 395

ITEMIZED COST SUMMARY FOR ALTERNATIVE D3-II
(GUM BASE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 93.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	195450.00
	2. LAND	3500.00
	3. ENGINEERING	19540.00
	4. CONTINGENCY	19540.00
	5. PVC LINER	4390.00
	TOTAL	242420.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	39300.00
	3. CHEMICALS	2430.00
	4. MAINTENANCE&SUPPLIES	4730.00
	5. PVC LINER	250.00
	TOTAL	52960.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	52960.00
	2. YEARLY INVESTMENT COST RECOVERY	9700.00
	3. DEPRECIATION	11950.00
	TOTAL	74610.00

The resulting BOD waste load is 0.087 kg/kkg (0.17 lb/ton), and the suspended solids load is 0.027 kg/kkg (0.054 lb/ton).

Costs: Total investment cost: $218,870
Total yearly cost: $ 75,770

An itemized breakdown of costs is presented in Table 396. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 94 percent
SS: 93 percent

Alternative D 3-IV - This alternative adds sand drying beds to Alternative D 3-III.

The resulting BOD waste load is 0.087 kg/kkg (0.17 lb/ton), and the suspended solids load is 0.027 kg/kkg (0.054 lb/ton).

Costs: Total investment cost: $248,350
Total yearly cost: $ 82,920

An itemized breakdown of costs is presented in Table 397. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 94 percent
SS: 93 percent

Alternative D 3-V - This alternative adds dual media filtration to Alternative D 3-IV.

The resulting BOD waste load is 0.029 kg/kkg (0.058 lb/ton), and the suspended solids load is 0.012 kg/kkg (0.024 lb/ton).

Costs: Total investment cost: $281,420
Total yearly cost: $ 92,150

An itemized breakdown of costs is presented in Table 398. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98 percent
SS: 97 percent

A cost efficiency curve is presented in Figure ?79.

Alternative D 3-VI - This alternative adds spray irrigation onto Alternative D 3-II and results in no discharge of polluted wastewaters.

DRAFT

TABLE 396

ITEMIZED COST SUMMARY FOR ALTERNATIVE D3-III (GUM BASE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 93.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- R...AEROBIC DIGESTOR

INVESTMENT COSTS:		
	1. CONSTRUCTION	157400.00
	2. LAND	29990.00
	3. ENGINEERING	15740.00
	4. CONTINGENCY	15740.00
	TOTAL	218870.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	8720.00
	3. CHEMICALS	2430.00
	4. MAINTENANCE&SUPPLIES	8950.00
	TOTAL	57580.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	57580.00
	2. YEARLY INVESTMENT COST RECOVERY	8750.00
	3. DEPRECIATION	9440.00
	TOTAL	75770.00

DRAFT

TABLE 397

ITEMIZED COST SUMMARY FOR ALTERNATIVE D3-IV
(GUM BASE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 93.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
P...AEROBIC DIGESTER
T...SAND DRYING BEDS

INVESTMENT COSTS:

1. CONSTRUCTION	192380.00
2. LAND	17490.00
3. ENGINEERING	19240.00
4. CONTINGENCY	19240.00
TOTAL	248350.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	8720.00
3. CHEMICALS	2430.00
4. MAINTENANCE&SUPPLIES	12820.00
TOTAL	61450.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	61450.00
2. YEARLY INVESTMENT COST RECOVERY	9930.00
3. DEPRECIATION	11540.00
TOTAL	82920.00

TABLE 398

ITEMIZED COST SUMMARY FOR ALTERNATIVE D3-V
(GUM BASE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	219950.00
2. LAND	17490.00
3. ENGINEERING	21990.00
4. CONTINGENCY	21990.00
TOTAL	281420.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	14310.00
3. CHEMICALS	2430.00
4. MAINTENANCE&SUPPLIES	13470.00
TOTAL	67690.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	67690.00
2. YEARLY INVESTMENT COST RECOVERY	11260.00
3. DEPRECIATION	13200.00
TOTAL	92150.00

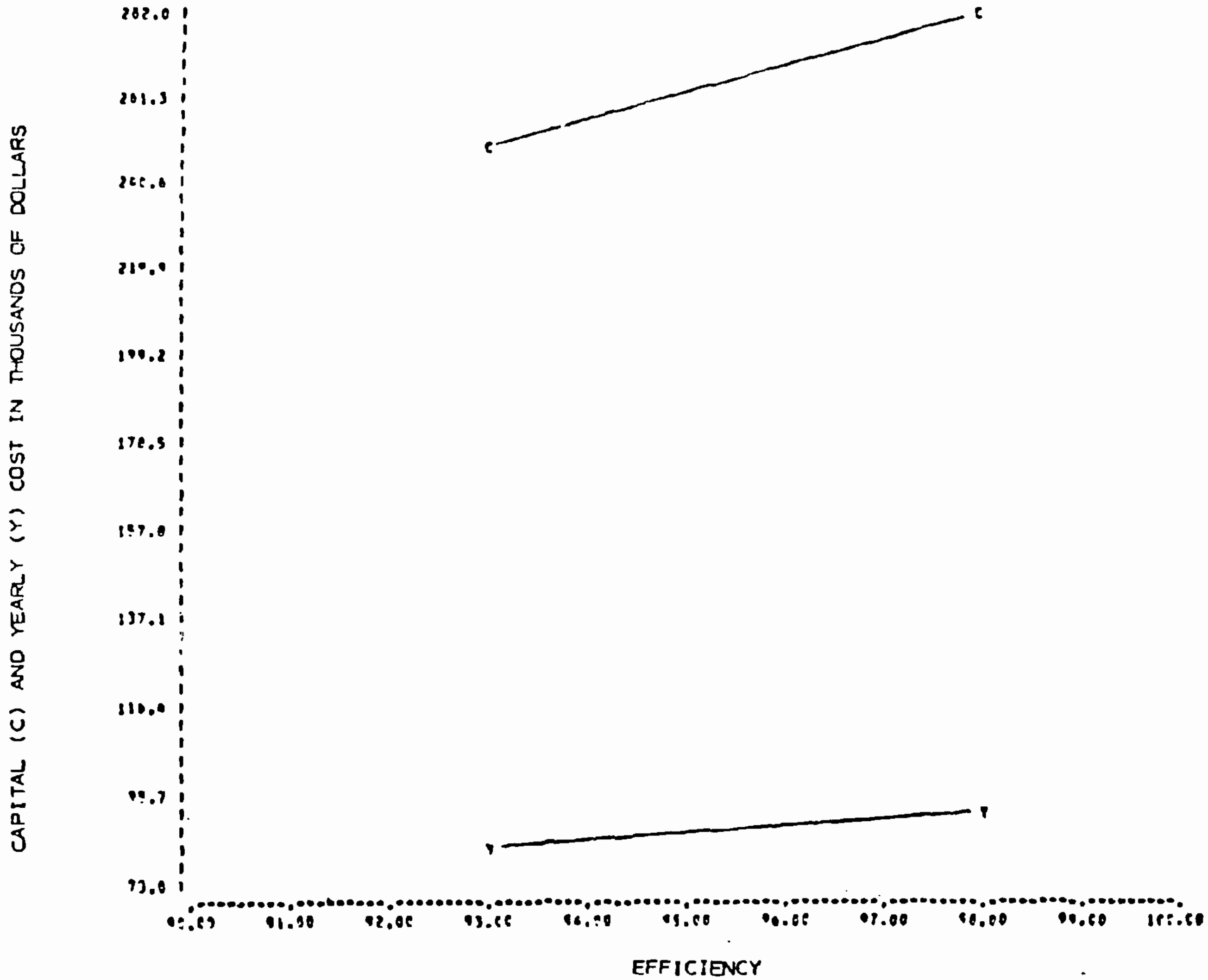


FIGURE 349

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D3, ALT. V

Costs: Total investment cost: $377,260
Total yearly cost: $ 89,140

An itemized breakdown of costs is presented in Table 399. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

A cost efficiency curve is presented in Figure 350.

Alternative D 3-VII - This alternative adds spray irrigation onto Alternative D 3-III and provides no discharge of polluted wastewater.

Costs: Total investment cost: $226,720
Total yearly cost: $ 89,230

An itemized breakdown of costs is presented in Table 400. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

A cost efficiency curve is presented in Figure 351.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory D 5 - Chocolate with Condensory Processing

A model plant representative of Subcategory D 5 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 330 kkg (360 ton) of chocolate per day.

Alternative D 5-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 330 kkg per day plant is 761 cu m (0.201 MG) per day. The BOD waste load is 7.48 kg/kkg (14.9 lb/ton), the suspended solids load is 1.68 kg/kkg (3.35 lb/ton), and the oil and grease load is 0.69 kg/kkg (1.38 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative D 5-II - This alternative provides a pumping station, flow equalization, and air flotation.

DRAFT

TABLE 399

ITEMIZED COST SUMMARY FOR ALTERNATIVE D3-VI
(GUM BASE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- L...SPRAY IRRIGATION

INVESTMENT COSTS:

1.	CONSTRUCTION	281440.00
2.	LAND	35150.00
3.	ENGINEERING	28140.00
4.	CONTINGENCY	28140.00
5.	PVC LINER	4390.00
TOTAL		377260.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	40860.00
3.	CHEMICALS	2430.00
4.	MAINTENANCE&SUPPLIES	7150.00
5.	PVC LINER	250.00
TOTAL		56940.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	56940.00
2.	YEARLY INVESTMENT COST RECOVERY	15090.00
3.	DEPRECIATION	17110.00
TOTAL		89140.00

DRAFT

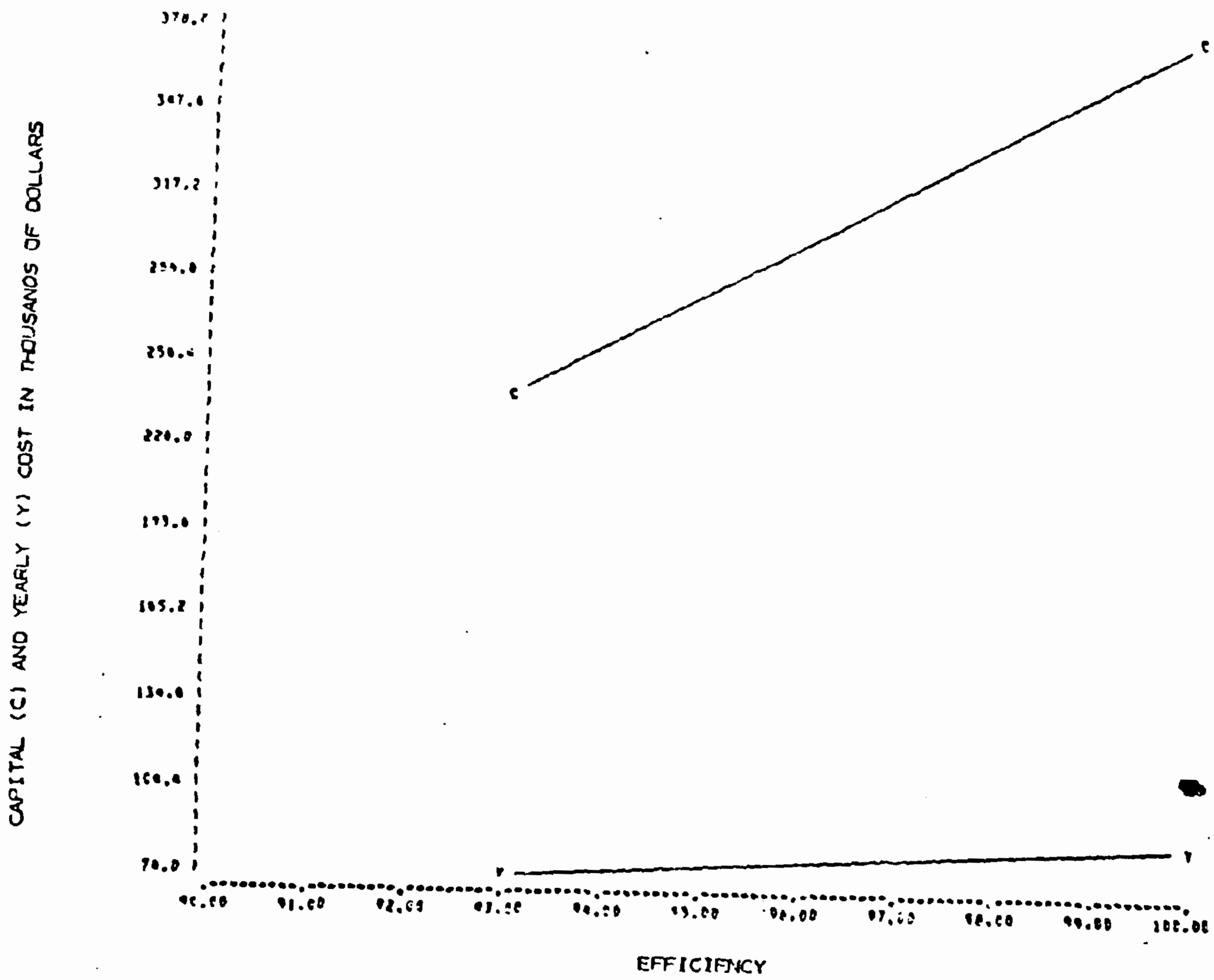


FIGURE 350

DRAFT

TABLE 400

ITEMIZED COST SUMMARY FOR ALTERNATIVE D3-VII
(GUM BASE)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTER
- L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	243390.00
	2. LAND	34650.00
	3. ENGINEERING	24340.00
	4. CONTINGENCY	24340.00
	TOTAL	326720.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	10280.00
	3. CHEMICALS	2430.00
	4. MAINTENANCE&SUPPLIES	11370.00
	TOTAL	61560.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	61560.00
	2. YEARLY INVESTMENT COST RECOVERY	13070.00
	3. DEPRECIATION	14600.00
	TOTAL	89230.00

1271

DRAFT

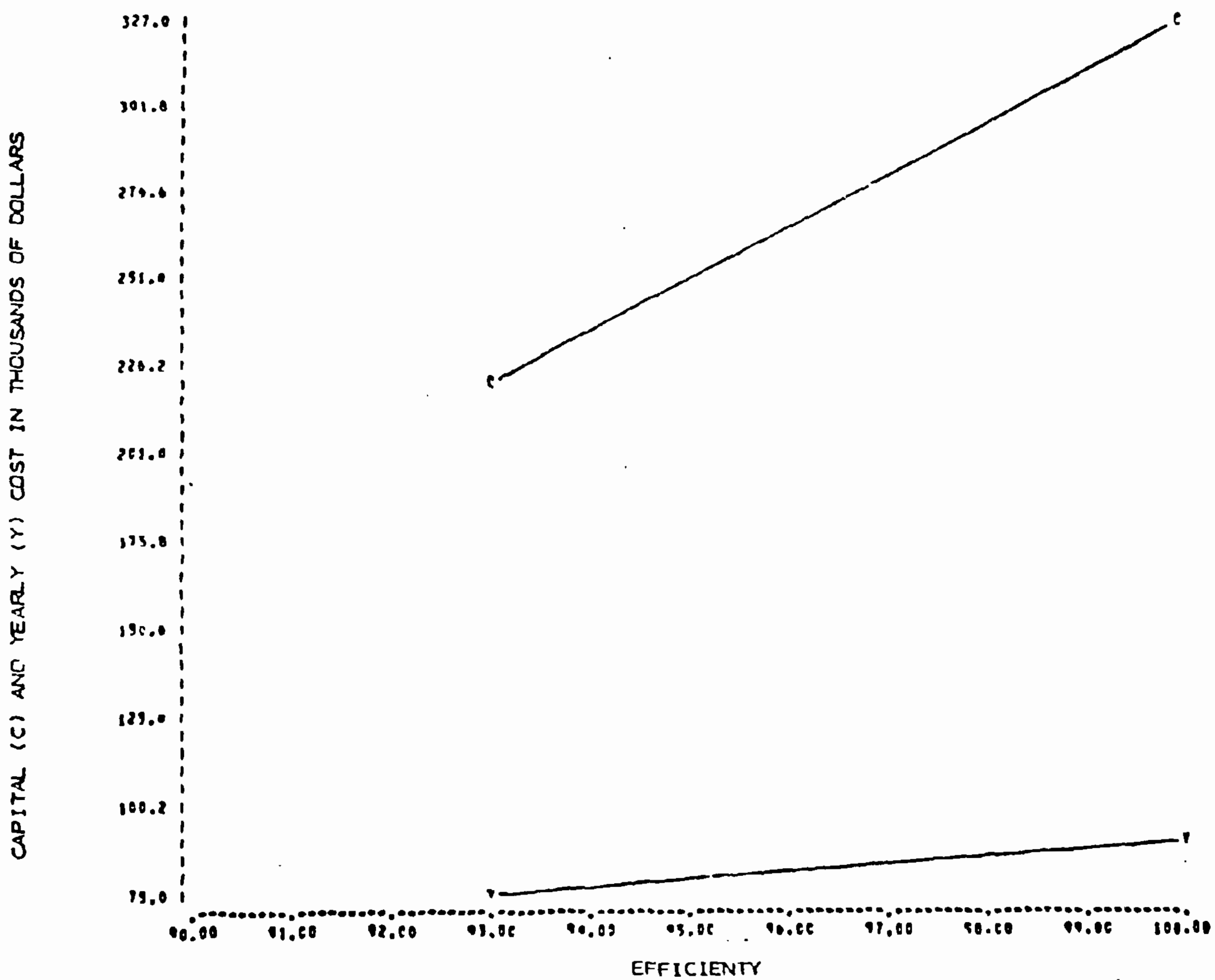


FIGURE 351

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D3, ALT. VII

The resulting BOD waste load is 5.24 kg/kkg (10.5 lb/ton), the suspended solids load is 1.18 kg/kkg (2.36 lb/ton), and the oil and grease load is 0.28 kg/kkg (0.56 lb/ton).

Costs: Total investment cost: $170,350
Total yearly cost: $ 37,860

An itemized breakdown of costs is presented in Table 401. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 30 percent
SS: 30 percent
O&G: 60 percent

Alternative D 5-III - This alternative provides a pumping station, flow equalization, and an aerated lagoon.

The resulting BOD waste load is 0.37 kg/kkg (0.74 lb/ton), the suspended solids load is 0.25 kg/kkg (0.50 lb/ton), and the oil and grease load is 0.07 kg/kkg (0.14 lb/ton).

Costs: Total investment cost: $484,700
Total yearly cost: $199,330

An itemized breakdown of costs is presented in Table 402. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 95 percent
SS: 85 percent
O&G: 90 percent

Alternative D 5-IV - This alternative replaces the aerated lagoon of Alternative D 5-III with activated sludge and provides sludge thickening and aerobic digestion.

The resulting BOD waste load is 0.22 kg/kkg (0.44 lb/ton), the suspended solids load is 0.17 kg/kkg (0.34 lb/ton), and the oil and grease load is 0.069 kg/kkg (0.14 lb/ton).

Costs: Total investment cost: $565,180
Total yearly cost: $196,740

An itemized breakdown of costs is presented in Table 403. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97 percent
SS: 90 percent
O&G: 90 percent

DRAFT

TABLE 401

ITEMIZED COST SUMMARY FOR ALTERNATIVE D5-II
(CHOCOLATE WITH CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 30.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	114190.00
	2. LAND	33320.00
	3. ENGINEERING	11420.00
	4. CONTINGENCY	11420.00
	TOTAL	170350.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	4720.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	6990.00
	TOTAL	24200.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	24200.00
	2. YEARLY INVESTMENT COST RECOVERY	6810.00
	3. DEPRECIATION	6850.00
	TOTAL	37860.00

DRAFT

TABLE 402

ITEMIZED COST SUMMARY FOR ALTERNATIVE D5-III
(CHOCOLATE WITH CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	389750.00
	2. LAND	5660.00
	3. ENGINEERING	38970.00
	4. CONTINGENCY	38970.00
	5. PVC LINER	11350.00
	TOTAL	484700.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	115750.00
	3. CHEMICALS	22730.00
	4. MAINTENANCE&SUPPLIES	10750.00
	5. PVC LINER	510.00
	TOTAL	155990.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	155990.00
	2. YEARLY INVESTMENT COST RECOVERY	19390.00
	3. DEPRECIATION	23950.00
	TOTAL	199330.00

DRAFT

TABLE 403

ITEMIZED COST SUMMARY FOR ALTERNATIVE D5-IV
(CHOCOLATE WITH CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR

INVESTMENT COSTS:

1.	CONSTRUCTION	443220.00
2.	LAND	33320.00
3.	ENGINEERING	44320.00
4.	CONTINGENCY	44320.00
TOTAL		565120.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	34450.00
3.	CHEMICALS	22730.00
4.	MAINTENANCE&SUPPLIES	52880.00
TOTAL		147540.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	147540.00
2.	YEARLY INVESTMENT COST RECOVERY	22610.00
3.	DEPRECIATION	26590.00
TOTAL		196740.00

Alternative D 5-V - This alternative adds sand drying beds to Alternative D 5-IV.

The resulting BOD waste load is 0.22 kg/kkg (0.44 lb/ton), the suspended solids load is 0.17 kg/kkg (0.34 lb/ton), and the oil and grease load is 0.069 kg/kkg (0.14 lb/ton).

Costs:	Total investment cost:	$954,170
	Total yearly cost:	$227,630

An itemized breakdown of costs is presented in Table 404. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits:	BOD:	97 percent
	SS:	90 percent
	O&G:	90 percent

Alternative D 5-VI - This alternative adds air flotation to Alternative D 5-IV.

The resulting BOD waste load is 0.15 kg/kkg (0.30 lb/ton), the suspended solids load is 0.12 kg/kkg (0.24 lb/ton), and the oil and grease load is 0.028 kg/kkg (0.056 lb/ton).

Costs:	Total investment cost:	$623,250
	Total yearly cost:	$208,200

An itemized breakdown of costs is presented in Table 405. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits:	BOD:	98 percent
	SS:	93 percent
	O&G:	96 percent

Alternative D 5-VII - This alternative adds dual media filtration to Alternative D 5-VI.

The resulting BOD waste load is 0.025 kg/kkg (0.15 lb/ton), the suspended solids load is 0.034 kg/kkg (0.068 lb/ton), and the oil and grease load is 0.0069 kg/kkg (0.014 lb/ton).

Costs:	Total investment cost:	$651,200
	Total yearly cost:	$215,360

An itemized breakdown of costs is presented in Table 406. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

DRAFT

TABLE 404

ITEMIZED COST SUMMARY FOR ALTERNATIVE DE-V
(CHOCOLATE WITH CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS

INVESTMENT COSTS:

1. CONSTRUCTION	763910.00
2. LAND	37480.00
3. ENGINEERING	76390.00
4. CONTINGENCY	76390.00
TOTAL	954170.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	34450.00
3. CHEMICALS	22730.00
4. MAINTENANCE&SUPPLIES	48970.00
TOTAL	143630.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	143630.00
2. YEARLY INVESTMENT COST RECOVERY	38170.00
3. DEPRECIATION	45830.00
TOTAL	227630.00

DRAFT

TABLE 405

ITEMIZED COST SUMMARY FOR ALTERNATIVE D5-VI (CHOCOLATE WITH CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- J...AIR FLOTATION

INVESTMENT COSTS:

1. CONSTRUCTION	491610.00
2. LAND	33320.00
3. ENGINEERING	49160.00
4. CONTINGENCY	49160.00
TOTAL	623250.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	34500.00
3. CHEMICALS	22730.00
4. MAINTENANCE&SUPPLIES	59060.00
TOTAL	153770.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	153770.00
2. YEARLY INVESTMENT COST RECOVERY	24930.00
3. DEPRECIATION	29500.00
TOTAL	208200.00

DRAFT

TABLE 406

ITEMIZED COST SUMMARY FOR ALTERNATIVE D5-VII (CHOCOLATE WITH CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1...CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
F...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
H...AEROBIC DIGESTION
J...AIR FLOTATION
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	514900.00
2. LAND	33320.00
3. ENGINEERING	51490.00
4. CONTINGENCY	51490.00
TOTAL	651200.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	38790.00
3. CHEMICALS	22730.00
4. MAINTENANCE&SUPPLIES	59420.00
TOTAL	158420.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	158420.00
2. YEARLY INVESTMENT COST RECOVERY	26050.00
3. DEPRECIATION	30890.00
TOTAL	215360.00

Reduction Benefits: BOD: 99 percent
SS: 98 percent
O&G: 99 percent

A cost efficiency curve is presented in Figure 352.

<u>Alternative D 5-VIII</u> - This alternative adds air flotation to Alternative D 5-III.

The resulting BOD waste load is 0.22 kg/kkg (0.44 lb/ton), the suspended solids load is 0.17 kg/kkg (0.34 lb/ton), and the oil and grease load is 0.028 kg/kkg (0.055 lb/ton).

Costs: Total investment cost: $542,770
Total yearly cost: $217,040

An itemized breakdown of costs is presented in Table 407. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97 percent
SS: 90 percent
O&G: 96 percent

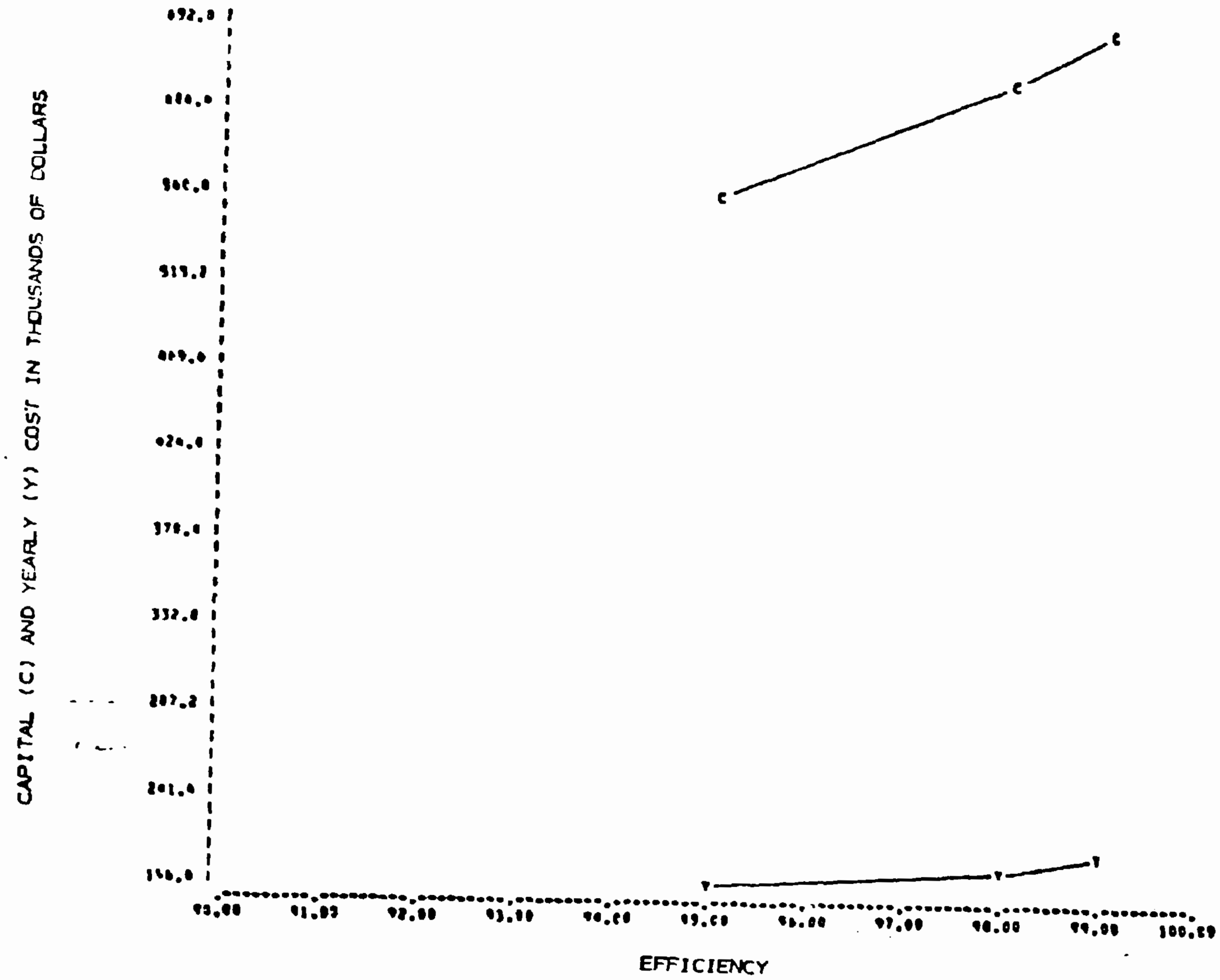
<u>Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory D 6 - Chocolate Without Condensory Processing</u>

A model plant representative of Subcategory D 6 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eight alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 220 kkg (240 ton) of chocolate per day.

<u>Alternative D 6-I</u> - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 220 kkg per day plant is 920 cu m (0.243 MG) per day. The BOD waste load is 4.63 kg/kkg (9.24 lb/ton), the suspended solids load is 1.50 kg/kkg (3.01 lb/ton), and the oil and grease load is 1.06 kg/kkg (2.12 lb/ton).

Costs: 0
Reduction Benefits: None

<u>Alternative D 6-II</u> - This alternative provides a pumping station, flow equalization, and air flotation.



DRAFT

FIGURE 352

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D5, ALT. VII

DRAFT

TABLE 407

ITEMIZED COST SUMMARY FOR ALTERNATIVE D5-VIII (CHOCOLATE WITH CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- L...AERATED LAGOON
- J...AIR FLOTATION

INVESTMENT COSTS:

1. CONSTRUCTION	438140.00
2. LAND	5660.00
3. ENGINEERING	43810.00
4. CONTINGENCY	43810.00
5. PVC LINER	11350.00
TOTAL	542770.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	115810.00
3. CHEMICALS	22730.00
4. MAINTENANCE&SUPPLIES	16930.00
5. PVC LINER	510.00
TOTAL	168470.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	168470.00
2. YEARLY INVESTMENT COST RECOVERY	21710.00
3. DEPRECIATION	26860.00
TOTAL	217040.00

The resulting BOD waste load is 3.24 kg/kkg (6.48 lb/ton), the suspended solids load is 1.05 kg/kkg (2.1 lb/ton), and the oil and grease load is 0.42 kg/kkg (0.84 lb/ton).

Costs: Total investment cost: $185,710
Total yearly cost: $ 40,170

An itemized breakdown of costs is presented in Table 408. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 30 percent
SS: 30 percent
O&G: 60 percent

Alternative D 6-III - This alternative provides a pumping station, flow equalization, and an aerated lagoon.

The resulting BOD waste load is 0.23 kg/kkg (0.46 lb/ton), the suspended solids load is 0.32 kg/kkg (0.44 lb/ton), and the oil and grease load is 1.06 kg/kkg (2.1 lb/ton).

Costs: Total investment cost: $546,650
Total yearly cost: $219,260

An itemized breakdown of costs is presented in Table 409. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 95 percent
SS: 85 percent
O&G: 90 percent

Alternative D 6-IV - This alternative replaces the aerated lagoon of Alternative D 6-III with activated sludge and provides sludge thickening and aerobic digestion.

The resulting BOD waste load is 0.18 kg/kkg (0.36 lb/ton), the suspended solids load is 0.20 kg/kkg (0.40 lb/ton), and the oil and grease load is 0.106 kg/kkg (0.21 lb/ton).

Costs: Total investment cost: $406,730
Total yearly cost: $129,920

An itemized breakdown of costs is presented in Table 410. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 96 percent
SS: 87 percent
O&G: 90 percent

DRAFT

TABLE 408

ITEMIZED COST SUMMARY FOR ALTERNATIVE D6-II
(CHOCOLATE WITHOUT CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 30.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	126990.00
	2. LAND	33320.00
	3. ENGINEERING	12700.00
	4. CONTINGENCY	12700.00
	TOTAL	185710.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	5420.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	7210.00
	TOTAL	25120.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	25120.00
	2. YEARLY INVESTMENT COST RECOVERY	7430.00
	3. DEPRECIATION	7620.00
	TOTAL	40170.00

DRAFT

TABLE 409

ITEMIZED COST SUMMARY FOR ALTERNATIVE D6-III
(CHOCOLATE WITHOUT CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	439020.00
	2. LAND	6160.00
	3. ENGINEERING	43900.00
	4. CONTINGENCY	43900.00
	5. PVC LINER	13670.00
	TOTAL	546650.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	140780.00
	3. CHEMICALS	10530.00
	4. MAINTENANCE&SUPPLIES	12200.00
	5. PVC LINER	610.00
	TOTAL	170370.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	170370.00
	2. YEARLY INVESTMENT COST RECOVERY	21870.00
	3. DEPRECIATION	27020.00
	TOTAL	219260.00

DRAFT

TABLE 410

ITEMIZED COST SUMMARY FOR ALTERNATIVE D6-IV
(CHOCOLATE WITHOUT CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
F...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTER

INVESTMENT COSTS:

1. CONSTRUCTION	311170.00
2. LAND	33320.00
3. ENGINEERING	31120.00
4. CONTINGENCY	31120.00
TOTAL	406730.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	21290.00
3. CHEMICALS	10530.00
4. MAINTENANCE&SUPPLIES	25680.00
TOTAL	94980.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	94980.00
2. YEARLY INVESTMENT COST RECOVERY	16270.00
3. DEPRECIATION	18670.00
TOTAL	129920.00

Alternative D 6-V - This alternative adds sand drying beds to Alternative D 6-IV.

The resulting BOD waste load is 0.18 kg/kkg (0.36 lb/ton), the suspended solids load is 0.20 kg/kkg (0.40 lb/ton), and the oil and grease load is 0.106 kg/kkg (0.21 lb/ton).

Costs: Total investment cost: $581,990
Total yearly cost: $144,720

An itemized breakdown of costs is presented in Table 411. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 96 percent
SS: 87 percent
O&G: 90 percent

Alternative D 6-VI - This alternative adds air flotation to Alternative D 6-IV.

The resulting BOD waste load is 0.18 kg/kkg (0.36 lb/ton), the suspended solids load is 0.14 kg/kkg (0.28 lb/ton), and the oil and grease load is 0.032 kg/kkg (0.064 lb/ton).

Costs: Total investment cost: $643,830
Total yearly cost: $156,710

An itemized breakdown of costs is presented in Table 412. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 96 percent
SS: 91 percent
O&G: 97 percent

Alternative D 6-VII - This alternative adds dual media filtration to Alternative D 6-VI.

The resulting BOD waste load is 0.046 kg/kkg (0.092 lb/ton), the suspended soldis load is 0.06 kg/kkg (0.12 lb/ton), and the oil and grease load is 0.010 kg/kkg (0.02 lb/ton).

Costs: Total investment cost: $686,580
Total yearly cost: $168,720

An itemized breakdown of costs is presented in Table 413. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

DRAFT

TABLE 411

ITEMIZED COST SUMMARY FOR ALTERNATIVE D6-V
(CHOCOLATE WITHOUT CONDENSORY PROCESSING)

```
ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
                        PI..CONTROL HOUSE
                        A...PUMPING STATION
                        C...EQUALIZATION BASIN
                        H...NITROGEN ADDITION
                        K...ACTIVATED SLUDGE
                        Q...SLUDGE THICKENER
                        R...AEROBIC DIGESTOR
                        T...SAND DRYING BEDS

INVESTMENT COSTS:
                  1.  CONSTRUCTION              462770.00
                  2.  LAND                       26660.00
                  3.  ENGINEERING                46280.00
                  4.  CONTINGENCY                46280.00
                  TOTAL                         581990.00

YEARLY OPERATING COSTS:
                  1.  LABOR                      37480.00
                  2.  POWER                      21290.00
                  3.  CHEMICALS                  10530.00
                  4.  MAINTENANCE&SUPPLIES       24370.00
                  TOTAL                          93670.00

TOTAL YEARLY COSTS:
                  1. YEARLY OPERATING COST       93670.00
                  2. YEARLY INVESTMENT
                     COST RECOVERY               23280.00
                  3. DEPRECIATION                27770.00
                  TOTAL                         144720.00
```

DRAFT

TABLE 412

ITEMIZED COST SUMMARY FOR ALTERNATIVE D6-VI (CHOCOLATE WITHOUT CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS
- J...AIR FLOTATION

INVESTMENT COSTS:	
1. CONSTRUCTION	514310.00
2. LAND	26660.00
3. ENGINEERING	51430.00
4. CONTINGENCY	51430.00
TOTAL	643830.00
YEARLY OPERATING COSTS:	
1. LABOR	37480.00
2. POWER	21360.00
3. CHEMICALS	10530.00
4. MAINTENANCE&SUPPLIES	30730.00
TOTAL	100100.00
TOTAL YEARLY COSTS:	
1. YEARLY OPERATING COST	100100.00
2. YEARLY INVESTMENT COST RECOVERY	25750.00
3. DEPRECIATION	30860.00
TOTAL	156710.00

DRAFT

TABLE 413

ITEMIZED COST SUMMARY FOR ALTERNATIVE D6-VII
(CHOCOLATE WITHOUT CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS
J...AIR FLOTATION
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	549940.00
2. LAND	26660.00
3. ENGINEERING	54990.00
4. CONTINGENCY	54990.00
TOTAL	686580.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	28850.00
3. CHEMICALS	10530.00
4. MAINTENANCE&SUPPLIES	31400.00
TOTAL	108260.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	108260.00
2. YEARLY INVESTMENT COST RECOVERY	27460.00
3. DEPRECIATION	33000.00
TOTAL	168720.00

Reduction Benefits:	BOD:	99 percent
	SS:	96 percent
	O&G:	99 percent

A cost efficiency curve is presented in Figure 353.

<u>Alternative D 6-VIII</u> - This alternative adds air flotation to Alternative D 6-III.

The resulting BOD waste load is 0.18 kg/kkg (0.36 lb/ton), the suspended solids load is 0.15 kg/kkg (0.30 lb/ton), and the oil and grease load is 0.032 kg/kkg (0.064 lb/ton).

Costs:	Total investment cost:	$608,510
	Total yearly cost:	$231,260

An itemized breakdown of costs is presented in Table 414. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits:	BOD:	96 percent
	SS:	90 percent
	O&G:	97 percent

A cost efficiency curve is presented in Figure 354.

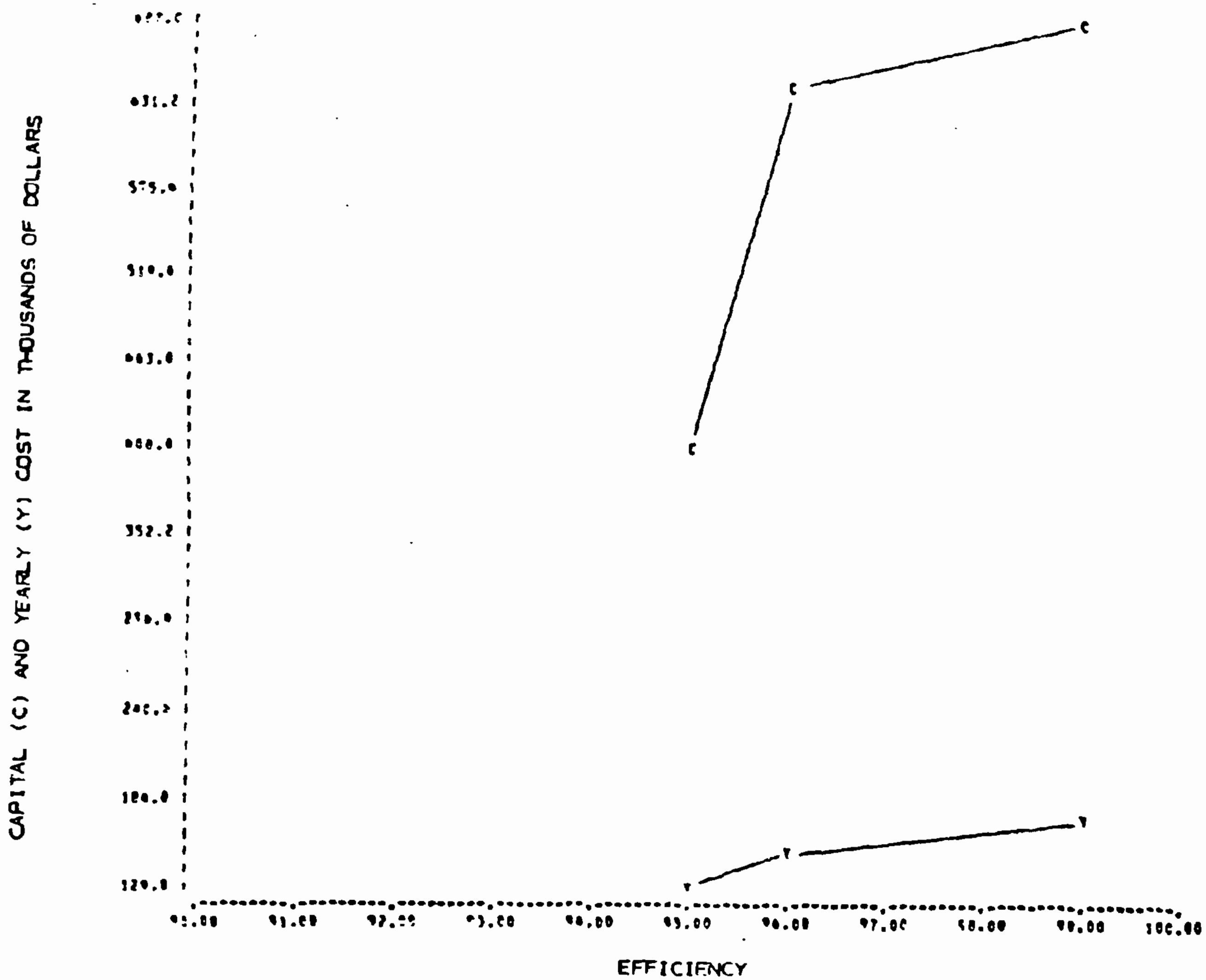


FIGURE 353

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D6, ALT. VII

DRAFT

DRAFT

TABLE 414

ITEMIZED COST SUMMARY FOR ALTERNATIVE D6-VIII
(CHOCOLATE WITHOUT CONDENSORY PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
L...AERATED LAGOON
J...AIR FLOTATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	490560.00
	2. LAND	6160.00
	3. ENGINEERING	49060.00
	4. CONTINGENCY	49060.00
	5. PVC LINER	13670.00
	TOTAL	608510.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	140840.00
	3. CHEMICALS	10530.00
	4. MAINTENANCE&SUPPLIES	18570.00
	5. PVC LINER	610.00
	TOTAL	176800.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	176800.00
	2. YEARLY INVESTMENT COST RECOVERY	24340.00
	3. DEPRECIATION	30120.00
	TOTAL	231260.00

DRAFT

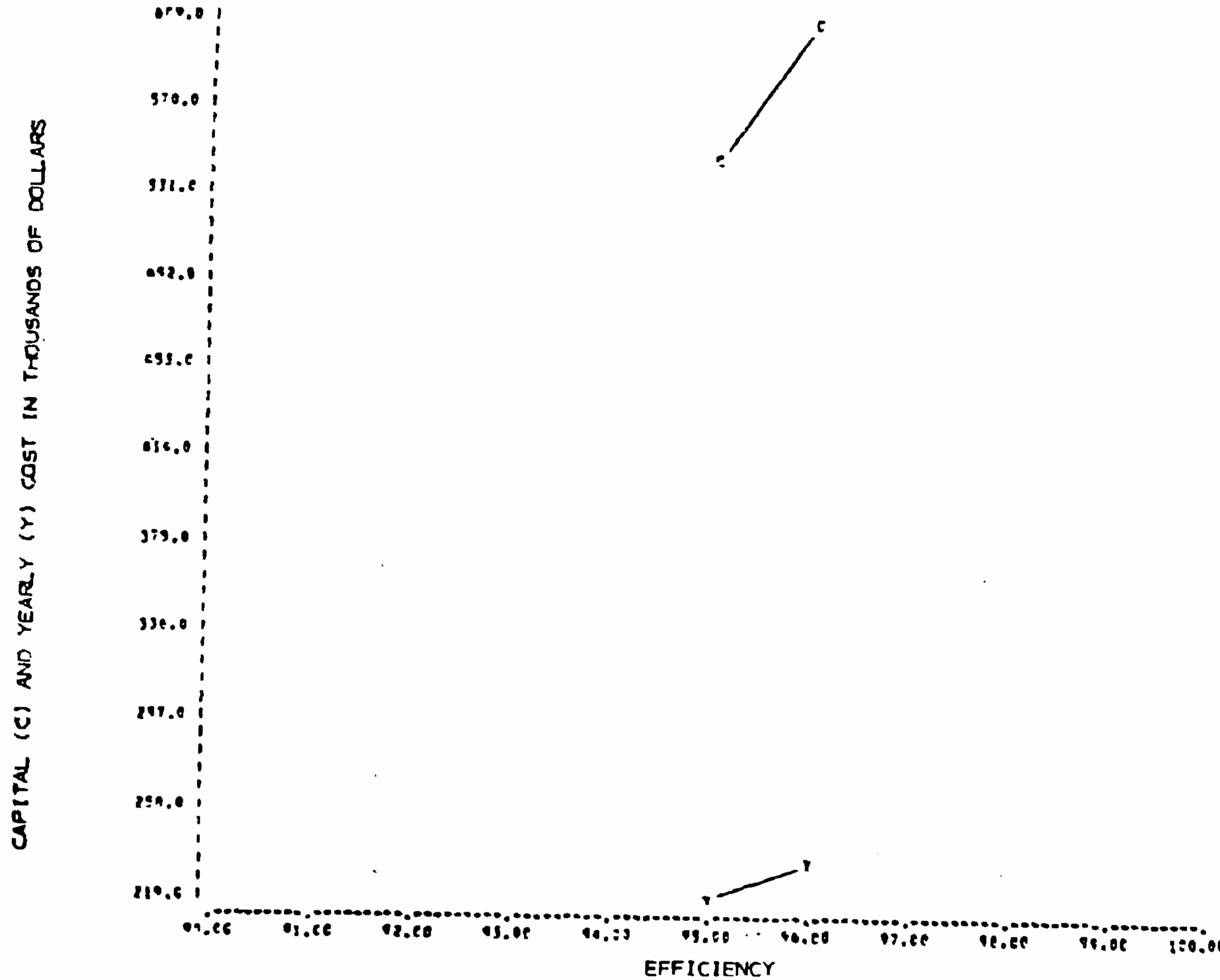


FIGURE 354

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY U6, ALT. VIII

DRAFT

PET FOODS

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 5 - Low Meat Pet Food

A model plant representative of subcategory B 5 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 159 kkg (175 ton) of product per day.

Alternative B 5-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 159 kkg per day plant is 556 cu m (0.147 MG) per day. The BOD waste load is 3.55 kg/kkg (7.11 lb/ton), the suspended solids load is 2.66 kg/kkg (5.33 lb/ton), and the oil and grease load is 1.40 kg/kkg (2.80 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative B 5-II - This alternative provides a pumping station, flow equalization, dissolved air flotation, and vacuum filtration of sludge.

The resulting BOD waste load is 1.1 kg/kkg (2.2 lb/ton), the suspended solids load is 0.53 kg/kkg (1.0 lb/ton), and the oil and grease load is 0.70 kg/kkg (1.4 lb/ton).

Costs: Total investment cost: $229,630
Total yearly cost: $ 59,780

An itemized breakdown of costs is presented in Table 416. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 70.0 percent
SS: 80.0 percent
O&G: 50.0 percent

Alternative B 5-III - This alternative provides in addition to Alternative B 5-II a complete-mix activated sludge system, a sludge thickener for the waste activated sludge, and increased capacity for the vacuum filter.

The resulting BOD waste load is 0.11 kg/kkg (0.22 lb/ton), the suspended solids load is 0.11 kg/kkg (0.22 lb/ton), and the oil and grease load is 0.14 kg/kkg (0.28 lb/ton).

Costs: Total investment cost: $511,100
Total yearly cost: $125,490

DRAFT

TABLE 415

ITEMIZED COST SUMMARY FOR ALTERNATIVE B5-II
(LOW MEAT PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...70.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	187890.00
2.	LAND	4160.00
3.	ENGINEERING	18790.00
4.	CONTINGENCY	18790.00
	TOTAL	229630.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	10860.00
3.	CHEMICALS	4260.00
4.	MAINTENANCE&SUPPLIES	11710.00
	TOTAL	39320.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	39320.00
2.	YEARLY INVESTMENT COST RECOVERY	9190.00
3.	DEPRECIATION	11270.00
	TOTAL	59780.00

An itemized breakdown of costs is presented in Table 416. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 97.0 percent
SS: 96.0 percent
O&G: 90.0 percent

Alternative B 5-IV - This alternative provides dual media filtration in addition to Alternative B 5-III.

The resulting BOD waste load is 0.071 kg/kkg (0.14 lb/ton), the suspended solids load is 0.053 kg/kkg (0.10 lb/ton), and the oil and grease load is 0.07 kg/kkg (0.14 lb/ton).

Costs: Total investment cost: $557,310
Total yearly cost: $138,950

An itemized breakdown of costs is presented in Table 417. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.0 percent
SS: 98.0 percent
O&G: 95.0 percent

A cost efficiency curve is presented in Figure 355.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 6 - Hion Meat Pet Food

A model plant representative of subcategory B 6 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, five alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 270 kkg (300 ton) per day.

Alternative B 6-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 270 kkg per day plant is 1100 cu m (0.3 MG) per day. The BOD waste load is 54 kg/kkg (108 lb/ton), the suspended solids load is 21 kg/kkg (42 lb/ton), and the oil and grease load is 31 kg/kkg (63 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative B 6-II - This alternative provides a pumping station, flow equalization and centrifugation.

DRAFT

TABLE 416

ITEMIZED COST SUMMARY FOR ALTERNATIVE B5-III
(LOW MEAT PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER

INVESTMENT COSTS:		
	1. CONSTRUCTION	412040.00
	2. LAND	16660.00
	3. ENGINEERING	41200.00
	4. CONTINGENCY	41200.00
	TOTAL	511100.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	31210.00
	3. CHEMICALS	7240.00
	4. MAINTENANCE&SUPPLIES	16890.00
	TOTAL	80330.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	80330.00
	2. YEARLY INVESTMENT COST RECOVERY	20440.00
	3. DEPRECIATION	24720.00
	TOTAL	125490.00

TABLE 417

ITEMIZED COST SUMMARY FOR ALTERNATIVE B5-IV
(LOW MEAT PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	450550.00
2. LAND	16660.00
3. ENGINEERING	45050.00
4. CONTINGENCY	45050.00
TOTAL	557310.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	39800.00
3. CHEMICALS	7240.00
4. MAINTENANCE&SUPPLIES	17600.00
TOTAL	89630.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	89630.00
2. YEARLY INVESTMENT COST RECOVERY	22290.00
3. DEPRECIATION	27030.00
TOTAL	138950.00

DRAFT

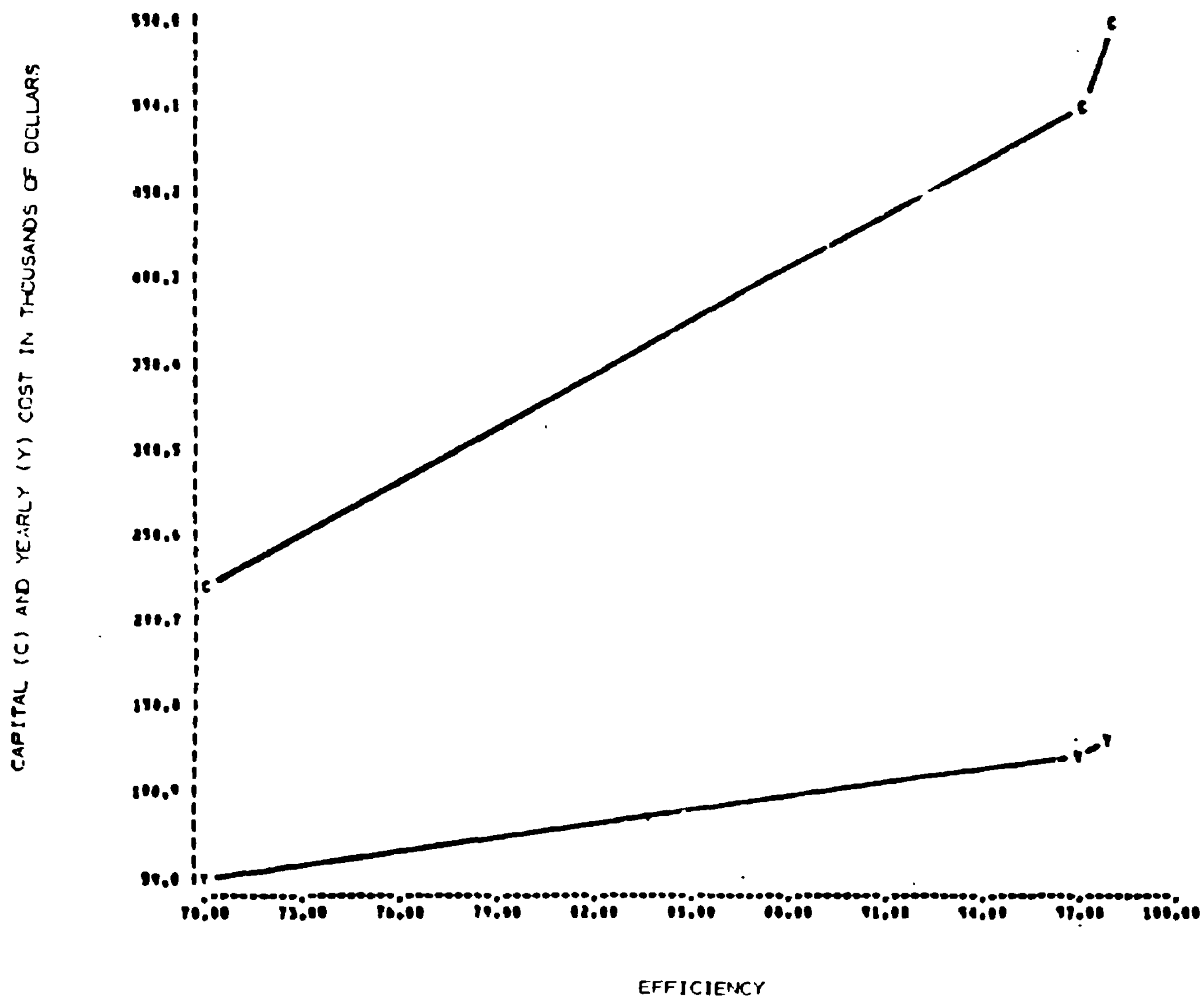


FIGURE 355

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY 65, ALT. IV

The resulting BOD waste load is 27 kg/kkg (54 lb/ton), the suspended solids load is 6.3 kg/kkg (12.6 lb/ton), and the oil and grease load is 12.4 kg/kkg (24.8 lb/ton).

Costs: Total investment cost: $243,880
Total yearly cost: $101,560

An itemized breakdown of costs is presented in Table 418. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 50.0 percent
SS: 70.0 percent
O&G: 60.0 percent

Alternative B 6-III - This alternative adds air flotation and vacuum filtration to the treatment modules of Alternative B 6-II.

The resulting BOD waste load is 8.1 kg/kkg (16.2 lb/ton), the suspended solids load is 1.3 kg/kkg (2.6 lb/ton), and the oil and grease load is 4.3 kg/kkg (8.6 lb/ton).

Costs: Total investment cost: $310,850
Total yearly cost: $132,390

An itemized breakdown of costs is presented in Table 419. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 85.0 percent
SS: 94.0 percent
O&G: 96.0 percent

Alternative B 6-IV - This alternative provides in addition to Alternative B 6-III, a complete-mix activated sludge treatment system sludge thickening for the waste activated sludge, and additional vacuum filter capacity.

The resulting BOD waste load is 0.54 kg/kkg (1.08 lb/ton), the suspended solids load is 0.63 kg/kkg (1.26 lb/ton), and the oil and grease load is 1.24 kg/kkg (2.48 lb/ton).

Costs: Total investment cost: $908,830
Total yearly cost: $397,000

An itemized breakdown of costs is presented in Table 420. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.0 percent
SS: 97.0 percent
O&G: 96.0 percent

DRAFT

TABLE 418

ITEMIZED COST SUMMARY FOR ALTERNATIVE BG-II (HIGH MEAT PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 50.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- C...EQUALIZATION BASIN
- F...PUMPING STATION
- C...CENTRIFUGATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1.	CONSTRUCTION	169920.00
2.	LAND	39980.00
3.	ENGINEERING	16990.00
4.	CONTINGENCY	16990.00
	TOTAL	243880.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	14970.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	41650.00
	TOTAL	81610.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	81610.00
2.	YEARLY INVESTMENT COST RECOVERY	9760.00
3.	DEPRECIATION	10190.00
	TOTAL	101560.00

DRAFT

TABLE 419

ITEMIZED COST SUMMARY FOR ALTERNATIVE B6-III
(HIGH MEAT PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 65.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

HS...CONTROL HOUSE
C...EQUALIZATION BASIN
P...PUMPING STATION
C...CENTRIFUGATION
Y...HOLDING TANK
J...AIR FLOTATION
S...VACUUM FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	225730.00
2.	LAND	39980.00
3.	ENGINEERING	22570.00
4.	CONTINGENCY	22570.00
TOTAL		310650.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	15050.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	66380.00
TOTAL		106420.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	106420.00
2.	YEARLY INVESTMENT COST RECOVERY	12430.00
3.	DEPRECIATION	13540.00
TOTAL		132390.00

DRAFT

TABLE 420

ITEMIZED COST SUMMARY FOR ALTERNATIVE B6-IV (HIGH MEAT PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 90.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
D...PUMPING STATION
O...CENTRIFUGATION
Y...HOLDING TANK
J...AIR FLOTATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER

INVESTMENT COSTS:

1. CONSTRUCTION	724050.00
2. LAND	39980.00
3. ENGINEERING	72400.00
4. CONTINGENCY	72400.00
TOTAL	908830.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	120410.00
3. CHEMICALS	85120.00
4. MAINTENANCE&SUPPLIES	66690.00
TOTAL	317210.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	317210.00
2. YEARLY INVESTMENT COST RECOVERY	36350.00
3. DEPRECIATION	43440.00
TOTAL	397000.00

Alternative B 6-V - This alternative adds dual media filtration to Alternative B 6-IV.

The resulting BOD waste load is 0.54 kg/kkg (1.08 lb/ton), the suspended solids load is 0.21 kg/kkg (0.42 lb/ton) and the oil and grease load is 0.62 kg/kkg (1.24 lb/ton).

Costs: Total investment cost: $956,910
Total yearly cost: $410,850

An itemized breakdown of costs is presented in Table 421. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.0 percent
SS: 99.0 percent
O&G: 98.0 percent

A cost efficiency curve is presented in Figure 356.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 7- Dry Pet Food

A model plant representative of subcategory B 7 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 270 kkg (300 ton) per day.

Alternative B 7-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 270 kkg per day plant is 114 cu m (0.03 MG) per day. The BOD waste load is 0.085 kg/kkg (0.17 lb/ton), the suspended solids load is 0.042 kg/kkg (0.08 lb/ton), and the oil and grease load is 0.11 kg/kkg (0.21 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative B 7-II - This alternative provides a pumping station, flow equalization, and dissolved air flotation.

The resulting BOD waste load is 0.042 kg/kkg (0.085 lb/ton), the suspended solids load is 0.008 kg/kkg (0.016 lb/ton), and the oil and grease load is 0.055 kg/kkg (0.11 lb/ton).

Costs: Total investment cost: $74,120
Total yearly cost: $20,940

DRAFT

TABLE 421

ITEMIZED COST SUMMARY FOR ALTERNATIVE B6-V (HIGH MEAT PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
A...PUMPING STATION
C...CENTRIFUGATION
Y...HOLDING TANK
J...AIR FLOTATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
F...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	764110.00
2. LAND	39980.00
3. ENGINEERING	76410.00
4. CONTINGENCY	76410.00
TOTAL	956910.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	129180.00
3. CHEMICALS	85120.00
4. MAINTENANCE&SUPPLIES	87430.00
TOTAL	326720.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	326720.00
2. YEARLY INVESTMENT COST RECOVERY	38280.00
3. DEPRECIATION	45850.00
TOTAL	410850.00

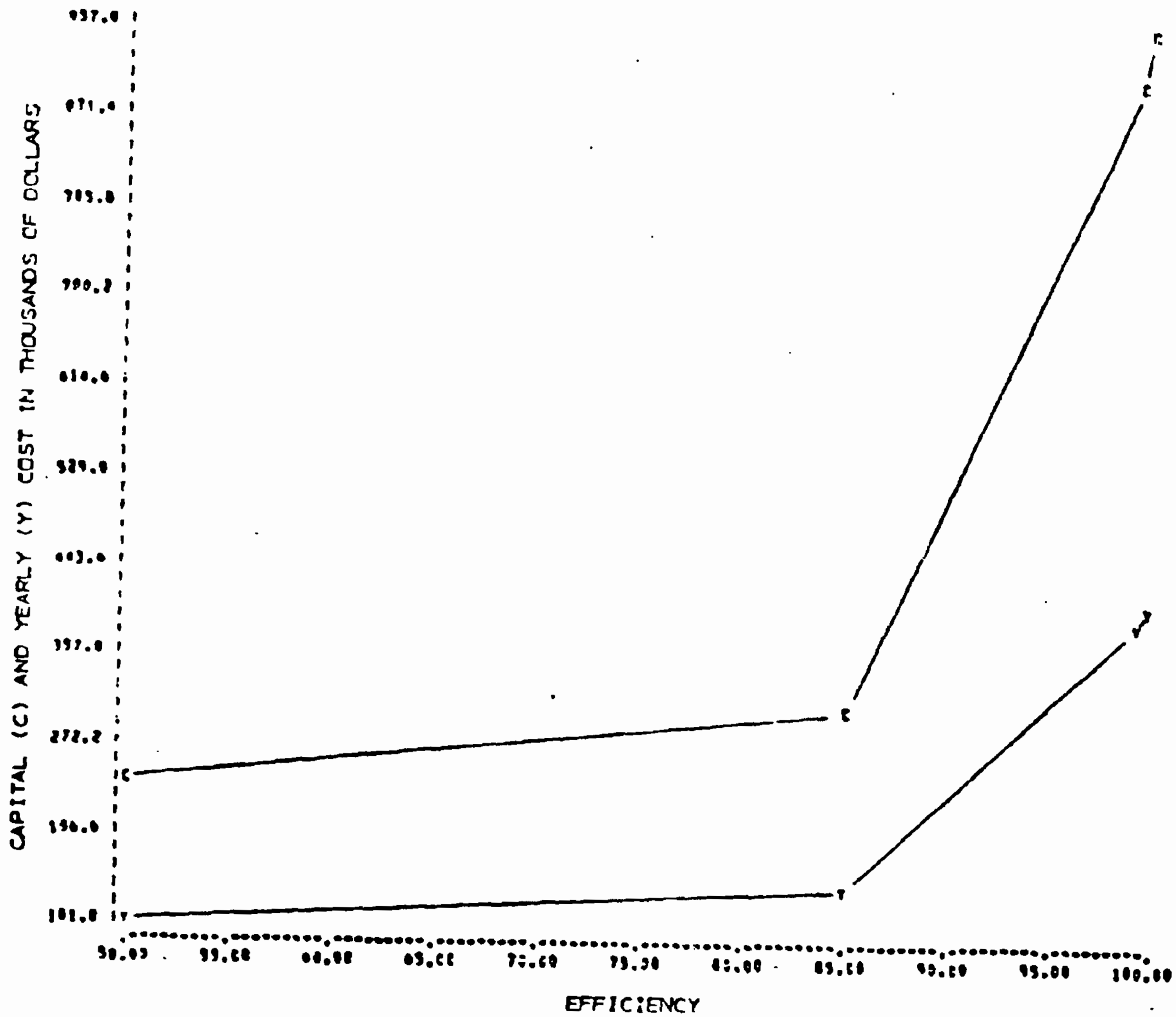


FIGURE 356

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY E5, ALT. V

An itemized breakdown of costs is presented in Table 422. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits: BOD: 50.0 percent
SS: 80.0 percent
O&G: 50.0 percent

Alternative B 7-III - This alternative provides complete mix activated sludge in addition to Alternative B 7-II.

The resulting BOD waste load is 0.0085 kg/kkg (0.017 lb/ton), the suspended solids load is 0.0059 kg/kkg (0.012 lb/ton), and the oil and grease load is 0.016 kg/kkg (0.032 lb/ton).

Costs: Total investment cost: $125,910
Total yearly cost: $ 34,380

An itemized breakdown of costs is presented in Table 423. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 90.0 percent
SS: 86.0 percent
O&G: 85.0 percent

Alternative B 7-IV - This alternative provides dual media filtration in addition to Alternative B 7-III.

The resulting BOD waste load is 0.004 kg/kkg (0.008 lb/ton), the suspended solids load is 0.0017 kg/kkg (0.0036 lb/ton), and the oil and grease load is 0.0088 kg/kkg (0.018 lb/ton).

Costs: Total investment cost: $153,030
Total yearly cost: $ 41,450

An itemized breakdown of costs is presented in Table 424. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 95.0 percent
SS: 96.0 percent
O&G: 92.0 percent

A cost efficiency curve is presented in Figure 357.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 8- Soft Moist Pet Food

A model plant representative of subcategory B 8 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being

DRAFT

TABLE 422

ITEMIZED COST SUMMARY FOR ALTERNATIVE B7-II
(DRY PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...90.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION

INVESTMENT COSTS:

1. CONSTRUCTION	58300.00
2. LAND	4160.00
3. ENGINEERING	5830.00
4. CONTINGENCY	5830.00
TOTAL	74120.00

YEARLY OPERATING COSTS:

1. LABOR	6250.00
2. POWER	2050.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	6180.00
TOTAL	14480.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	14480.00
2. YEARLY INVESTMENT COST RECOVERY	2960.00
3. DEPRECIATION	3500.00
TOTAL	20940.00

TABLE 423

ITEMIZED COST SUMMARY FOR ALTERNATIVE B7-III (DRY PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...90.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE

INVESTMENT COSTS:

1.	CONSTRUCTION	97980.00
2.	LAND	8330.00
3.	ENGINEERING	9800.00
4.	CONTINGENCY	9800.00
TOTAL		125910.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	4080.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	6890.00
TOTAL		23460.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	23460.00
2.	YEARLY INVESTMENT COST RECOVERY	5040.00
3.	DEPRECIATION	5880.00
TOTAL		34380.00

DRAFT

TABLE 424

ITEMIZED COST SUMMARY FOR ALTERNATIVE B7-IV
(DRY PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
K...ACTIVATED SLUDGE
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	120580.00
	2. LAND	8330.00
	3. ENGINEERING	12060.00
	4. CONTINGENCY	12060.00
	TOTAL	153030.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	6940.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	8670.00
	TOTAL	28100.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	28100.00
	2. YEARLY INVESTMENT COST RECOVERY	6120.00
	3. DEPRECIATION	7230.00
	TOTAL	41450.00

DRAFT

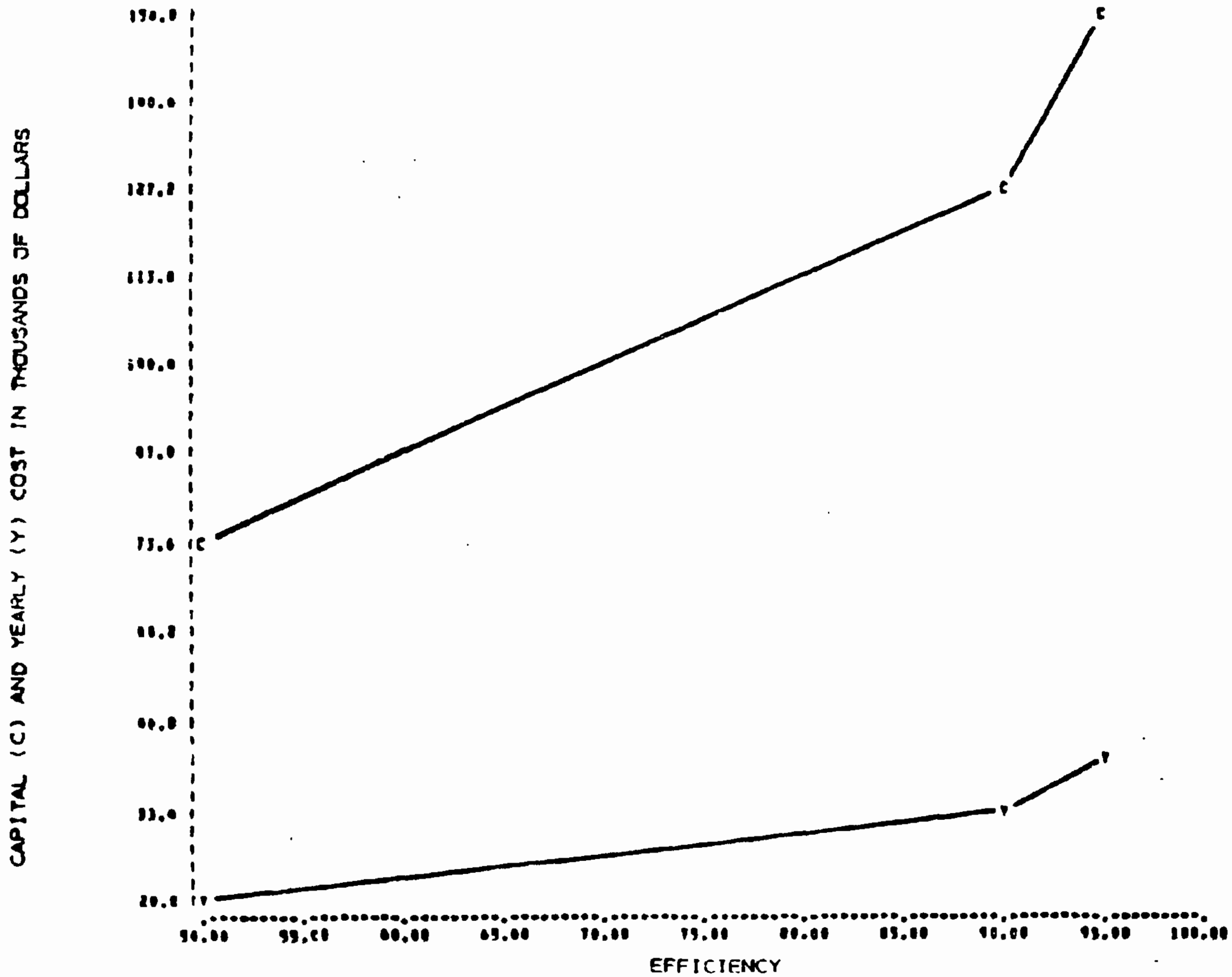


FIGURE 357

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY B7, ALT. IV

applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 500 kg (550 ton) per day.

Alternative B 8-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 500 kkg per day plant is 114 cu m (0.03 MG) per day. The BOD waste load is 0.89 kg/kkg (1.77 lb/ton), the suspended solids load is 0.48 kg/kkg (0.96 lb/ton), and the oil and grease load is 0.18 kg/kkg (0.36 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative B 8-II - This alternative provides a pumping station, flow equalization, dissolved air flotation, and vacuum filtration of sludge.

The resulting BOD waste load is 0.36 kg/kkg (0.72 lb/ton), the suspended solids load is 0.096 kg/kkg (0.19 lb/ton), and the oil and grease load is 0.36 kg/kkg (0.72 lb/ton).

Costs: Total investment cost: $247,670
Total yearly cost: $ 89,780

An itemized breakdown of costs is presented in Table 425. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 60.0 percent
SS: 80.0 percent
O&G: 80.0 percent

Alternative B 8-III - This alternative provides in addition to Alternative B 8-II a complete-mix activated sludge system and a sludge thickener for the waste activated sludge. Additional capacity for the vacuum filter is included.

The resulting BOD waste load is 0.036 kg/kkg (0.072 lb/ton), the suspended solids load is 0.048 kg/kkg (0.096 lb/ton), and the oil and grease load is 0.011 kg/kkg (0.022 lb/ton).

Costs: Total investment cost: $717,810
Total yearly cost: $194,050

An itemized breakdown of costs is presented in Table 426. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 96.0 percent
SS: 90.0 percent
O&G: 94.0 percent

TABLE 425

ITEMIZED COST SUMMARY FOR ALTERNATIVE B8-II
(SOFT MOIST PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY....60.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	202930.00
2.	LAND	4160.00
3.	ENGINEERING	20290.00
4.	CONTINGENCY	20290.00
	TOTAL	247670.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	18810.00
3.	CHEMICALS	17020.00
4.	MAINTENANCE&SUPPLIES	19370.00
	TOTAL	67690.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	67690.00
2.	YEARLY INVESTMENT COST RECOVERY	9910.00
3.	DEPRECIATION	12180.00
	TOTAL	89780.00

DRAFT

TABLE 426

ITEMIZED COST SUMMARY FOR ALTERNATIVE B8-III (SOFT MOIST PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER

INVESTMENT COSTS:		
	1. CONSTRUCTION	584290.00
	2. LAND	16660.00
	3. ENGINEERING	58430.00
	4. CONTINGENCY	58430.00
	TOTAL	717810.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	57220.00
	3. CHEMICALS	21280.00
	4. MAINTENANCE&SUPPLIES	26790.00
	TOTAL	130280.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	130280.00
	2. YEARLY INVESTMENT COST RECOVERY	28710.00
	3. DEPRECIATION	35060.00
	TOTAL	194050.00

Alternative B 8-IV - This alternative provides dual media filtration in addition to Alternative B 8-III.

The resulting BOD waste load is 0.018 kg/kkg (0.036 lb/ton), the suspended solids load is 0.014 kg/kkg (0.028 lb/ton), and the oil and grease load is 0.0054 kg/kkg (0.011 lb/ton).

Costs:	Total investment cost:	$913,950
	Total yearly cost:	$213,510

An itemized breakdown of costs is presented in Table 427. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	98.0 percent
	SS:	97.0 percent
	O&G:	97.0 percent

A cost efficiency curve is presented in Figure 358.

MISCELLANEOUS AND SPECIALITY PRODUCTS

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 29 - Flavorings and Extracts

A model plant representative of subcategory A 29 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, eleven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 300 cu m (0.08 MG) of finished flavors per day.

Alternative A 29-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 300 cu m (0.08 MG) per day plant is 125 cu m (0.033 MG) per day. The BOD waste load is 0.56 kg/cu m (4.6 lb/1000 gal), and the suspended solids load is 0.054 kg/cu m (0.45 lb/1000 gal).

Alternative A 29-II - This alternative consists of a pumping station, a holding tank and spray irrigation of the raw waste effluent. Truck hauling of alcohol still bottoms and wastewater generated from the vacuum still and organic synthesis areas is also provided.

The resulting BOD waste load is 0.0 kg/cu m (0.0 lb/1000 gal).

Costs:	Total investment cost:	$102,590
	Total yearly cost:	$ 18,570

An itemized breakdown of costs is presented in Table 428. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one-half time operator is required.

DIUFT

TABLE 427

ITEMIZED COST SUMMARY FOR ALTERNATIVE B8-IV (SOFT MOIST PET FOOD)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- C...EQUALIZATION BASIN
- E...PUMPING STATION
- J...AIR FLOTATION
- E...PUMPING STATION
- S...VACUUM FILTRATION
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- E...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRA...

INVESTMENT COSTS:

1. CONSTRUCTION	622800.00
2. LAND	166590.00
3. ENGINEERING	62280.00
4. CONTINGENCY	62280.00
TOTAL	913950.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	65810.00
3. CHEMICALS	21280.00
4. MAINTENANCE&SUPPLIES	27500.00
TOTAL	139580.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	139580.00
2. YEARLY INVESTMENT COST RECOVERY	36560.00
3. DEPRECIATION	37370.00
TOTAL	213510.00

DRAFT

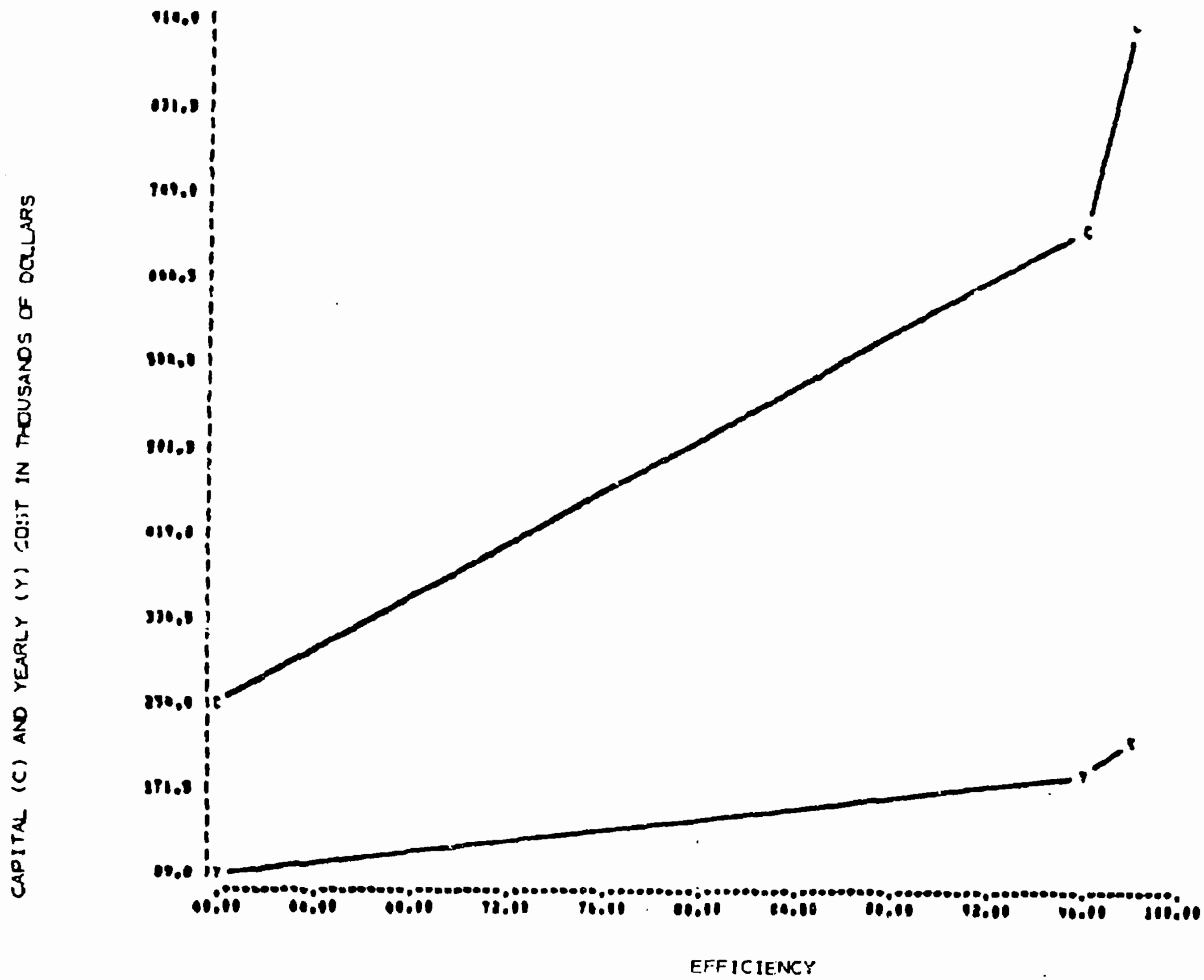


FIGURE 358

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY B8, ALT. IV

DRAFT

TABLE 428

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-II
(FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	76330.00
	2. LAND	11000.00
	3. ENGINEERING	7630.00
	4. CONTINGENCY	7630.00
	TOTAL	102590.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	1000.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	2640.00
	TOTAL	9890.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	9890.00
	2. YEARLY INVESTMENT COST RECOVERY	4100.00
	3. DEPRECIATION	4580.00
	TOTAL	18570.00

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Alternative A 29-III - This alternative consists of a pumping station, a flow equalization tank, a complete mix activated sludge system, a sludge thickener, vacuum filtration, and a sludge storage tank. Truck hauling of alcohol still bottoms and wastewater generated from vacuum still and organic synthesis areas is also provided.

The resulting BOD waste load is 0.041 kg/cu m (0.102 lb/1000 gal).

Costs: Total investment cost: $143,380
Total yearly cost: $ 37,280

An itemized breakdown of costs is presented in Table 429. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 92.6 percent
SS: 76.9 percent

Alternative 29-IV - This alternative replaces vacuum filtration of Alternative A 29-III with aerobic digestion followed by sand drying beds.

The resulting BOD waste load is 0.041 kg/cu m (0.34 lb/1000 gal), and the suspended solids load is 0.0123 kg/cu m (0.102 lb/1000 gal).

Costs: Total investment cost: $196,570
Total yearly cost: $ 44,310

An itemized breakdown of costs is presented in Table 430. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 92.6 percent
SS: 76.9 percent

Alternative A 29-V - This alternative consists of a pumping station, a flow equalization tank, and an aerated lagoon. Truck hauling of alcohol still bottoms, and wastewater generated from vacuum still and organic synthesis areas is also provided.

The resulting BOD waste load is 0.041 kg/cu m (0.34 lb/1000 gal), and the suspended solids load is 0.0123 kg/cu m (0.102 lb/1000 gal).

Costs: Total investment cost: $163,470
Total yearly cost: $ 43,530

An itemized breakdown of costs is presented in Table 431. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 92.6 percent
SS: 76.9 percent

DRAFT

TABLE 429

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-III (FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 92.[illegible] PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
R...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	97260.00
	2. LAND	26660.00
	3. ENGINEERING	9730.00
	4. CONTINGENCY	9730.00
	TOTAL	143380.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	7470.00
	3. CHEMICALS	1920.00
	4. MAINTENANCE&SUPPLIES	3820.00
	TOTAL	25700.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	25700.00
	2. YEARLY INVESTMENT COST RECOVERY	5740.00
	3. DEPRECIATION	5840.00
	TOTAL	37280.00

TABLE 430

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-IV (FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 92.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
P...AEROBIC DIGESTER
T...SAND DRYING BEDS
Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	151320.00
2. LAND	14990.00
3. ENGINEERING	15130.00
4. CONTINGENCY	15130.00
TOTAL	196570.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	7690.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	7190.00
TOTAL	27370.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	27370.00
2. YEARLY INVESTMENT COST RECOVERY	7860.00
3. DEPRECIATION	9080.00
TOTAL	44310.00

DRAFT

TABLE 431

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-V
(FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 92.6 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	131530.00
	2. LAND	1670.00
	3. ENGINEERING	13150.00
	4. CONTINGENCY	13150.00
	5. PVC LINER	3970.00
	TOTAL	163470.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	14040.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	2280.00
	5. PVC LINER	90.00
	TOTAL	28900.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	28900.00
	2. YEARLY INVESTMENT COST RECOVERY	6540.00
	3. DEPRECIATION	8090.00
	TOTAL	43530.00

Alternative A 29-VI - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 29-III.

The resulting BOD waste load is 0.020 kg/cu m (0.17 lb/1000 gal), and the suspended solids load is 0.0062 kg/cu m (0.051 lb/1000 gal).

Costs: Total investment cost: $160,180
Total yearly cost: $ 42,240

An itemized breakdown of costs is presented in Table 432. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 96.3 percent
SS: 88.5 percent

Alternative A 29-VII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 29-IV.

The resulting BOD waste load is 0.020 kg/cu m (0.17 lb/1000 gal), and the suspended solids load is 0.0062 kg/cu m (0.051 lb/1000 gal).

Costs: Total investment cost: $213,370
Total yearly cost: $ 49,260

An itemized breakdown of costs is presented in Table 433. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 96.3 percent
SS: 88.5 percent

Alternative A 29-VIII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 29-V.

The resulting BOD waste load is 0.020 kg/cu m (0.17 lb/1000 gal), and the suspended solids load is 0.0062 kg/cu m (0.051 lb/1000 gal).

Costs: Total investment cost: $180,280
Total yearly cost: $ 48,490

An itemized breakdown of costs is presented in Table 434. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 96.3 percent
SS: 88.5 percent

Alternative A 29-IX - This alternative provides carbon adsorption in addition to the treatment modules of Alternative VI.

DRAFT

TABLE 432

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-VI (FLAVORINGS AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A...PUMPING STATION
- C...EQUALIZATION BASIN
- K...ACTIVATED SLUDGE
- R...SLUDGE THICKENER
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	111260.00
	2. LAND	26660.00
	3. ENGINEERING	11130.00
	4. CONTINGENCY	11130.00
	TOTAL	160180.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	9430.00
	3. CHEMICALS	1920.00
	4. MAINTENANCE&SUPPLIES	5310.00
	TOTAL	29150.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	29150.00
	2. YEARLY INVESTMENT COST RECOVERY	6410.00
	3. DEPRECIATION	6680.00
	TOTAL	42240.00

DRAFT

TABLE 433

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-VII (FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
H...AEROBIC DIGESTOR
T...SAND DRYING BEDS
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	165320.00
2.	LAND	14990.00
3.	ENGINEERING	16530.00
4.	CONTINGENCY	16530.00
	TOTAL	213370.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	9650.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	8670.00
	TOTAL	30810.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	30810.00
2.	YEARLY INVESTMENT COST RECOVERY	8530.00
3.	DEPRECIATION	9920.00
	TOTAL	49260.00

DRAFT

TABLE 434

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-VIII (FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.3 PERCENT BOD REDUCTION

TREATMENT MODULES:

D...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	145540.00
	2. LAND	1670.00
	3. ENGINEERING	14550.00
	4. CONTINGENCY	14550.00
	5. PVC LINER	3970.00
	TOTAL	180280.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	16000.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	3770.00
	5. PVC LINER	90.00
	TOTAL	32350.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	32350.00
	2. YEARLY INVESTMENT COST RECOVERY	7210.00
	3. DEPRECIATION	8930.00
	TOTAL	48490.00

The resulting BOD waste load is 0.0123 kg/cu m (0.102 lb/1000 gal), and the suspended solids load is 0.004 kg/cu m (0.033 lb/1000 gal).

Costs: Total investment cost: $207,270
Total yearly cost: $ 61,610

An itemized breakdown of costs is presented in Table 435. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.8 percent
SS: 92.3 percent

A cost efficiency curve is presented in Figure 359.

Alternative A 29-X - This alternative provides carbon adsorption in addition to the treatment modules of Alternative VII.

The resulting BOD waste load is 0.0123 kg/cu m (0.102 lb/1000 gal), and the suspended solids load is 0.004 kg/cu m (0.033 lb/1000 gal).

Costs: Total investment cost: $200,490
Total yearly cost: $ 68,640

An itemized breakdown of costs is presented in Table 436. It is assumed that land costs $20,510 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.8 percent
SS: 92.3 percent

A cost efficiency curve is presented in Figure 360.

Alternative A 29-XI - This alternative provides carbon adsorption in addition to the treatment modules of Alternative A 29-VIII.

The resulting BOD waste load is 0.0123 kg/cu m (0.102 lb/1000 gal), and the suspended solids load is 0.004 kg/cu m (0.033 lb/1000 gal).

Costs: Total investment cost: $227,390
Total yearly cost: $ 67,880

An itemized breakdown of costs is presented in Table 437. It is assumed that land costs $4100 per hectare ($1600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.8 percent
SS: 92.3 percent

A cost efficiency curve is presented in Figure 361.

DRAFT

TABLE 435

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-IX
(FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	150510.00
2. LAND	26660.00
3. ENGINEERING	15050.00
4. CONTINGENCY	15050.00
TOTAL	207270.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	11900.00
3. CHEMICALS	1920.00
4. MAINTENANCE&SUPPLIES	17980.00
TOTAL	44290.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	44290.00
2. YEARLY INVESTMENT COST RECOVERY	8290.00
3. DEPRECIATION	9030.00
TOTAL	61610.00

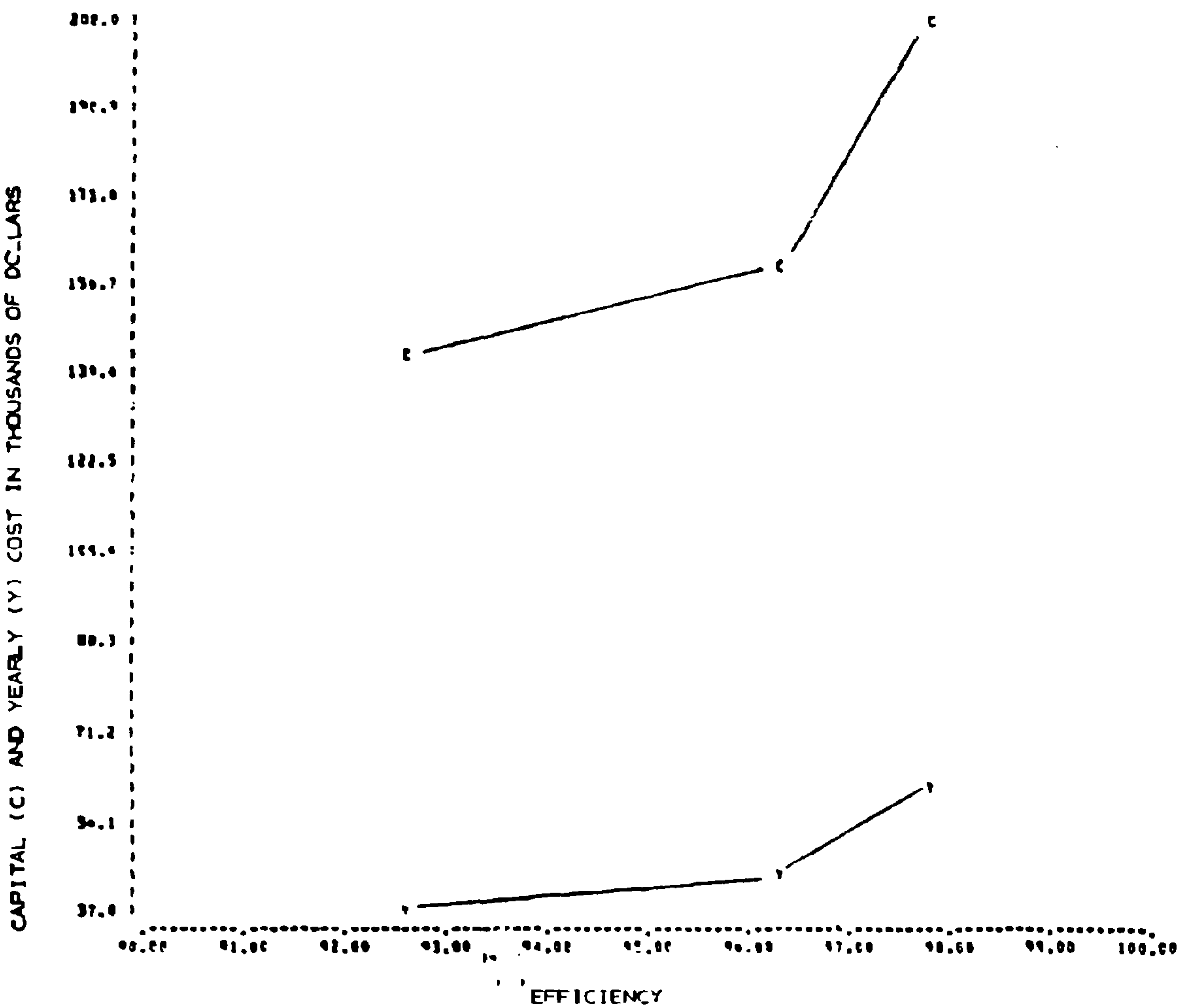


FIGURE 359

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 29, ALT. III, VI, IX

DRAFT

TABLE 436

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-X
(FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B...PUMPING STATION
- C...EQUALIZATION BASIN
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- T...SAND DRYING BEDS
- Y...HOLDING TANK
- P...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	204580.00
2.	LAND	14990.00
3.	ENGINEERING	20460.00
4.	CONTINGENCY	20460.00
TOTAL		260490.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	12120.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	21340.00
TOTAL		45950.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	45950.00
2.	YEARLY INVESTMENT COST RECOVERY	10420.00
3.	DEPRECIATION	12270.00
TOTAL		68640.00

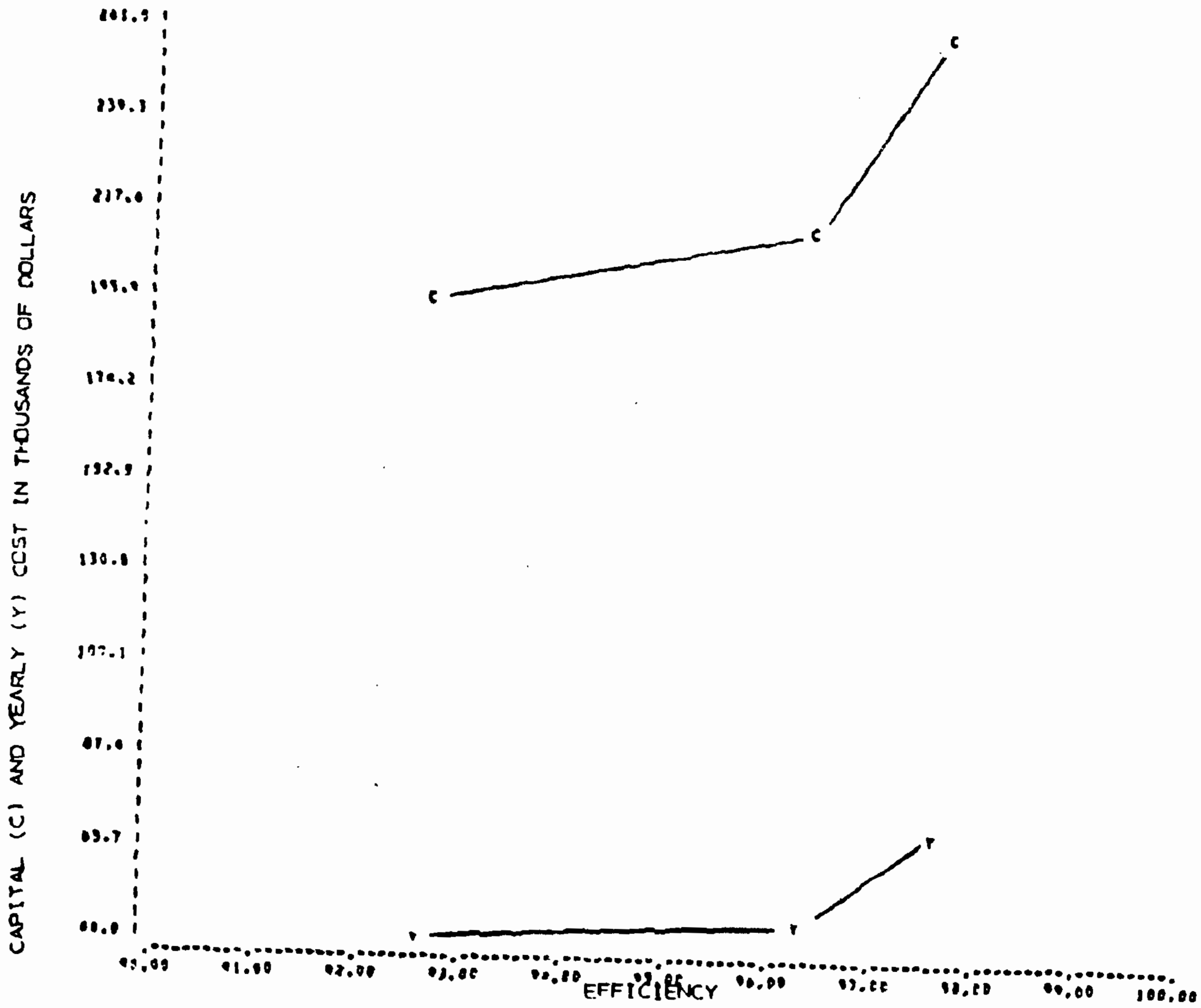


FIGURE 360

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 29, ALT. IV, VII, X

DRAFT

TABLE 437

ITEMIZED COST SUMMARY FOR ALTERNATIVE A29-XI
(FLAVORING AND EXTRACTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON
F...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	184790.00
2.	LAND	1670.00
3.	ENGINEERING	18480.00
4.	CONTINGENCY	18480.00
5.	PVC LINER	3970.00
	TOTAL	227390.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	18470.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	16440.00
5.	PVC LINER	90.00
	TOTAL	47490.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	47490.00
2.	YEARLY INVESTMENT COST RECOVERY	9100.00
3.	DEPRECIATION	11290.00
	TOTAL	67880.00

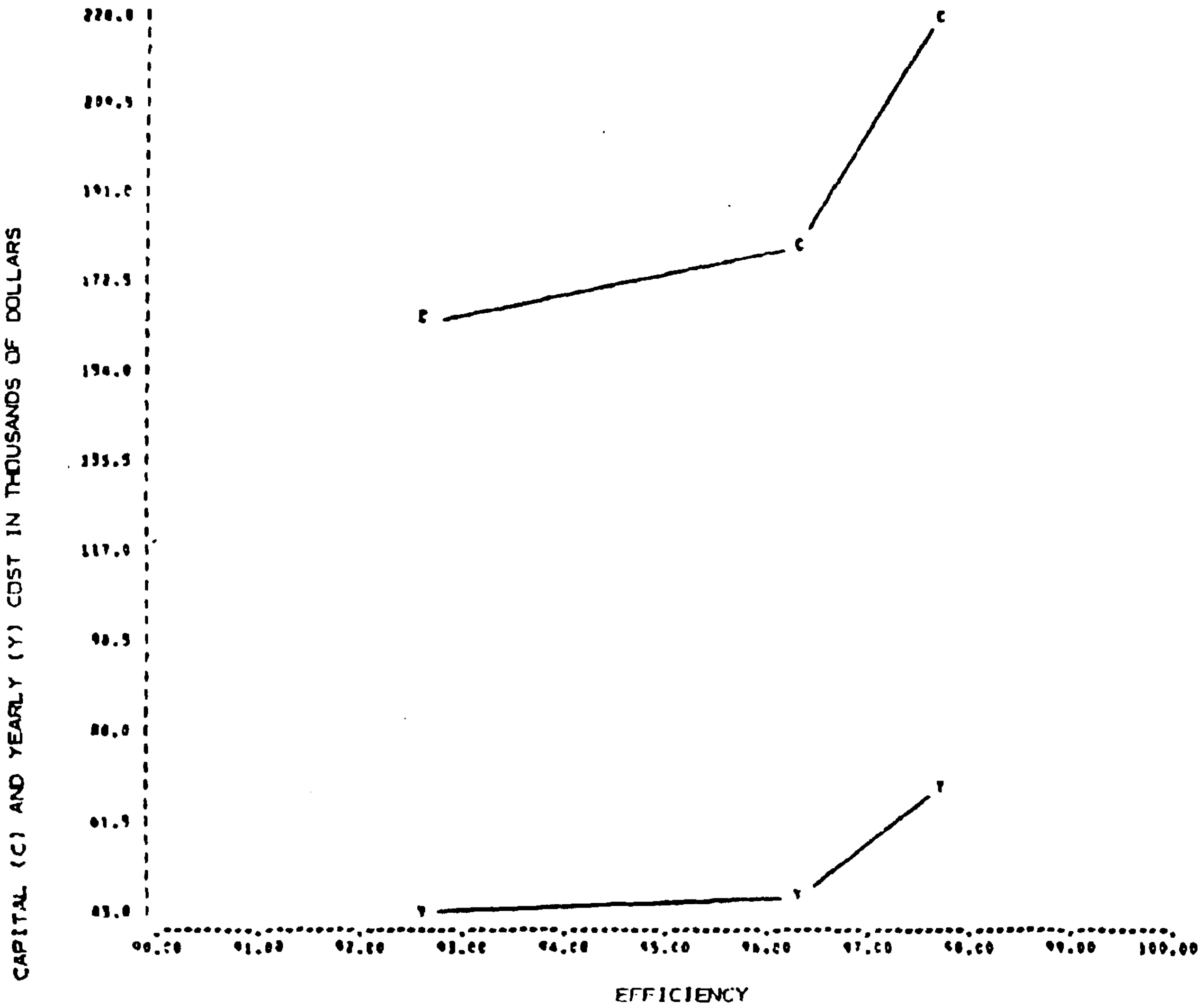


FIGURE 361

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 29, ALT. V, VIII, XI

Cost and Reduction Benefits of Alternative Treatment
Technologies for Subcategory A 31, Bouillon

A model plant representative of subcategory A 31 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, seven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 7.3 kkg (8.0 ton) of bouillon products per day.

It is estimated that the effluent from a 7.3 kkg (8.0 ton) per day plant is 114 cu m (0.03 MG) per day. The BOD waste load is 46.9 kg/kkg (93.8 lb/ton). the suspended solids load is 3.13 kg/kkg (6.26 lb/ton), and the oil and grease load is 2.35 kg/kkg (4.69 lb/ton).

Alternative A 31-I - This alternative consists of pumping station, a holding tank, and spray irrigation of the raw waste effluent.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton) and the oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

Costs: Total investment cost: $92,030
Total yearly cost: $10,840

An itemized breakdown of costs is presented in Table 438. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 31-II - This alternative consists of a pumping station, a flow equalization tank, a complete-mix activated sludge basin, a sludge thickening and vacuum filtration.

The resulting BOD waste load is 2.34 kg/kkg (4.68 lb/ton), the suspended solids load is 0.626 kg/kkg (1.25 lb/ton) and the oil and grease load is 0.626 kg/kkg (1.25 lb/ton).

Costs: Total investment cost: $264,500
Total yearly cost: $ 59,290

An itemized breakdown of costs is presented in Table 439. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 95.0 percent
SS: 80.0 percent
O&G: 73.3 percent

DRAFT

TABLE 43B

ITEMIZED COST SUMMARY FOR ALTERNATIVE A31-I
(BOUILLON CUBES)

TEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
ESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

REATMENT MODULES:
Y...HOLDING TANK
U...SPRAY IRRIGATION

NVESTMENT COSTS:		
	1. CONSTRUCTION	66150.00
	2. LAND	12660.00
	3. ENGINEERING	6610.00
	4. CONTINGENCY	6610.00
	TOTAL	92030.00
EARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	980.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	2210.00
	TOTAL	3190.00
OTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	3190.00
	2. YEARLY INVESTMENT COST RECOVERY	3680.00
	3. DEPRECIATION	3970.00
	TOTAL	10840.00

DRAFT

TABLE 439

ITEMIZED COST SUMMARY FOR ALTERNATIVE A31-II (BOUILLON CUBES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- H1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- S...VACUUM FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	198200.00
	2. LAND	26660.00
	3. ENGINEERING	19820.00
	4. CONTINGENCY	19820.00
	TOTAL	264500.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	16700.00
	3. CHEMICALS	2180.00
	4. MAINTENANCE&SUPPLIES	5450.00
	TOTAL	36820.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	36820.00
	2. YEARLY INVESTMENT COST RECOVERY	10580.00
	3. DEPRECIATION	11890.00
	TOTAL	59290.00

Alternative A 31-III - This alternative replaces the vacuum filtration of Alternative A 31-II with sand drying beds.

The resulting BOD waste load is 2.34 kg/kkg (4.68 lb/ton), the suspended solids load is 0.626 kg/kkg (1.25 lb/ton) and the oil and grease load is 0.626 kg/kkg (1.25 lb/ton).

Costs:	Total investment cost:	$342,090
	Total yearly cost:	$ 72,940

An itemized breakdown of costs is presented in Table 440. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that one operator is required.

Reduction Benefits:	BOD:	95.0 percent
	SS:	80.0 percent
	O&G:	73.3 percent

Alternative A 31-IV - This alternative consists of a pumping station, a flow equalization tank, and an aerated lagoon.

The resulting BOD waste load is 2.34 kg/kkg (4.68 lb/ton), the suspended solids load is 0.626 kg/kkg (1.25 lb/ton) and the oil and grease load is 0.626 kg/kkg (1.25 lb/ton).

Costs:	Total investment cost:	$157,920
	Total yearly cost:	$ 41,660

An itemized breakdown of costs is presented in Table 441. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits:	BOD:	95.0 percent
	SS:	80.0 percent
	O&G:	73.3 percent

Alternative A 31-V - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 29-II.

The resulting BOD waste load is 1.09 kg/kkg (2.18 lb/ton), the suspended solids load is 0.313 kg/kkg (0.6[illegible] lb/ton) and the oil and grease load is 0.313 kg/kkg (0.626 lb/ton).

Costs:	Total investment cost:	$281,050
	Total yearly cost:	$ 64,180

An itemized breakdown of costs is presented in Table 442. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

TABLE 440

ITEMIZED COST SUMMARY FOR ALTERNATIVE A31-III (BOUILLON CUBES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- F...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- T...SAND DRYING BEDS

INVESTMENT COSTS:

1.	CONSTRUCTION	268420.00
2.	LAND	19990.00
3.	ENGINEERING	26840.00
4.	CONTINGENCY	26840.00
	TOTAL	342090.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	14670.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	16000.00
	TOTAL	43160.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	43160.00
2.	YEARLY INVESTMENT COST RECOVERY	13680.00
3.	DEPRECIATION	16100.00
	TOTAL	72940.00

DRAFT

TABLE 441

ITEMIZED COST SUMMARY FOR ALTERNATIVE A31-IV (BOUILLON CUBES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

P...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON

INVESTMENT COSTS:

1. CONSTRUCTION	126080.00
2. LAND	3000.00
3. ENGINEERING	12610.00
4. CONTINGENCY	12610.00
5. PVC LINER	3620.00
TOTAL	157920.00

YEARLY OPERATING COSTS:

1. LABOR	6250.00
2. POWER	18540.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	2720.00
5. PVC LINER	80.00
TOTAL	27590.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	27590.00
2. YEARLY INVESTMENT COST RECOVERY	6320.00
3. DEPRECIATION	7750.00
TOTAL	41660.00

DRAFT

TABLE 442

ITEMIZED COST SUMMARY FOR ALTERNATIVE A31-V
(BOUILLON CUBES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

- 51..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- S...VACUUM FILTRATION
- P...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1. CONSTRUCTION	211990.00
2. LAND	26660.00
3. ENGINEERING	21200.00
4. CONTINGENCY	21200.00
TOTAL	281050.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	18550.00
3. CHEMICALS	2180.00
4. MAINTENANCE&SUPPLIES	7000.00
TOTAL	40220.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	40220.00
2. YEARLY INVESTMENT COST RECOVERY	11240.00
3. DEPRECIATION	12720.00
TOTAL	64180.00

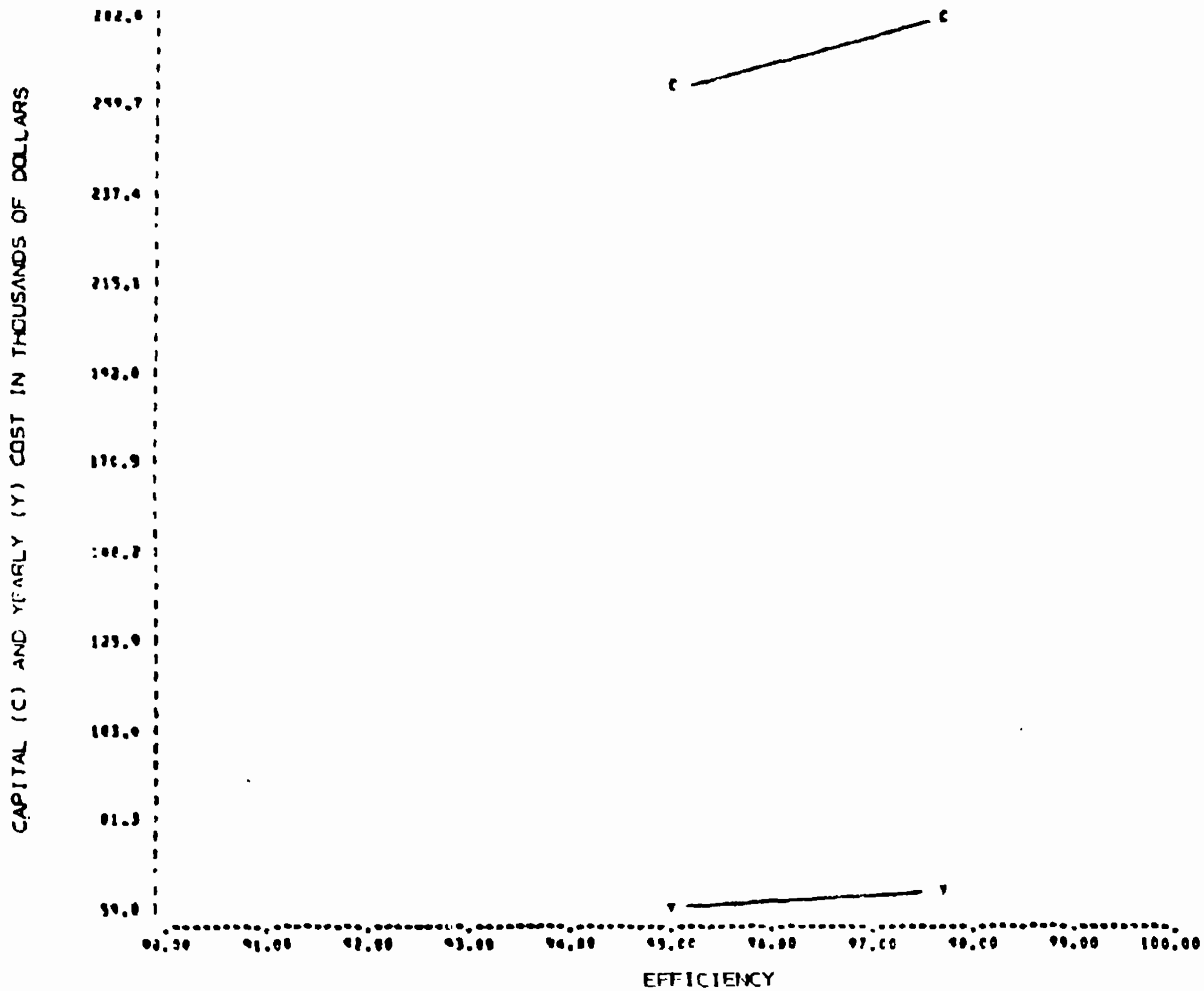


FIGURE 362A

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 31, ALT. II, V

DRAFT

Reduction Benefits: BOD: 97.6 percent
SS: 90.0 percent
O&G: 86.7 percent

A cost efficiency curve is presented in Figure 361.

Alternative A 31-VI - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 31-III.

The resulting BOD waste load is 1.09 kg/kkg (2.18 lb/ton), the suspended solids load is 0.313 kg/kkg (0.626 lb/ton) and the oil and grease load is 0.313 kg/kkg (0.626 lb/ton).

Costs: Total investment cost: $358,640
Total yearly cost: $ 77,840

An itemized breakdown of costs is presented in Table 443. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97.6 percent
SS: 90.0 percent
O&G: 86.7 percent

A cost efficiency curve is presented in Figure 362B.

Alternative A 31-VII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 31-IV.

The resulting BOD waste load is 1.09 kg/kkg (2.18 lb/ton), the suspended solids load is 0.313 kg/kkg (0.626 lb/ton) and the oil and grease load is 0.313 kg/kkg (0.626 lb/ton).

Costs: Total investment cost: $174,470
Total yearly cost: $ 46,540

An itemized breakdown of costs is presented in Table 444. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits: BOD: 97.6 percent
SS: 90.0 percent
O&G: 86.7 percent

A cost efficiency curve is presented in Figure 363.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 32 - Non-Dairy Creamer

A model plant representative of subcategory A 32 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, five alternatives were selected as being

DRAFT

TABLE 443

ITEMIZED COST SUMMARY FOR ALTERNATIVE A31-VI
(BOUILLON CUBES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.7 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
T...SAND DRYING BEDS
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	2[illegible]2210.00
2.	LAND	13990.00
3.	ENGINEERING	26220.00
4.	CONTINGENCY	28[illegible]20.00
TOTAL		3586[illegible]0.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	16530.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	17540.00
TOTAL		46560.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	46560.00
2.	YEARLY INVESTMENT COST RECOVERY	14350.00
3.	DEPRECIATION	16930.00
TOTAL		77840.00

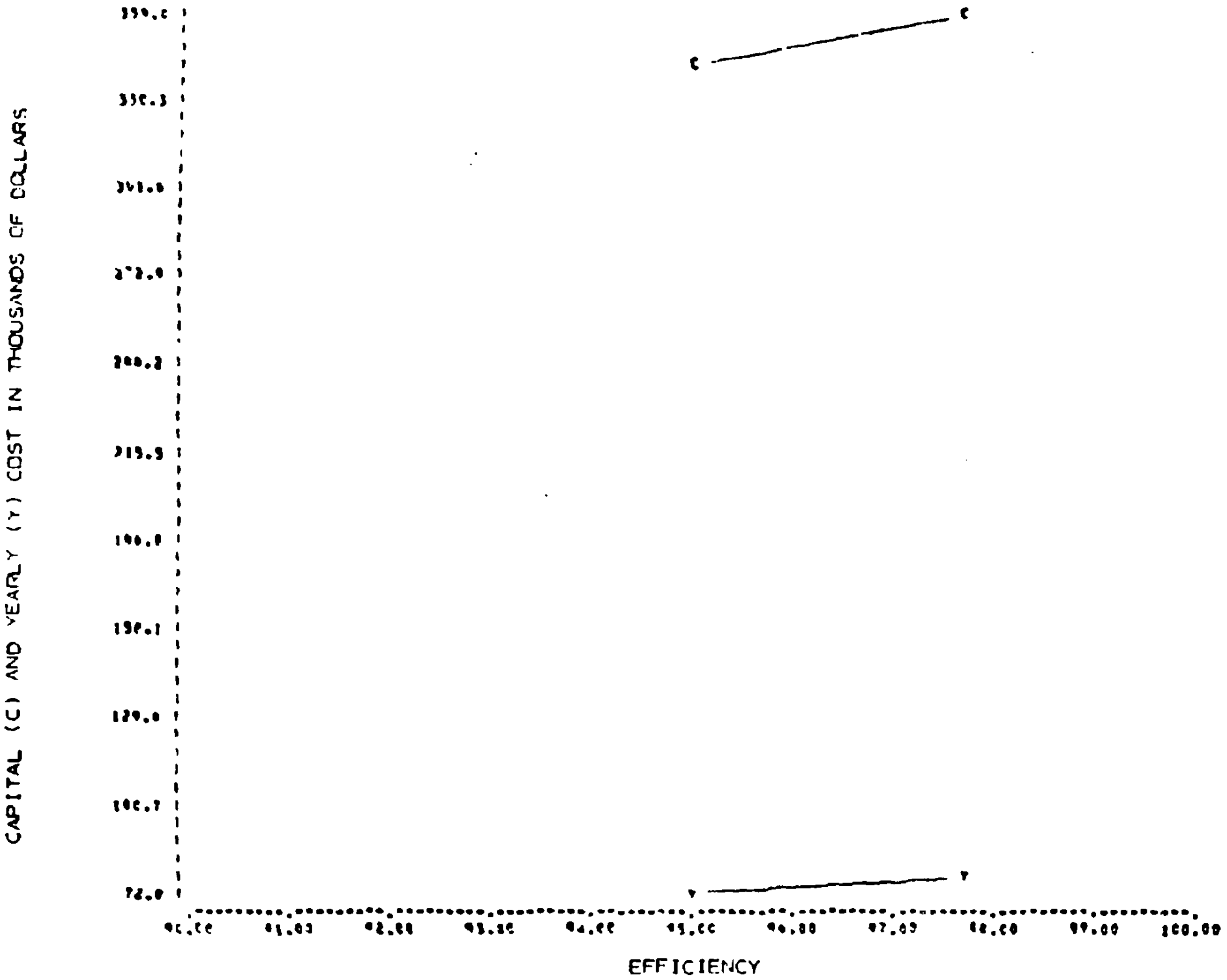


FIGURE 362B

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 31, ALT. III, VI

DRAFT

TABLE 444

ITEMIZED COST SUMMARY FOR ALTERNATIVE A31-VII
(BOUILLON CUBES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- L...AERATED LAGOON
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	139870.00
2.	LAND	3000.00
3.	ENGINEERING	13990.00
4.	CONTINGENCY	13990.00
5.	PVC LINER	3620.00
	TOTAL	174470.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	20390.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	4270.00
5.	PVC LINER	80.00
	TOTAL	30990.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	30990.00
2.	YEARLY INVESTMENT COST RECOVERY	6980.00
3.	DEPRECIATION	8570.00
	TOTAL	46540.00

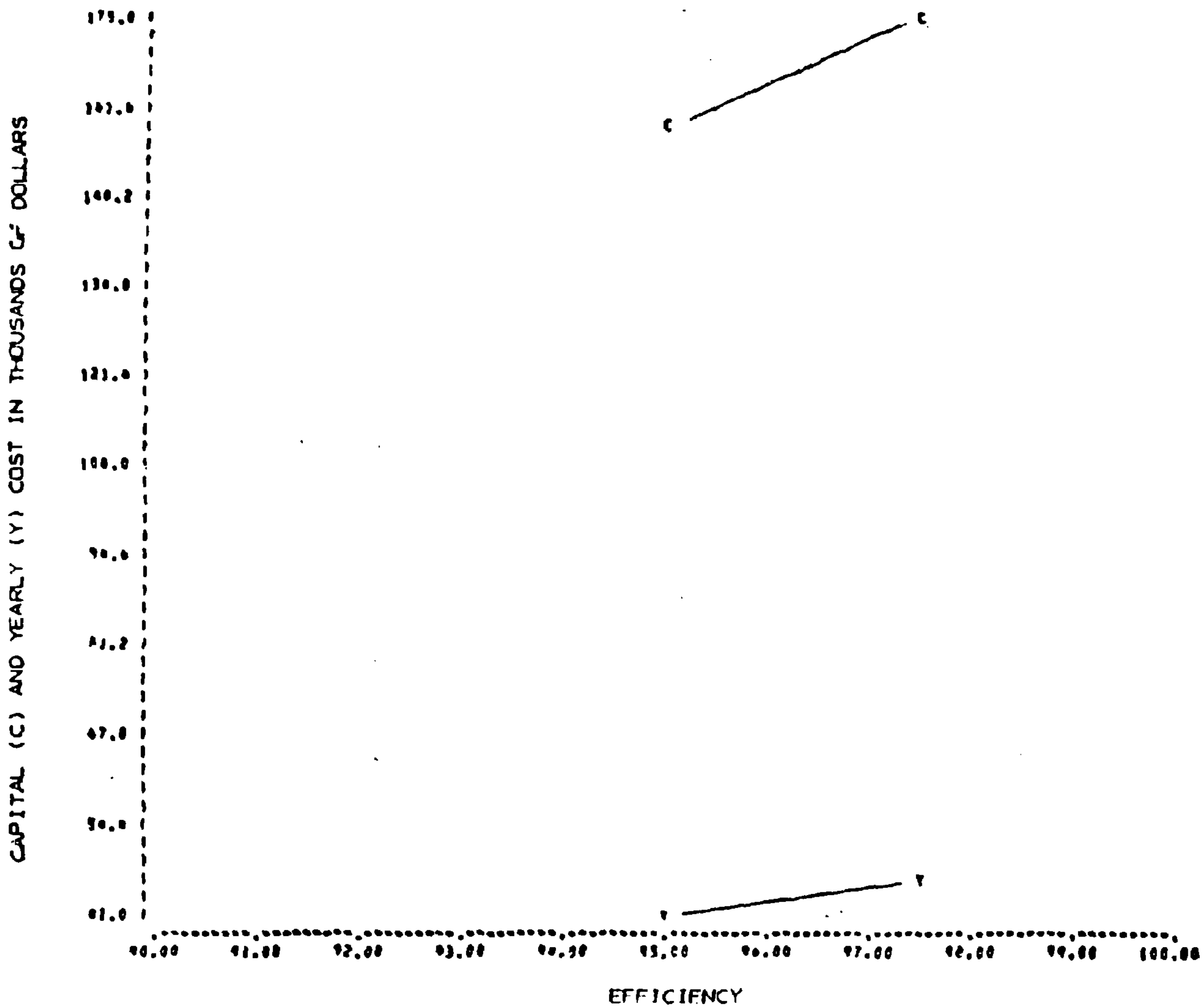


FIGURE 363

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 31, ALT. IV, VII applicable engineering alternatives These alternatives provide for various levels of waste reductions for the model plant which produces either 91 kkg (100 ton) of solid creamer per day.

It is estimated that the effluent from a 91 kkg (100 ton) per day plant is 64.3 cu m (0.017 MG) per day. The BOD waste load is 0.78 kg/kkg (1.56 lb/ton), the suspended solids load is 0.312 kg/kkg (0.624 lb/ton), and the oil and grease load is 0.184 kg/kkg (0.369 lb/ton).

Alternative A 32-I - This alternative consists of a pumping station, a holding tank and spray irrigation of the raw waste effluent.

The resulting BOD waste load is 0.0 kg/kkg (0.0 lb/ton), the suspended solids load is 0.0 kg/kkg (0.0 lb/ton) and the oil and grease load is 0.0 kg/kkg (0.0 lb/ton).

Costs: Total investment cost: $58,360
Total yearly cost: $13,830

An itemized breakdown of costs is presented in Table 445. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 32-II - This alternative consists of a pumping station, flow equalization, dissolved air flotation, nutrient addition, a complete-mix activated sludge basin, a sludge thickening, and a sludge holding tank.

The resulting BOD waste load is 0.025 kg/kkg (0.050 lb/ton), the suspended solids load is 0.071 kg/kkg (0.142 lb/ton) and the oil and grease load is 0.0425 kg/kkg (0.085 lb/ton).

Costs: Total investment cost: $157,360
Total yearly cost: $ 40,610

An itemized breakdown of costs is presented in Table 446. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 96.8 percent
SS: 77.2 percent
O&G: 77.4 percent

Alternative A 32-III - This alternative consists of a pumping station, a flow equalization tank, nutrient addition and an aerated lagoon.

DRAFT

TABLE 445

ITEMIZED COST SUMMARY FOR ALTERNATIVE A32-I
(NON-DAIRY CREAMER)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY....100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
L...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	43920.00
2. LAND	5660.00
3. ENGINEERING	4390.00
4. CONTINGENCY	4390.00
TOTAL	58360.00

YEARLY OPERATING COSTS:

1. LABOR	6250.00
2. POWER	920.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	1700.00
TOTAL	8870.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	8870.00
2. YEARLY INVESTMENT COST RECOVERY	2330.00
3. DEPRECIATION	2630.00
TOTAL	13830.00

DRAFT

TABLE 446

ITEMIZED COST SUMMARY FOR ALTERNATIVE A32-II
(NON-DAIRY CREAMER)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...96.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
Y...HOLDING TANK

INVESTMENT COSTS:

1.	CONSTRUCTION	108920.00
2.	LAND	26660.00
3.	ENGINEERING	10890.00
4.	CONTINGENCY	10890.00
TOTAL		157360.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	4210.00
3.	CHEMICALS	220.00
4.	MAINTENANCE&SUPPLIES	10870.00
TOTAL		27790.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	27790.00
2.	YEARLY INVESTMENT COST RECOVERY	6290.00
3.	DEPRECIATION	6530.00
TOTAL		40610.00

The resulting BOD waste load is 0.025 kg/kkg (0.050 lb/ton), the suspended solids load is 0.071 kg/kkg (0.142 lb/ton) and the oil and grease load is 0.0425 kg/kkg (0.085 lb/ton).

Costs: Total investment cost: $148,790
Total yearly cost: $ 42,380

An itemized breakdown of costs is presented in Table 447. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 96.8 percent
SS: 77.2 percent
O&G: 77.4 percent

Alternative A 32-IV - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 32-II.

The resulting BOD waste load is 0.0106 kg/kkg (0.0212 lb/ton), the suspended solids load is 0.0142 kg/kkg (0.0284 lb/ton) and the oil and grease load is 0.0142 kg/kkg (0.0284 lb/ton).

Costs: Total investment cost: $183,100
Total yearly cost: $ 47,270

An itemized breakdown of costs is presented in Table 448. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.6 percent
SS: 95.5 percent
O&G: 92.5 percent

A cost efficiency curve is presented in Figure 354.

Alternative A 32-V - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 32-III.

The resulting BOD waste load is 0.0106 kg/kkg (0.0212 lb/ton), the suspended solids load is 0.0142 kg/kkg (0.0284 lb/ton) and the oil and grease load is 0.0142 kg/kkg (0.0284 lb/ton).

Costs: Total investment cost: $164,220
Total yearly cost: $ 46,960

An itemized breakdown of costs is presented in Table 449. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.6 percent
SS: 95.5 percent
O&G: 92.5 percent

DRAFT

TABLE 447

ITEMIZED COST SUMMARY FOR ALTERNATIVE A32-III
(NON-DAIRY CREAMER)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.8 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	118270.00
	2. LAND	3330.00
	3. ENGINEERING	11830.00
	4. CONTINGENCY	11530.00
	5. PVC LINER	3530.00
	TOTAL	148790.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	10590.00
	3. CHEMICALS	220.00
	4. MAINTENANCE&SUPPLIES	5810.00
	5. PVC LINER	50.00
	TOTAL	29160.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	29160.00
	2. YEARLY INVESTMENT COST RECOVERY	5950.00
	3. DEPRECIATION	7270.00
	TOTAL	42380.00

DRAFT

TABLE 448

ITEMIZED COST SUMMARY FOR ALTERNATIVE A32-IV (NON-DAIRY CREAMER)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...98.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
Y...HOLDING TANK
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	130360.00
	2. LAND	26660.00
	3. ENGINEERING	13040.00
	4. CONTINGENCY	13040.00
	TOTAL	183100.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	6540.00
	3. CHEMICALS	220.00
	4. MAINTENANCE&SUPPLIES	12880.00
	TOTAL	32130.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	32130.00
	2. YEARLY INVESTMENT COST RECOVERY	7320.00
	3. DEPRECIATION	7820.00
	TOTAL	47270.00

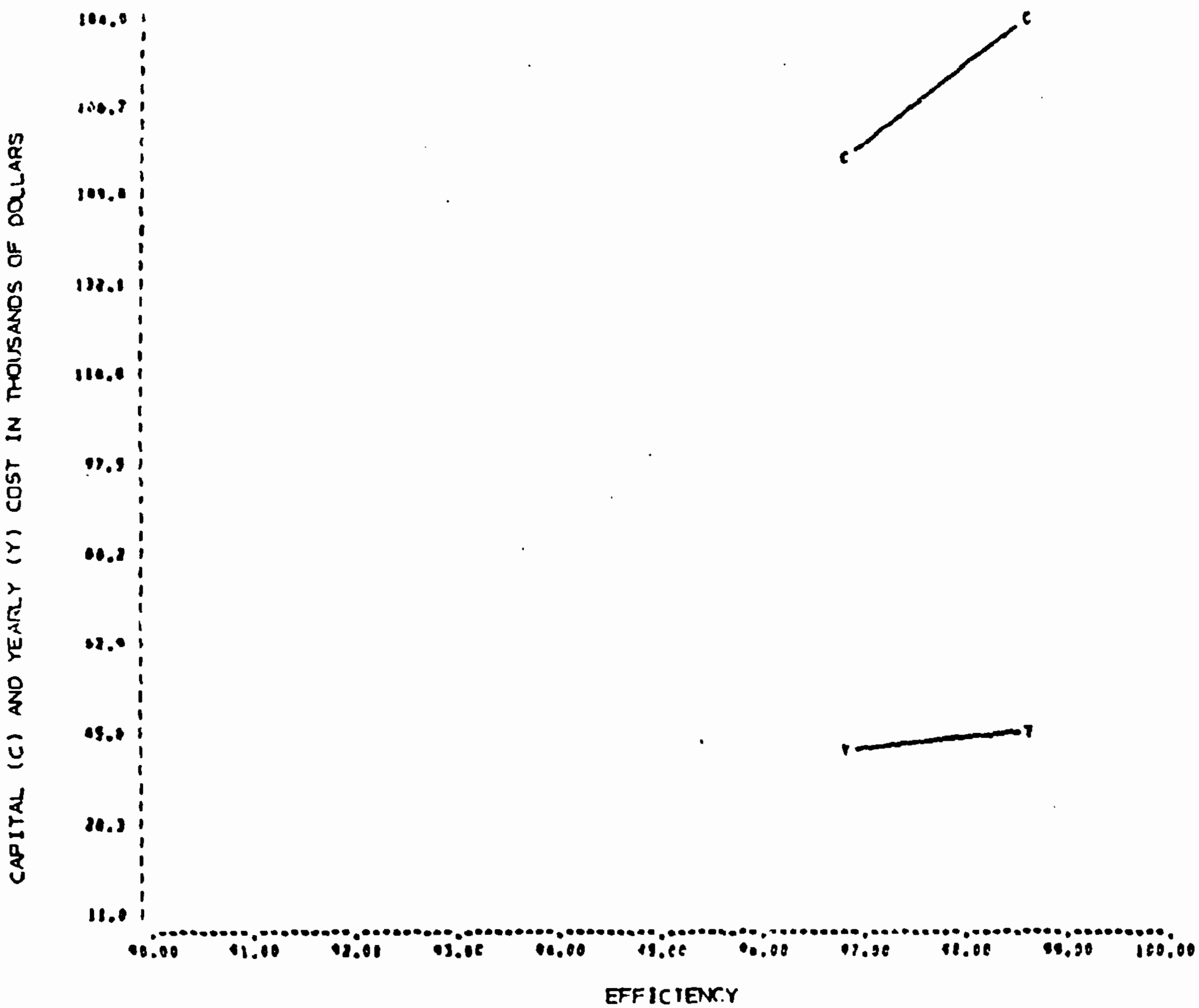


FIGURE 364

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 32, ALT. II, IV

DRAFT

TABLE 449

ITEMIZED COST SUMMARY FOR ALTERNATIVE A32-V
(NON-DAIRY CREAMER)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	131140.00
2. LAND	3330.00
3. ENGINEERING	13110.00
4. CONTINGENCY	13110.00
5. PVC LINER	3530.00
TOTAL	164220.00

YEARLY OPERATING COSTS:

1. LABOR	12490.00
2. POWER	12090.00
3. CHEMICALS	220.00
4. MAINTENANCE&SUPPLIES	7590.00
5. PVC LINER	50.00
TOTAL	32350.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	32350.00
2. YEARLY INVESTMENT COST RECOVERY	6570.00
3. DEPRECIATION	8040.00
TOTAL	46960.00

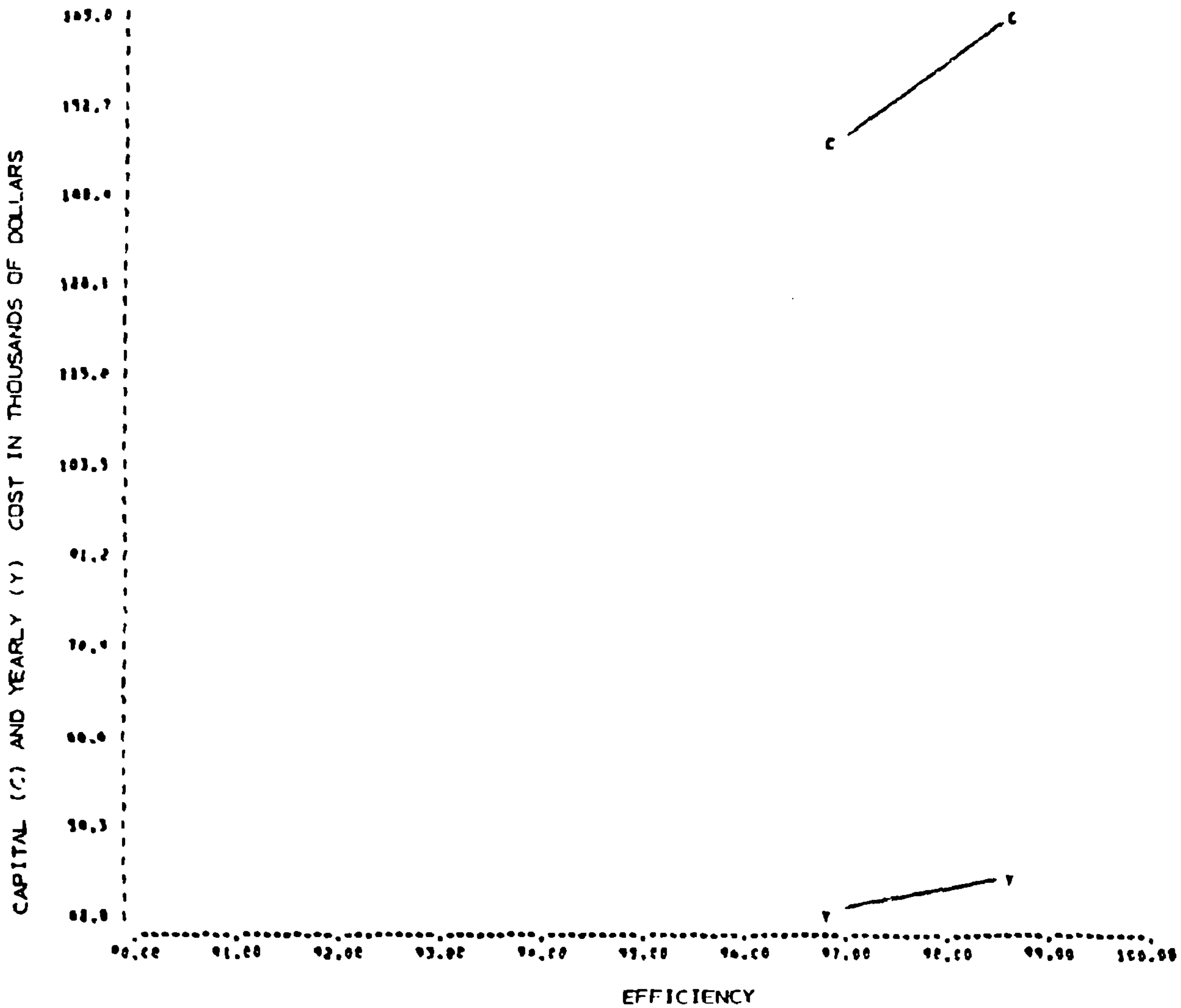


FIGURE 365

INVESTMENT AND YEARLY COST FOR SUBCATEGORY A 32, ALT. III, V

A cost efficiency curve is presented in Figure 365.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 33- Yeast

A model plant representative of subcategory A 33 was developed in Section V for the purpose of apply control and treatment alternatives. In Section VII, twenty alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 82 kkg (90.4 tons) of yeast per day.

Alternative A 33-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 82 kkg (90.4 ton) per day plant is 2650 cu m (0.70 MG) per day. The BOD waste load is 204 kg/kkg (407 lb/ton), and the suspended solids load is 60 kg/kkg (120 lb/ton).

The model plant assumes segregation of process water from storm, cooling, and other non-contact water discharges. Third separation spent beer is assumed to be reused as second separation wash water.

Costs: 0
Reduction Benefits: None

Alternative A 33-II - This alternative provides a control house, flow equalization, nutrient addition, and an aerated lagoon system.

The resulting BOD waste load is 3.23 kg/kkg (6.46 lb/ton), and the suspended solids load is 1.62 kg/kkg (3.24 lb/ton).

Costs: Total investment cost: $3,031,510
Total yearly cost: $1,802,880

An itemized breakdown of costs is presented in Table 450. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 98.4 percent
SS: 97.3 percent

Alternative A 33-III - This alternative provides in addition to Alternative A 33-II dual media filtration.

The resulting BOD waste load is 1.62 kg/kkg (3.24 lb/ton), and the suspended solids load is 0.81 kg/kkg (1.6 lb/ton).

Costs: Total investment cost: $3,077,380
Total yearly cost: $1,813,590

DRAFT

TABLE 450

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-II (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	2431550.00
2.	LAND	24740.00
3.	ENGINEERING	243150.00
4.	CONTINGENCY	243150.00
5.	PVC LINER	88920.00
TOTAL		3031510.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	1277220.00
3.	CHEMICALS	105780.00
4.	MAINTENANCE&SUPPLIES	122430.00
5.	PVC LINER	860.00
TOTAL		1531280.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	1531280.00
2.	YEARLY INVESTMENT COST RECOVERY	121260.00
3.	DEPRECIATION	150340.00
TOTAL		1802880.00

An itemized breakdown of costs is presented in Table 451. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.7 percent

Alternative A 33-IV - This alternative provides in addition to Alternative A 33-III activated carbon adsorption.

The resulting BOD waste load is 0.81 kg/kkg (1.6 lb/ton), and the suspended solids load is 0.40 kg/kkg (0.80 lb/ton).

Costs: Total investment cost: $3,695,700
Total yearly cost: $1,913,920

An itemized breakdown of costs is presented in Table 452. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent

A cost efficiency curve is presented in Figure 366.

Alternative A 33-V - This alternative provides a control house, flow equalization, primary clarification, nutrient addition, a complete-mix activated sludge system, sludge thickening aerobic digestion, and vacuum filtration.

The resulting BOD waste load is 3.23 kg/kkg (6.46 lb/ton), and the suspended solids load is 1.62 kg/kkg (3.24 lb/ton).

Costs: Total investment cost: $2,263,380
Total yearly cost: $ 686,240

An itemized breakdown of costs is presented in Table 453. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98.4 percent
SS: 97.3 percent

Alternative A 33-VI - This alternative provides in addition to Alternative A 33-V dual media filtration.

The resulting BOD waste load is 1.62 kg/kkg (3.24 lb/ton), and the suspended solids load is 0.81 kg/kkg (1.6 lb/ton).

Costs: Total investment cost: $2,308,260
Total yearly cost: $ 696,940

DRAFT

TABLE 451

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-III
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	2469760.00
2.	LAND	24740.00
3.	ENGINEERING	246980.00
4.	CONTINGENCY	246980.00
5.	PVC LINER	88920.00
TOTAL		3077380.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	1283170.00
3.	CHEMICALS	105780.00
4.	MAINTENANCE&SUPPLIES	123060.00
5.	PVC LINER	860.00
TOTAL		1537860.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	1537860.00
2.	YEARLY INVESTMENT COST RECOVERY	123100.00
3.	DEPRECIATION	152630.00
TOTAL		1813590.00

DRAFT

TABLE 452

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-IV (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- L...AERATED LAGOON
- N...DUAL MEDIA PRESSURE FILTRATION
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	2985040.00
2.	LAND	24740.00
3.	ENGINEERING	298500.00
4.	CONTINGENCY	298500.00
5.	PVC LINER	88920.00
TOTAL		3695700.00

YEARLY OPERATING COSTS:

1.	LABOR	24990.00
2.	POWER	1300550.00
3.	CHEMICALS	105780.00
4.	MAINTENANCE&SUPPLIES	150360.00
5.	PVC LINER	860.00
TOTAL		1582540.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	1582540.00
2.	YEARLY INVESTMENT COST RECOVERY	147630.00
3.	DEPRECIATION	183550.00
TOTAL		1913920.00

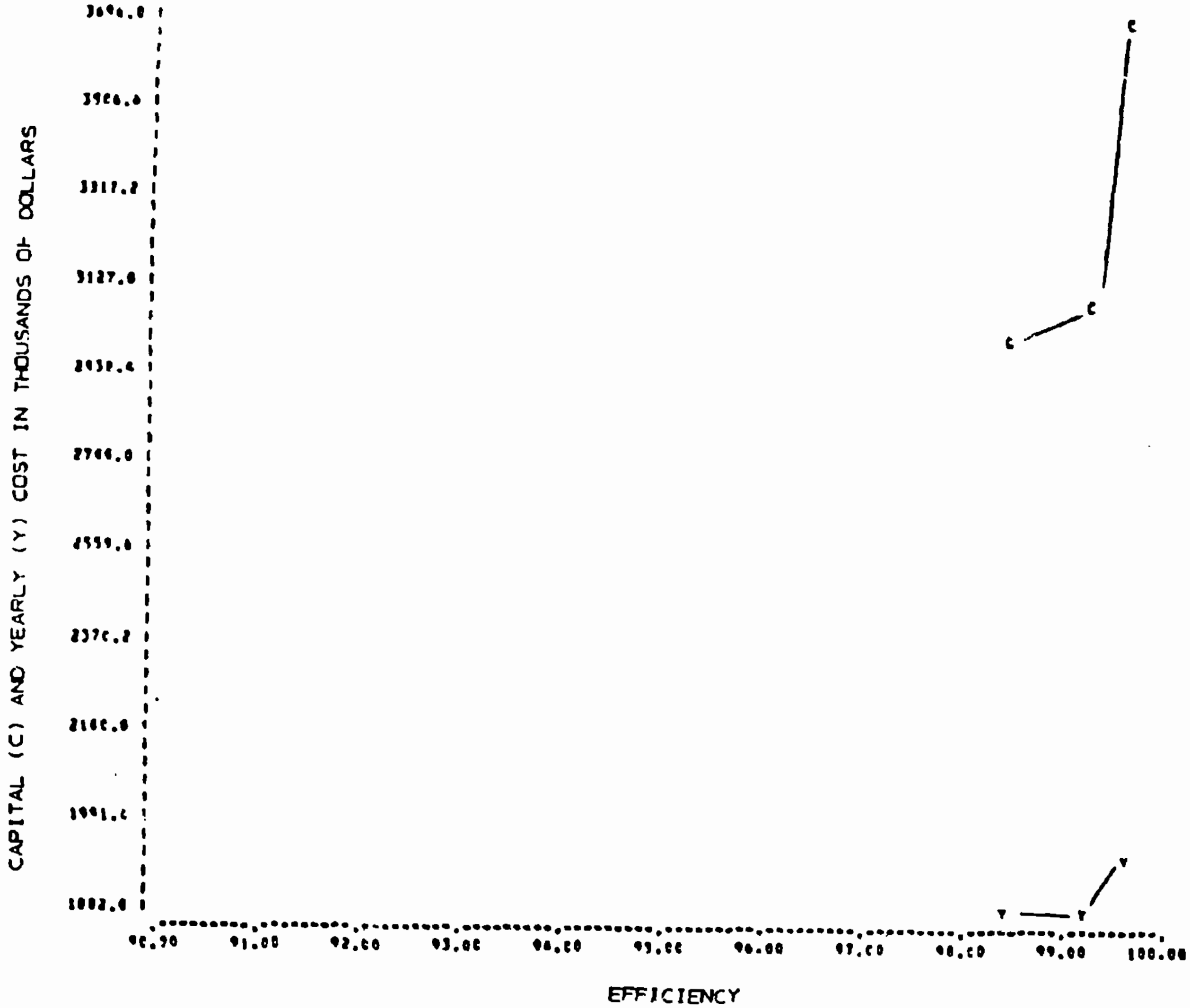


FIGURE 366

INVESTMENT AND YEARLY COST FOR SUBCATEGORY A 33, ALT. IV

DRAFT

TABLE 453

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-V (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- A1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- E...CLARIFIER
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK

INVESTMENT COSTS:

1. CONSTRUCTION	1844850.00
2. LAND	48610.00
3. ENGINEERING	184460.00
4. CONTINGENCY	184460.00
TOTAL	2262380.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	269650.00
3. CHEMICALS	118940.00
4. MAINTENANCE&SUPPLIES	58990.00
TOTAL	485060.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	485060.00
2. YEARLY INVESTMENT COST RECOVERY	90500.00
3. DEPRECIATION	110680.00
TOTAL	686240.00

An itemized breakdown of costs is presented in Table 454. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.7 percent

Alternative A 33-VII - This alternative provides in addition to Alternative A 33-VI activated carbon adsorption.

The resulting BOD waste load is 0.81 kg/kkg (1.62 lb/ton), and the suspended solids load is 0.40 kg/kkg (0.80 lb/ton).

Costs: Total investment cost: $2,926,580
Total yearly cost: $ 797,28[illegible]

An itemized breakdown of costs is presented in Table 455. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent

A cost efficiency curve is presented in Figure 367.

Alternative A 33-VIII - This alternative replaces vacuum filtration in Alternative A 33-V with spray irrigation of sludge.

The resulting BOD waste load is 3.23 kg/kkg (6.46 lb/ton), and the suspended solids load is 1.62 kg/kkg (3.24 lb/ton).

Costs: Total investment cost: $2,608,540
Total yearly cost: $ 771,590

An itemized breakdown of costs is presented in Table 456. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98.4 percent
SS: 97.3 percent

Alternative A 33-IX - This alternative provides in addition to Alternative A 33-VIII dual media filtration.

The resulting BOD waste load is 1.62 kg/kkg (3.24 lb/ton), and the suspended solids load is 0.31 kg/kkg (1.60 lb/ton).

Costs: Total investment cost: $2,654,390
Total yearly cost: $ 782,300

DRAFT

TABLE 454

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-VI (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- E...CLARIFIER
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	1882870.00
2.	LAND	48810.00
3.	ENGINEERING	188290.00
4.	CONTINGENCY	188290.00
	TOTAL	2308260.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	275600.00
3.	CHEMICALS	118940.00
4.	MAINTENANCE&SUPPLIES	59620.00
	TOTAL	491640.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	491640.00
2.	YEARLY INVESTMENT COST RECOVERY	92330.00
3.	DEPRECIATION	112970.00
	TOTAL	696940.00

DRAFT

TABLE 455

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-VII (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- A...PUMPING STATION
- C...EQUALIZATION BASIN
- E...CLARIFIER
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- O...SLUDGE THICKENER
- P...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- Y...HOLDING TANK
- W...DUAL MEDIA PRESSURE FILTRAIN
- Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	2398150.00
2.	LAND	42810.00
3.	ENGINEERING	239810.00
4.	CONTINGENCY	239810.00
TOTAL		2920580.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	292980.00
3.	CHEMICALS	118940.00
4.	MAINTENANCE&SUPPLIES	86930.00
TOTAL		536330.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	536330.00
2.	YEARLY INVESTMENT COST RECOVERY	117060.00
3.	DEPRECIATION	143890.00
TOTAL		797280.00

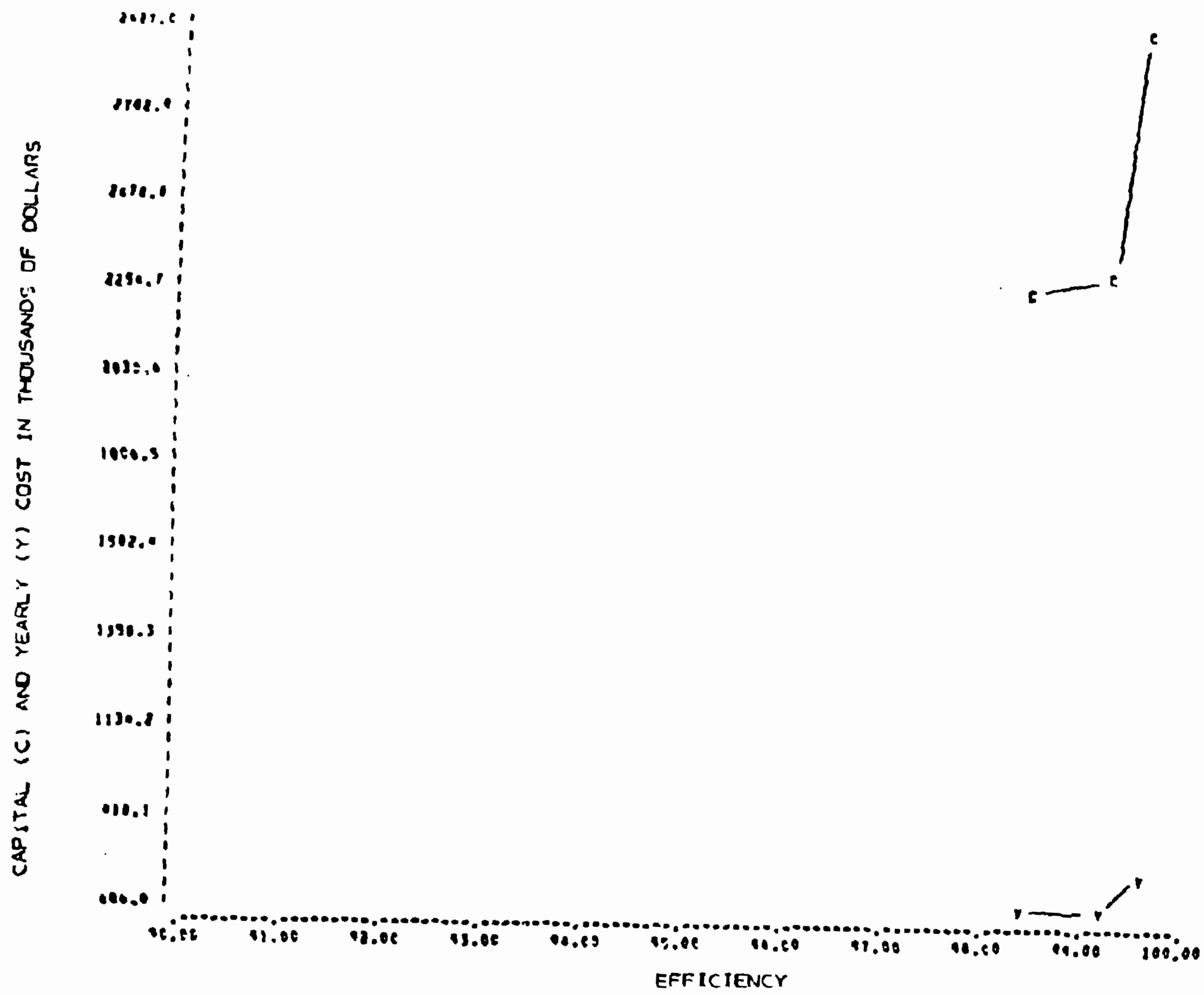


FIGURE 3'7

INVESTMENT AND YEARLY COST FOR SUBCATEGORY A 33, ALT. VII

DRAFT

DRAFT

TABLE 456

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-VIII
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:

1.	CONSTRUCTION	2152260.00
2.	LAND	25820.00
3.	ENGINEERING	215230.00
4.	CONTINGENCY	215230.00
TOTAL		2608540.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	381610.00
3.	CHEMICALS	77230.00
4.	MAINTENANCE&SUPPLIES	41790.00
TOTAL		538110.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	538110.00
2.	YEARLY INVESTMENT COST RECOVERY	104340.00
3.	DEPRECIATION	129140.00
TOTAL		771590.00

An itemized breakdown of costs is presented in Table 457. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.7 percent

Alternative A 33-X - This alternative provides in addition to Alternative A 33-IX activated carbon adsorption.

The resulting BOD waste load is 0.81 kg/kkg (1.6 lb/ton), and the suspended solids load is 0.40 kg/kkg (0.80 lb/ton).

Costs: Total investment cost: $3,272,710
Total yearly cost: $ 882,620

An itemized breakdown of costs is presented in Table 458. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent

A cost efficiency curve is presented in Figure 368.

Alternative A 33-XI - This alternative provides a control house, multi-effect evaporation of high strength waste with all necessary feed and by-product storage and pumping, flow equalization, nutrient addition, and an aerated lagoon system to treat evaporator condensate and all other low strength wastes.

The resulting BOD waste load is 3.23 kg/kkg (6.46 lb/ton), and the suspended solids load is 1.62 kg/kkg (3.24 lb/ton).

Costs: Total investment cost: $3,925,790
Total yearly cost: $1,311,960

An itemized breakdown of costs is presented in Table 459. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

In addition to the segregation of process water and the reuse of third separation beer, it is assumed that evaporation treats 50 percent of total plant flow (spent beer) containing 75 percent of the BOD and suspended solids. Evaporator removal efficiency is 90 percent of the BOD and 99 percent of the suspended solids in spent beer. It is recognized that evaporation may require additional boiler and cooling capacity not reflected in the costs presented.

Reduction Benefits: BOD: 98.4 percent
SS: 97.3 percent

DRAFT

TABLE 457

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-IX
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
F...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
L...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	2190470.00
2. LAND	25820.00
3. ENGINEERING	219050.00
4. CONTINGENCY	219050.00
TOTAL	2654390.00

YEARLY OPERATING COSTS:

1. LABOR	57480.00
2. POWER	367560.00
3. CHEMICALS	77230.00
4. MAINTENANCE&SUPPLIES	42420.00
TOTAL	544690.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	544690.00
2. YEARLY INVESTMENT COST RECOVERY	106180.00
3. DEPRECIATION	131430.00
TOTAL	782300.00

DRAFT

TABLE 458

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-X
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
V...HOLDING TANK
L...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	2705750.00
2.	LAND	25620.00
3.	ENGINEERING	270570.00
4.	CONTINGENCY	270570.00
TOTAL		3272710.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	404940.00
3.	CHEMICALS	77230.00
4.	MAINTENANCE/SUPPLIES	69720.00
TOTAL		589370.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	589370.00
2.	YEARLY INVESTMENT COST RECOVERY	130910.00
3.	DEPRECIATION	162340.00
TOTAL		882620.00

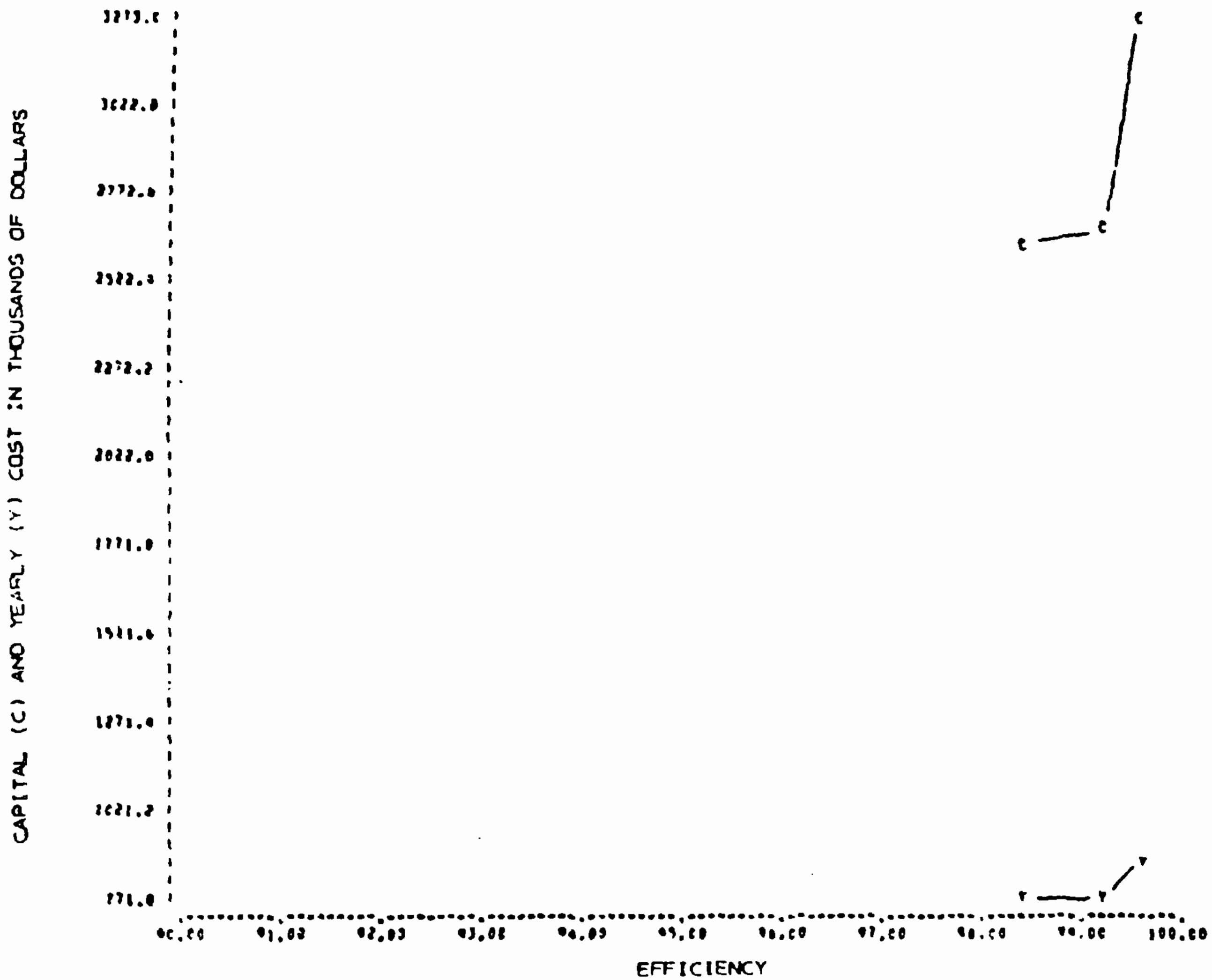


FIGURE 368

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 33, ALT. X

DRAFT

TABLE 459

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XI
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:
- B1..CONTROL HOUSE
- Y...HOLDING TANK
- B...PUMPING STATION
- Y...HOLDING TANK
- B...PUMPING STATION
- F1..MULTIPLE EFFECT EVAPORATOR
- C...EQUALIZATION BASIN
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- L...AERATED LAGOON

INVESTMENT COSTS:

1.	CONSTRUCTION	3230260.00
2.	LAND	12910.00
3.	ENGINEERING	323030.00
4.	CONTINGENCY	323030.00
5.	PVC LINER	36560.00
TOTAL		3925790.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	771200.00
3.	CHEMICALS	34810.00
4.	MAINTENANCE&SUPPLIES	76630.00
5.	PVC LINER	1680.00
TOTAL		959290.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	959290.00
2.	YEARLY INVESTMENT COST RECOVERY	157030.00
3.	DEPRECIATION	195640.00
TOTAL		1311960.00

Alternative A 33-XII - This alternative provides in addition to Alternative A 33-XI dual media filtration.

The resulting BOD waste load is 1.62 kg/kkg (3.24 lb/ton), and the suspended solids load is 0.81 kg/kkg (1.62 lb/ton).

Costs: Total investment cost: $3,971,660
Total yearly cost: $1,322,680

An itemized breakdown of costs is presented in Table 460. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.7 percent

Alternative A 33-XIII - This alternative provides in addition to Alternative A 33-XII activated carbon adsorption.

The resulting BOD waste load is 0.81 kg/kkg (1.62 lb/ton), and the suspended solids load is 0.40 kg/kkg (0.80 lb/ton).

Costs: Total investment cost: $4,589,990
Total yearly cost: $1,423,000

An itemized breakdown of costs is presented in Table 461. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent

A cost efficiency curve is presented in Figure 369.

Alternative A 33-XIV - This alternative replaces the aerated lagoon system in Alternative A 33-XI with primary clarification, a complete-mix activated sludge system, sludge thickening, aerobic digestion, and vacuum filtration.

The resulting BOD waste load is 3.23 kg/kkg (6.46 lb/ton), and the suspended solids load is 1.62 kg/kkg (3.24 lb/ton).

Costs: Total investment cost: $4,173,620
Total yearly cost: $1,162,480

An itemized breakdwon of costs is presented in Table 462. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.4 percent
SS: 97.3 percent

DRAFT

TABLE 460

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XII
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
F1..MULTIPLE EFFECT EVAPORATOR
C...EQUALIZATION BASIN
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	3268490.00
2.	LAND	12910.00
3.	ENGINEERING	326850.00
4.	CONTINGENCY	326850.00
5.	PVC LINER	36560.00
TOTAL		3971660.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	777150.00
3.	CHEMICALS	34810.00
4.	MAINTENANCE&SUPPLIES	77260.00
5.	PVC LINER	1680.00
TOTAL		965870.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	965870.00
2.	YEARLY INVESTMENT COST RECOVERY	158870.00
3.	DEPRECIATION	197940.00
TOTAL		1322680.00

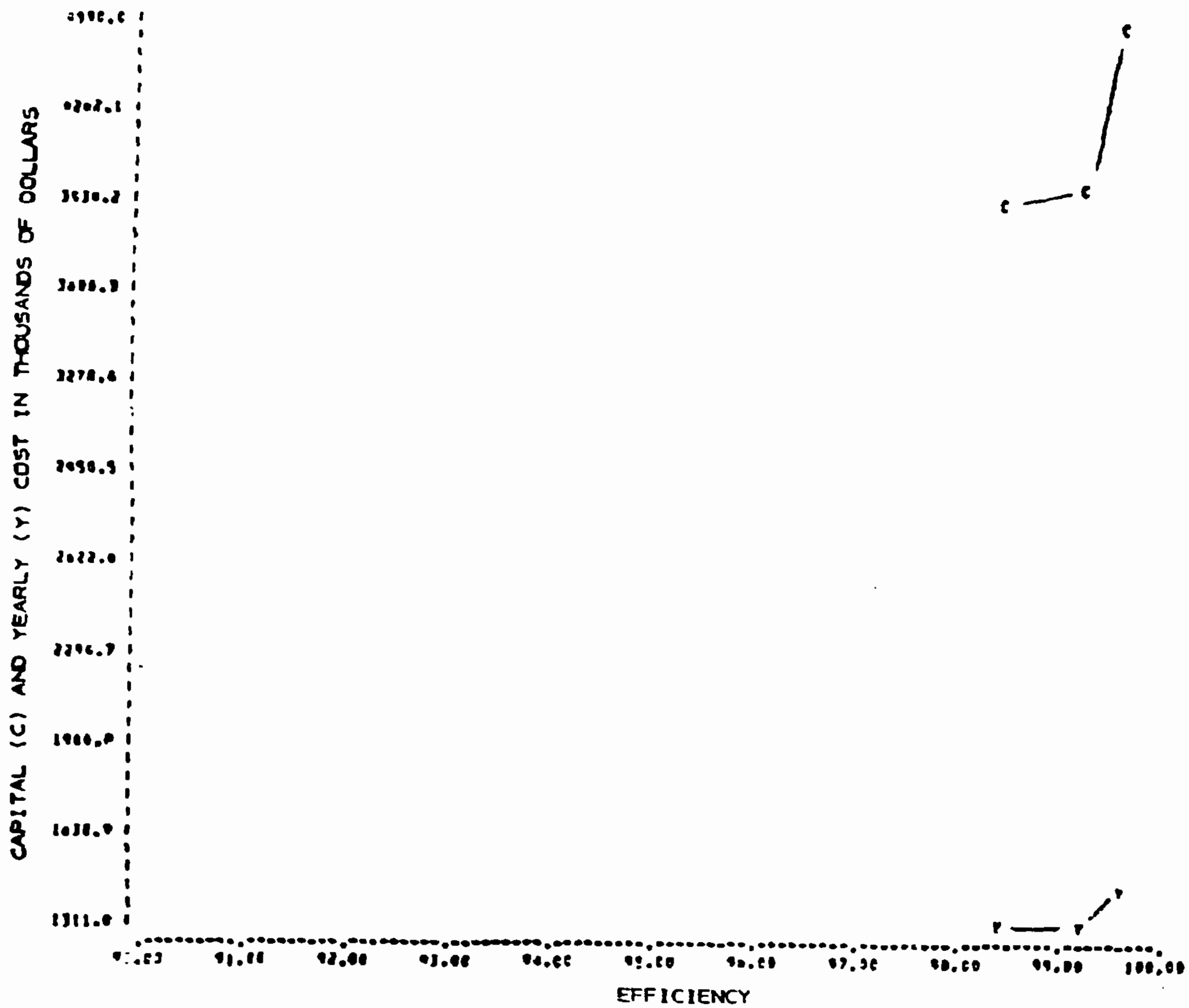


FIGURE 369

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A33, ALT. VIII

DRAFT

TABLE 461

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XIII
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 90.6 PERCENT COD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
F1...MULTIPLE EFFECT EVAPORATOR
C...EQUALIZATION BASIN
E...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
L...AERATED LAGOON
N...DUAL MEDIA PRESSURE FILTRATION
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	3783760.00
2.	LAND	12910.00
3.	ENGINEERING	378380.00
4.	CONTINGENCY	378380.00
5.	PVC LINER	36560.00
	TOTAL	4589990.00

YEARLY OPERATING COSTS:

1.	LABOR	78970.00
2.	POWER	794530.00
3.	CHEMICALS	34810.00
4.	MAINTENANCE&SUPPLIES	100560.00
5.	PVC LINER	1680.00
	TOTAL	1010550.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	1010550.00
2.	YEARLY INVESTMENT COST RECOVERY	183600.00
3.	DEPRECIATION	228850.00
	TOTAL	1423000.00

DRAFT

TABLE 462

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XIV (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

A1..CONTROL HOUSE
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
F1..MULTIPLE EFFECT EVAPORATOR
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	3437350.00
	2. LAND	48810.00
	3. ENGINEERING	343730.00
	4. CONTINGENCY	343730.00
	TOTAL	4173620.00
YEARLY OPERATING COSTS:		
	1. LABOR	74970.00
	2. POWER	608990.00
	3. CHEMICALS	32730.00
	4. MAINTENANCE&SUPPLIES	72610.00
	TOTAL	789300.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	789300.00
	2. YEARLY INVESTMENT COST RECOVERY	166940.00
	3. DEPRECIATION	206240.00
	TOTAL	1162480.00

DRAFT

Alternative A 33-XV - This alternative provides in addition to Alternative A 33-XIV dual media filtration.

The resulting BOD waste load is 1.62 kg/kkg (3.24 lb/ton), and the suspended solids load is 0.81 kg/kkg (1.62 lb/ton).

Costs: Total investment cost: $4,219,500
Total yearly cost: $1,173,190

An itemized breakdown of costs is presented in Table 463. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.7 percent

Alternative A 33-XVI - This alternative provides in addition to Alternative XV activated carbon adsorption.

The resulting BOD waste load is 0.81 kg/kkg (1.6 lb/ton), and the suspended solids load is 0.40 kg/kkg (0.80 lb/ton).

Costs: Total investment cost: $4,837,810
Total yearly cost: $1,273,520

An itemized breakdown of costs is presented in Table 464. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent

A cost efficiency curve is presented in Figure 370.

Alternative A 33-XVII - This alternative replaces vacuum filtration in Alternative A 33-XIV with spray irrigation of sludge.

The resulting BOD waste load is 3.23 kg/kkg (6.46 lb/ton), and the suspended solids load is 1.62 kg/kkg (3.24 lb/ton).

Costs: Total investment cost: $4,199,160
Total yearly cost: $1,141,040

An itemized breakdown of costs is presented in Table 465. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 98.4 percent
SS: 97.3 percent

DRAFT

TABLE 463

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XV
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
F1..MULTIPLE EFFECT EVAPORATOR
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTER
S...VACUUM FILTRATION
Y...HOLDING TANK
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	3475570.00
2. LAND	48810.00
3. ENGINEERING	347560.00
4. CONTINGENCY	347560.00
TOTAL	4219500.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	614940.00
3. CHEMICALS	32730.00
4. MAINTENANCE&SUPPLIES	73240.00
TOTAL	795880.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	795880.00
2. YEARLY INVESTMENT COST RECOVERY	168780.00
3. DEPRECIATION	208530.00
TOTAL	1173190.00

DRAFT

TABLE 464

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XVI (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
F1..MULTIPLE EFFECT EVAPORATOR
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
P...AEROBIC DIGESTOR
S...VACUUM FILTRATION
Y...HOLDING TANK
N...D L MEDIA PRESSURE FILTRAIN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1. CONSTRUCTION	3990840.00
2. LAND	48810.00
3. ENGINEERING	399080.00
4. CONTINGENCY	399080.00
TOTAL	4837810.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	632320.00
3. CHEMICALS	32730.00
4. MAINTENANCE&SUPPLIES	100540.00
TOTAL	840560.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	840560.00
2. YEARLY INVESTMENT COST RECOVERY	193510.00
3. DEPRECIATION	239450.00
TOTAL	1273520.00

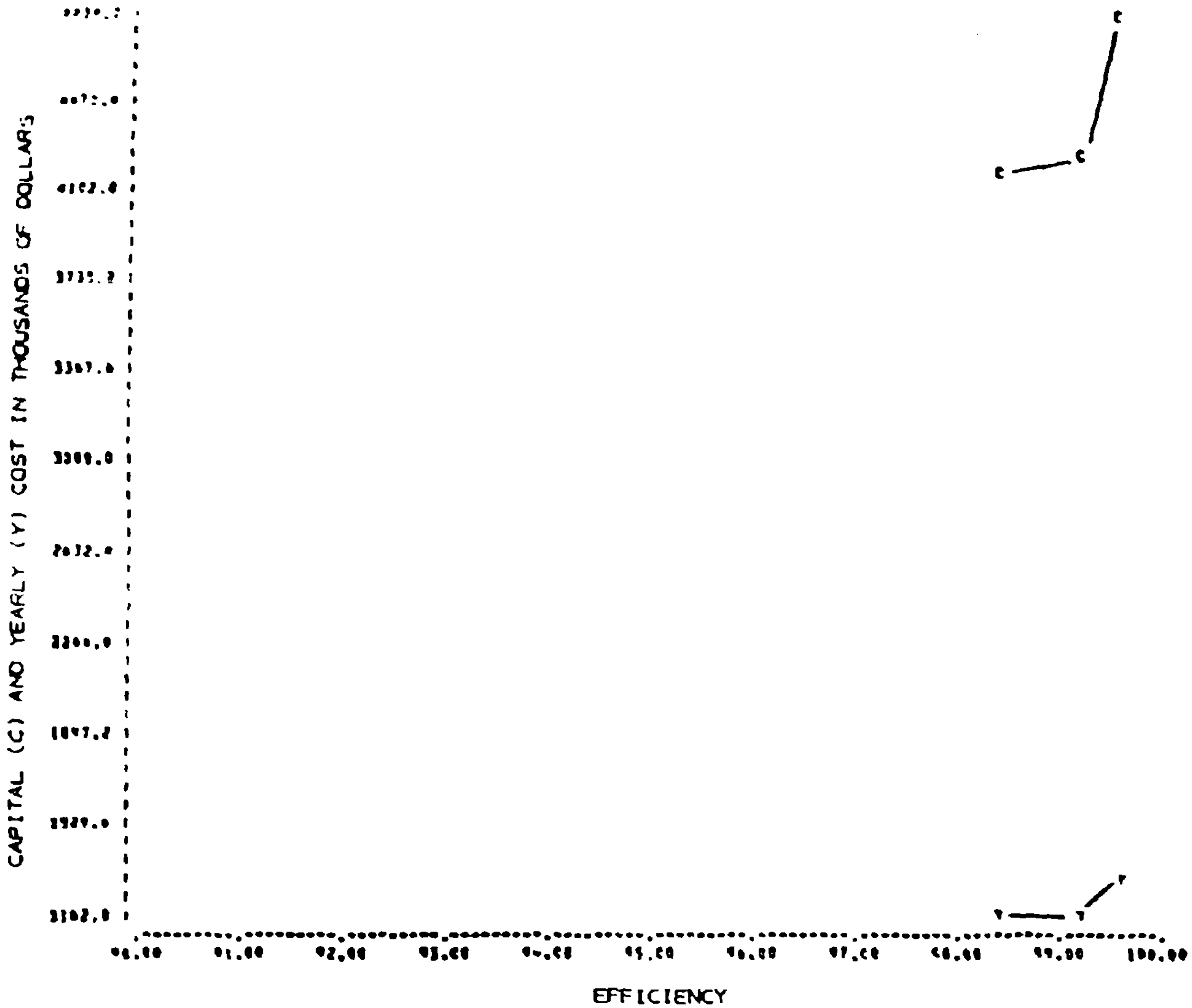


FIGURE 370

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 33, ALT. XVI

DRAFT

TABLE 465

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XVII (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.4 PERCENT BOD REDUCTION

TREATMENT MODULES:

- P1..CONTROL HOUSE
- B...PUMPING STATION
- Y...HOLDING TANK
- B...PUMPING STATION
- Y...HOLDING TANK
- F1..MULTIPLE EFFECT EVAPORATOR
- C...EQUALIZATION BASIN
- E...CLARIFIER
- H...NITROGEN ADDITION
- I...PHOSPHORUS ADDITION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- Y...HOLDING TANK
- U...SPRAY IRRIGATION

INVESTMENT COSTS:

1.	CONSTRUCTION	3450020.00
2.	LAND	59140.00
3.	ENGINEERING	345000.00
4.	CONTINGENCY	345000.00
	TOTAL	4199160.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	602310.00
3.	CHEMICALS	23370.00
4.	MAINTENANCE&SUPPLIES	65420.00
	TOTAL	766070.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	766070.00
2.	YEARLY INVESTMENT COST RECOVERY	167970.00
3.	DEPRECIATION	207000.00
	TOTAL	1141040.00

Alternative A 33-XVIII - This alternative provides in addition to Alternative A 33-XVII dual media filtration.

The resulting BOD waste load is 1.62 kg/kkg (3.24 lb/ton), and the suspended solids load is 0.81 kg/kkg (1.62 lb/ton).

Costs: Total investment cost: $4,245,020
Total yearly cost: $1,151,740

An itemized breakdown of costs is presented in Table 466. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.2 percent
SS: 98.7 percent

Alternative A 33-XIX - This alternative provides in addition to Alternative A 33-XVIII activated carbon adsorption.

The resulting BOD waste load is 0.81 kg/kkg (1.6 lb/ton), and the suspended solids load is 0.40 kg/kkg (0.80 lb/ton).

Costs: Total investment cost: $4,836,350
Total yearly cost: $1,252,070

An itemized breakdown of costs is presented in Table 467. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 99.6 percent
SS: 99.3 percent

A cost efficiency curve is presented in Figure 371.

Alternative A 33-XX - This alternative provides a holding tank and spray irrigation of the effluent.

The resulting waste load is zero.

Costs: Total investment cost: $1,056,800
Total yearly cost: $ 108,630

An itemized breakdown of costs is presented in Table 468. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that six operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 34 - Peanut Butter Plants with Jar Washing.

A model plant representative of subcategory A 34 was developed in Section V for the purpose of applying control and treatment alternatives.

DRAFT

TABLE 466

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XVIII
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
Y...HOLDING TANK
B...PUMPING STATION
Y...HOLDING TANK
F1..MULTIPLE EFFECT EVAPORATOR
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTER
Y...HOLDING TANK
L...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	3488240.00
2. LAND	59140.00
3. ENGINEERING	348820.00
4. CONTINGENCY	348820.00
TOTAL	4245020.00

YEARLY OPERATING COSTS:

1. LABOR	74970.00
2. POWER	608260.00
3. CHEMICALS	23370.00
4. MAINTENANCE&SUPPLIES	66050.00
TOTAL	772650.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	772650.00
2. YEARLY INVESTMENT COST RECOVERY	169800.00
3. DEPRECIATION	209290.00
TOTAL	1151740.00

DRAFT

TABLE 467

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XIX
(YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.6 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
P...PUMPING STATION
Y...HOLDING TANK
P...PUMPING STATION
Y...HOLDING TANK
F1..MULTIPLE EFFECT EVAPORATOR
C...EQUALIZATION BASIN
E...CLARIFIER
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
L...SPRAY IRRIGATION
N...DUAL MEDIA PRESSURE FILTRATN
Z...ACTIVATED CARBON ADSORPTION

INVESTMENT COSTS:

1.	CONSTRUCTION	4003510.00
2.	LAND	59140.00
3.	ENGINEERING	400350.00
4.	CONTINGENCY	400350.00
TOTAL		4863350.00

YEARLY OPERATING COSTS:

1.	LABOR	74970.00
2.	POWER	625640.00
3.	CHEMICALS	23370.00
4.	MAINTENANCE&SUPPLIES	93350.00
TOTAL		817330.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	817330.00
2.	YEARLY INVESTMENT COST RECOVERY	194530.00
3.	DEPRECIATION	240210.00
TOTAL		1252070.00

DRAFT

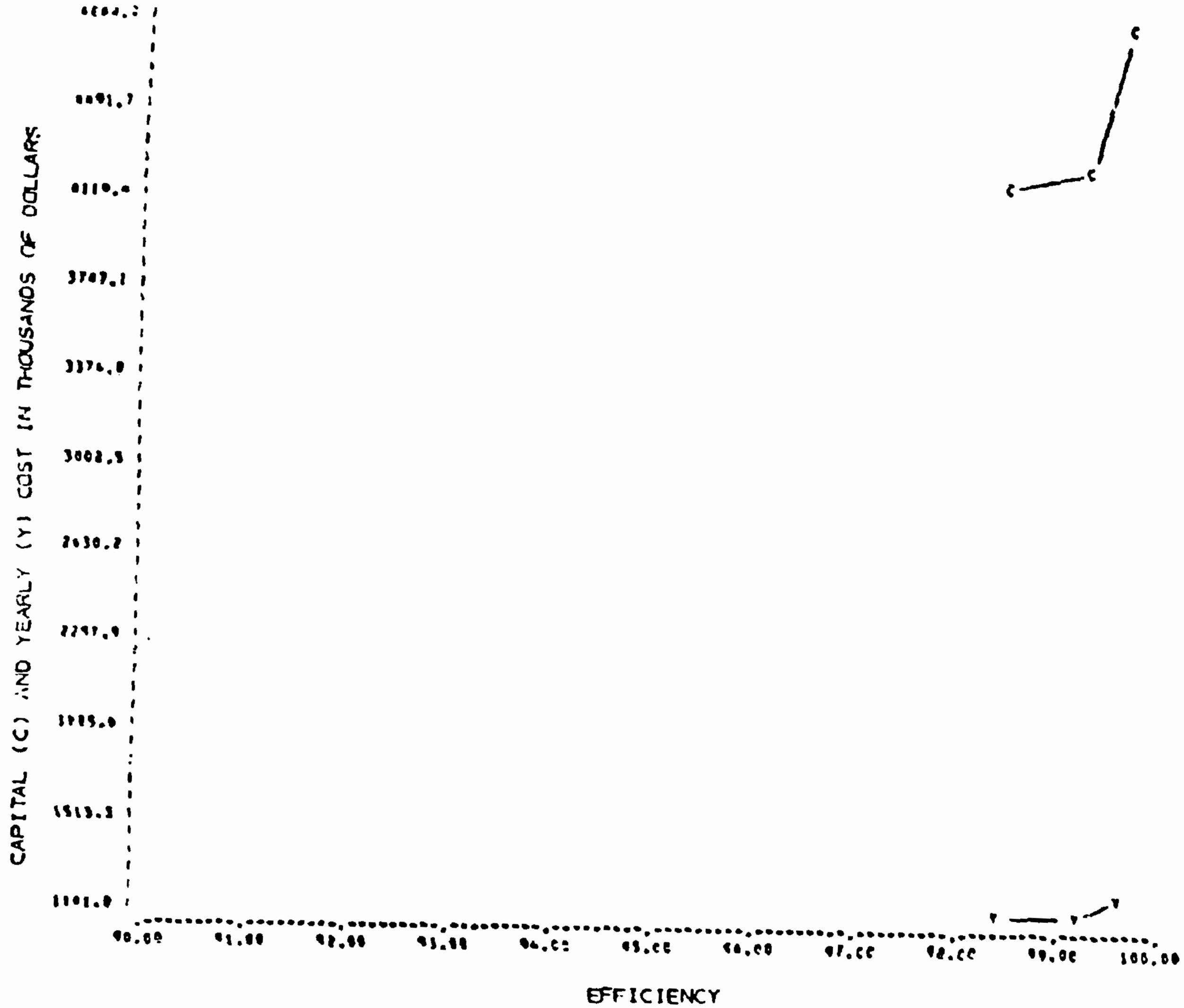


FIGURE 371

INVESTMENT AND YEARLY COST FOR SUBCATEGORY A 33, ALT. XIX

DRAFT

TABLE 468

ITEMIZED COST SUMMARY FOR ALTERNATIVE A33-XX (YEAST)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

Y...HOLDING TANK
U...SPRAY IRRIGATION

INVESTMENT COSTS:

1.	CONSTRUCTION	686310.00
2.	LAND	233230.00
3.	ENGINEERING	68630.00
4.	CONTINGENCY	68630.00
	TOTAL	1056800.00

YEARLY OPERATING COSTS:

1.	LABOR	2500.00
2.	POWER	7640.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	15040.00
	TOTAL	25180.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	25180.00
2.	YEARLY INVESTMENT COST RECOVERY	42270.00
3.	DEPRECIATION	41180.00
	TOTAL	108630.00

DRAFT

In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for zero discharge for the model plant.

Alternative A 34-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a peanut butter plant practicing jar washing is 2800 l (740 gal) per day.

It is assumed that wastes associated with jar washing and cleanup are segregated from non-contact water discharges.

Costs:	0
Reduction Benefits:	None

Alternative A 34-II - This alternative provides a holding tank and spray irrigation.

The resulting BOD waste load is zero, the suspended solids load is zero, and the oil and grease load is zero.

Costs:	Total investment cost:	$37,920
	Total yearly cost:	$ 5,190

An itemized breakdown of costs is presented in Table 469. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

It is assumed that wastes associated with jar washing and cleanup are segregated from non-contact water discharges.

Reduction Benefits:	BOD:	100 percent
	SS:	100 percent
	O&G:	100 percent

Alternative A 34-III - This alternative provides a holding tank and truck hauling.

The resulting BOD waste load is zero, the suspended solids load is zero, and the oil and grease load is zero.

Costs:	Total investment cost:	$23,800
	Total yearly cost:	$ 2,400

An itemized breakdown of costs is presented in Table 470. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

It is assumed that wastes associated with jar washing and cleanup are segregated from non-contact water discharges.

DRAFT

TABLE 469

ITEMIZED COST SUMMARY FOR ALTERNATIVE A34-II
(PEANUT BUTTER WITH JAR WASHING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	29160.00
	2. LAND	2920.00
	3. ENGINEERING	2920.00
	4. CONTINGENCY	2920.00
	TOTAL	37920.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	840.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1080.00
	TOTAL	1920.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	1920.00
	2. YEARLY INVESTMENT COST RECOVERY	1520.00
	3. DEPRECIATION	1750.00
	TOTAL	5190.00

DRAFT

TABLE 470

ITEMIZED COST SUMMARY FOR ALTERNATIVE A34-III (PEANUT BUTTER WITH JAR WASHING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

Y...HOLDING TANK
V... TRUCK HAULING

INVESTMENT COSTS:		
	1. CONSTRUCTION	8450.00
	2. LAND	2670.00
	3. ENGINEERING	840.00
	4. CONTINGENCY	840.00
	TOTAL	12800.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	0.0
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1380.00
	TOTAL	1380.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	1380.00
	2. YEARLY INVESTMENT COST RECOVERY	510.00
	3. DEPRECIATION	510.00
	TOTAL	2400.00

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 35 - Peanut Buttler Plants Without Jar Washing.

A model plant representative of subcategory A 35 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives.

Alternative A 35-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a peanut butter plant not practicing jar washing is 757 l (200 gal) per day.

It is assumed that cleanup wastewater is segregated from all non-contact water discharges.

Costs: 0
Reduction Benefits: None

Alternative A 35-II - This alternative provides a holding tank and spray irrigation.

The resulting BOD waste load is zero, the suspended solids load is zero, and the oil and grease load is zero.

Costs: Total investment cost: $37,170
Total yearly cost: $ 5,120

An itemized breakdown of costs is presented in Table 471. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

It is assumed that all cleanup wastewater is segregated from non-contact water discharged.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Alternative A 35-III - This alternative provides a holding tank and truck hauling.

The resulting BOD waste load is zero, the suspended solids load is zero, and the oil and grease load is zero.

Costs: Total investment cost: $12,710
Total yearly cost: $ 1,560

DRAFT

TABLE 471

ITEMIZED COST SUMMARY FOR ALTERNATIVE A35-II (PEANUT BUTTER WITHOUT JAR WASHING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN YL
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

Y...HOLDING TANK
L...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	28700.00
2. LAND	2730.00
3. ENGINEERING	2870.00
4. CONTINGENCY	2870.00
TOTAL	37170.00

YEARLY OPERATING COSTS:

1. LABOR	0.0
2. POWER	830.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	1080.00
TOTAL	1910.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	1910.00
2. YEARLY INVESTMENT COST RECOVERY	1490.00
3. DEPRECIATION	1720.00
TOTAL	5120.00

An itemized breakdown of costs is presented in Table 472. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

It is assumed that cleanup wastewater is segregated from all non-contact water discharged.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory A 36 - Pectin

A model plant representative of subcategory A 36 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, ten alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 1.8 kkg (2.0 ton) of unfinished pectin per day.

Alternative A 36-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 1.8 kkg (2.0 ton) per day plant is 1530 cu m (0.404 MG) per day. The BOD waste load is 4128 kg/kkg (8256 lb/ton), and the suspended solids load is 1751 kg/kkg (3502 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative A 36-II - This alternative consists of a pumping station, a holding tank, and spray irrigation of the raw waste effluent. Truck hauling of water softening regenerate, diatomaceous filter cake and sluice water, and alcohol still bottoms is also provided.

The resulting BOD waste load is zero, and the suspended solids load is zero.

Costs: Total investment cost: $605,360
Total yearly cost: $ 61,450

An itemized breakdown of costs is presented in Table 473. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that no operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

Alternative A 36-III - This alternative consists of a pumping station, a flow equalization tank, caustic neutralization, complete-mix activated sludge basins, sludge thickening, aerobic digestion, and vacuum filtration.

DRAFT

TABLE 472

ITEMIZED COST SUMMARY FOR ALTERNATIVE A35-III
(PEANUT BUTTER WITHOUT JAR WASHING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK
V... TRUCK HAULING

INVESTMENT COSTS:		
	1. CONSTRUCTION	8360.00
	2. LAND	2670.00
	3. ENGINEERING	840.00
	4. CONTINGENCY	840.00
	TOTAL	12710.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	0.0
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	550.00
	TOTAL	550.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	550.00
	2. YEARLY INVESTMENT COST RECOVERY	510.00
	3. DEPRECIATION	500.00
	TOTAL	1560.00

DRAFT

TABLE 473

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-II (PECTIN)

TEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
ESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

REATMENT MODULES:
Y...HOLDING TANK
L...SPRAY IRRIGATION

NVESTMENT COSTS:		
	1. CONSTRUCTION	389020.00
	2. LAND	138540.00
	3. ENGINEERING	38900.00
	4. CONTINGENCY	38900.00
	TOTAL	605360.00
EARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	4620.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	9280.00
	TOTAL	13900.00
OTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	13900.00
	2. YEARLY INVESTMENT COST RECOVERY	24210.00
	3. DEPRECIATION	23340.00
	TOTAL	61450.00

Truck hauling of water softening regenerate, diatomaceous filter cake and sluice water and alcohol still bottoms is also provided.

The resulting BOD waste load is 208.5 kg/kkg (417.0 lb/ton), and the suspended solids load is 175.1 kg/kkg (350.2 lb/ton).

Costs: Total investment cost: $2,315,170
Total yearly cost: $1,032,870

An itemized breakdown of costs is presented in Table 474. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that four operators are required.

Reduction Benefits: BOD: 94.9 percent
SS: 90.0 percent

Alternative A 36-IV - This alternative replaces the vacuum filtration module of alternative A 36-III with sand drying beds.

The resulting BOD waste load is 208.5 kg/kkg (417.0 lb/ton), and the suspended solids load is 175.1 kg/kkg (350.2 lb/ton).

Costs: Total investment cost: $3,697,430
Total yearly cost: $1,282,820

An itemized breakdown of costs is presented in Table 475. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that four operators are required.

Reduction Benefits: BOD: 94.9 percent
SS: 90.0 percent

Alternative A 36-V - This alternative replaces the vacuum filtration module of alternative A 36-III with spray irrigation of digestor sludge.

The resulting BOD waste load is 208.5 kg/kkg (417.0 lb/ton), and the suspended solids load is 175.1 kg/kkg (350.2 lb/ton).

Costs: Total investment cost: $2,322,150
Total yearly cost: $1,007,310

An itemized breakdown of costs is presented in Table 476. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that four operators are required.

Reduction Benefits: BOD: 94.9 percent
SS: 90.0 percent

Alternative A 36-VI - This alternative consists of a pumping station, a flow equalization tank, and an aerated lagoon. Truck hauling of alcohol still bottoms, diatomaceous filter cake and sluice water, and water

DRAFT

TABLE 474

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-III (PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1...CONTROL HOUSE
- A...PUMPING STATION
- C...EQUALIZATION BASIN
- G...CAUSTIC NEUTRALIZATION
- K...ACTIVATED SLUDGE
- Q...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- S...VACUUM FILTRATION
- V...HAULING

INVESTMENT COSTS:

1.	CONSTRUCTION	1895990.00
2.	LAND	39980.00
3.	ENGINEERING	189600.00
4.	CONTINGENCY	189600.00
TOTAL		2315170.00

YEARLY OPERATING COSTS:

1.	LABOR	49980.00
2.	POWER	392410.00
3.	CHEMICALS	18230.00
4.	MAINTENANCE&SUPPLIES	365880.00
TOTAL		826500.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	826500.00
2.	YEARLY INVESTMENT COST RECOVERY	92610.00
3.	DEPRECIATION	113760.00
TOTAL		1032870.00

DRAFT

TABLE 475

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-IV
(PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

M1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
G...CAUSTIC NEUTRALIZATION
K...ACTIVATED SLUDGE
F...SLUDGE THICKENER
R...AEROBIC DIGESTER
T...SAND DRYING BEDS
V...HAULING

INVESTMENT COSTS:

1. CONSTRUCTION	3064390.00
2. LAND	20160.00
3. ENGINEERING	306440.00
4. CONTINGENCY	306440.00
TOTAL	3697430.00

YEARLY OPERATING COSTS:

1. LABOR	49980.00
2. POWER	383930.00
3. CHEMICALS	8010.00
4. MAINTENANCE&SUPPLIES	509140.00
TOTAL	951060.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	951060.00
2. YEARLY INVESTMENT COST RECOVERY	147900.00
3. DEPRECIATION	183860.00
TOTAL	1282820.00

DRAFT

TABLE 476

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-V (PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- P...PUMPING STATION
- D...EQUALIZATION BASIN
- G...CAUSTIC NEUTRALIZATION
- K...ACTIVATED SLUDGE
- 6...SLUDGE THICKENER
- F...AEROBIC DIGESTOR
- Y...HOLDING TANK
- L...SPRAY IRRIGATION
- V...HAULING

INVESTMENT COSTS:

1. CONSTRUCTION	1923880.00
2. LAND	13490.00
3. ENGINEERING	192390.00
4. CONTINGENCY	192390.00
TOTAL	2322150.00

YEARLY OPERATING COSTS:

1. LABOR	49980.00
2. POWER	384900.00
3. CHEMICALS	8010.00
4. MAINTENANCE&SUPPLIES	356100.00
TOTAL	798990.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	798990.00
2. YEARLY INVESTMENT COST RECOVERY	92890.00
3. DEPRECIATION	115430.00
TOTAL	1007310.00

softening regenerate is also provided.

The resulting BOD waste load is 208.5 kg/kkg (417.0 lb/ton), and the suspended solids load is 175.1 kg/kkg (350.2 lb/ton).

Costs: Total investment cost: $737,920
Total yearly cost: $658,860

An itemized breakdown of costs is presented in Table 477. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one full-time and one-half time operator is required.

Reduction Benefits: BOD: 94.9 percent
SS: 90.0 percent

Alternative A 36-VII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 36-III.

The resulting BOD waste load is 104.3 kg/kkg (208.6 lb/ton), and the suspended solids load is 83.4 kg/kkg (167.0 lb/ton).

Costs: Total investment cost: $2,352,740
Total yearly cost: $1,041,740

An itemized breakdown of costs is presented in Table 478. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that four operators are required.

Reduction Benefits: BOD: 97.5 percent
SS: 95.2 percent

A cost efficiency curve is presented in Figure 372.

Alternative A 36-VIII - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 36-IV.

The resulting BOD waste load is 104.3 kg/kkg (208.6 lb/ton), and the suspended solids load is 83.4 kg/kkg (167.0 lb/ton).

Costs: Total investment cost: $3,734,990
Total yearly cost: $1,291,530

An itemized breakdown of costs is presented in Table 479. It is assumed that land costs $20,510 per hectare ($8300 per acre). It is further assumed that four operators are required.

Reduction Benefits: BOD: 97.5 percent
SS: 95.2 percent

A cost efficiency curve is presented in Figure 373.

DRAFT

TABLE 477

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-VI (PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 90.9 PERCENT BOD REDUCTION

TREATMENT MODULES:

P...PUMPING STATION
E...EQUALIZATION BASIN
L...AERATED LAGOON
V...HAULING

INVESTMENT COSTS:

1.	CONSTRUCTION	590200.00
2.	LAND	8560.00
3.	ENGINEERING	59020.00
4.	CONTINGENCY	59020.00
5.	PVC LINER	21020.00
	TOTAL	737920.00

YEARLY OPERATING COSTS:

1.	LABOR	187[illegible]0.00
2.	POWER	226180.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	346990.00
5.	PVC LINER	970.00
	TOTAL	592880.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	592880.00
2.	YEARLY INVESTMENT COST RECOVERY	29520.00
3.	DEPRECIATION	36460.00
	TOTAL	658860.00

DRAFT

TABLE 478

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-VII (PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
G...CAUSTIC NEUTRALIZATION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTOR
S...VACUUM FILTRATION
V...HAULING
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	1927300.00
2. LAND	39980.00
3. ENGINEERING	192730.00
4. CONTINGENCY	192730.00
TOTAL	2352740.00

YEARLY OPERATING COSTS:

1. LABOR	49980.00
2. POWER	397390.00
3. CHEMICALS	18230.00
4. MAINTENANCE&SUPPLIES	366390.00
TOTAL	831990.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	831990.00
2. YEARLY INVESTMENT COST RECOVERY	94110.00
3. DEPRECIATION	115640.00
TOTAL	1041740.00

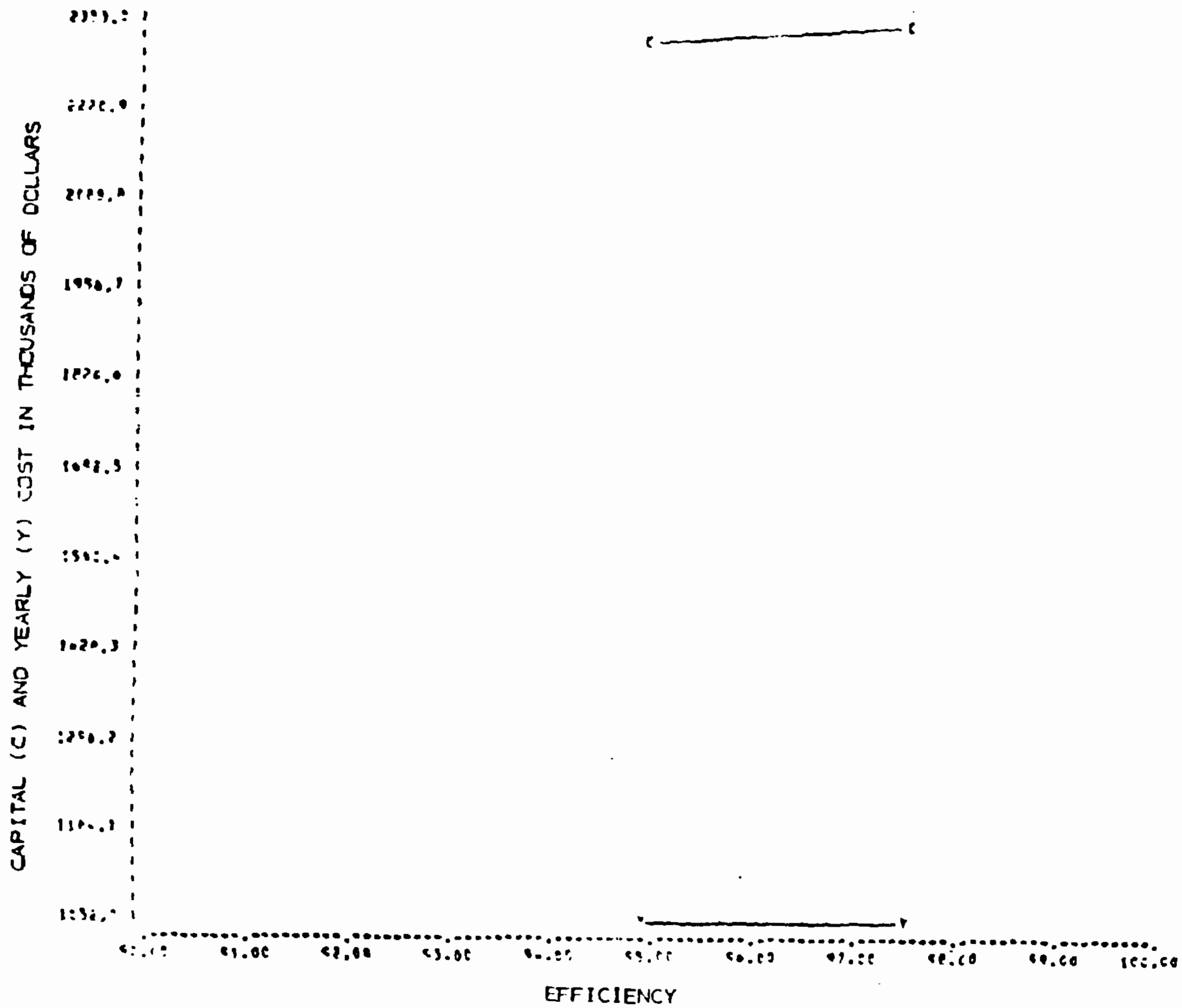


FIGURE 372

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 36, ALT. III, VII

DRAFT

TABLE 479

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-VIII
(PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
G...CAUSTIC NEUTRALIZATION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
R...AEROBIC DIGESTER
T...SAND DRYING BEDS
V...HAULING
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1. CONSTRUCTION	3095690.00
2. LAND	20160.00
3. ENGINEERING	309570.00
4. CONTINGENCY	309570.00
TOTAL	3734990.00

YEARLY OPERATING COSTS:

1. LABOR	49980.00
2. POWER	388920.00
3. CHEMICALS	8010.00
4. MAINTENANCE&SUPPLIES	509480.00
TOTAL	956390.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	956390.00
2. YEARLY INVESTMENT COST RECOVERY	149400.00
3. DEPRECIATION	185740.00
TOTAL	1291530.00

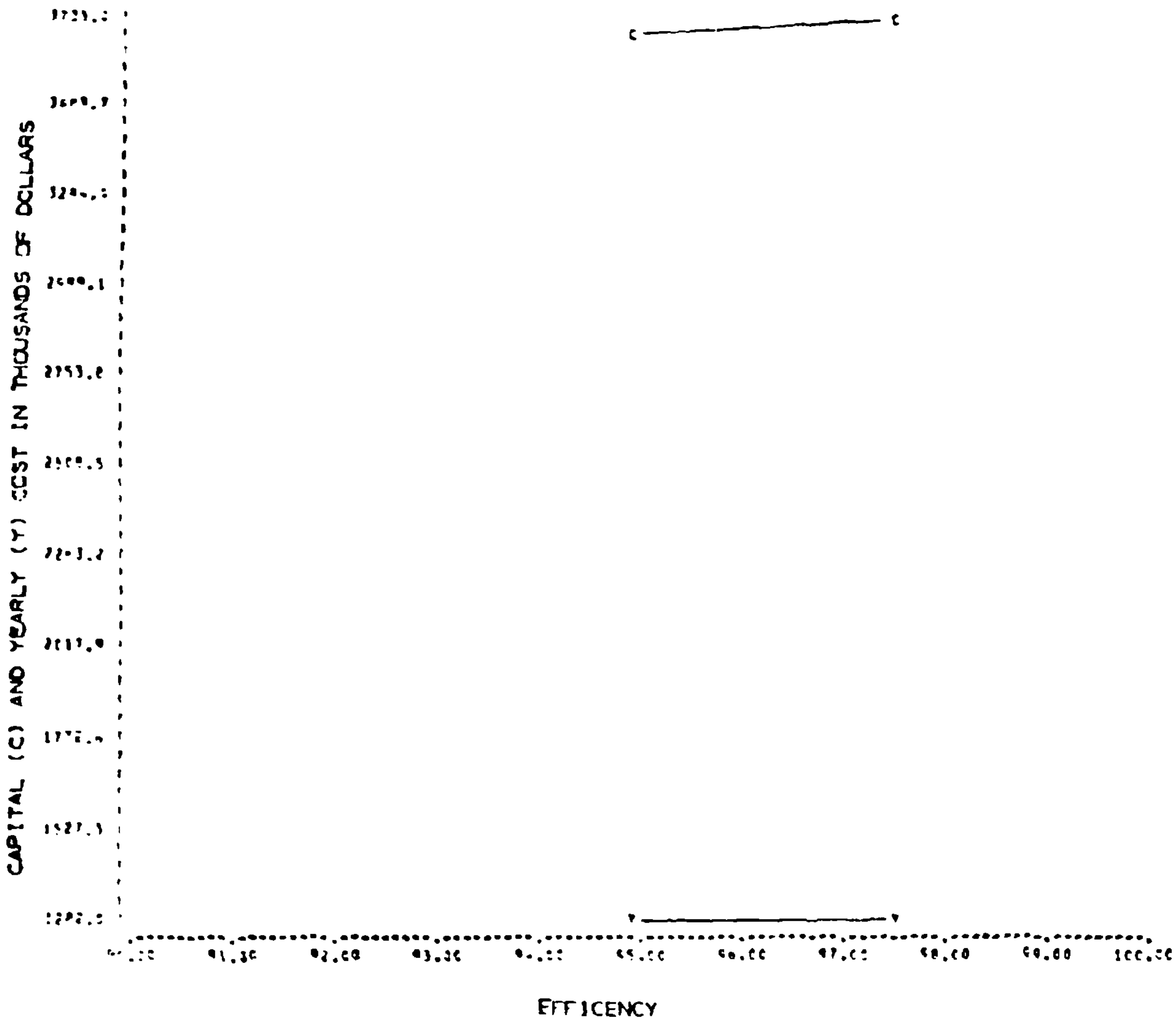


FIGURE 373

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A36, ALT. IV, VIII

Alternative A 36-IV - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 36-V.

The resulting BOD waste load is 104.3 kg/kkg (208.6 lb/ton), and the suspended solids load is 83.4 kg/kkg (167.0 lb/ton).

Costs: Total investment cost: $2,359,710
Total yearly cost: $1,016,190

An itemized breakdown of costs is presented in Table 480. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that four operators are required.

Reduction Benefits: BOD: 97.5 percent
SS: 95.2 percent

A cost efficiency curve is presented in Figure 374.

Alternative A 36-V - This alternative provides dual media filtration in addition to the treatment modules of Alternative A 36-VI.

The resulting BOD waste load is 104.3 kg/kkg (208.6 lb/ton), and the suspended solids load is 83.4 kg/kkg (167.0 lb/ton).

Costs: Total investment cost: $775,490
Total yearly cost: $667,730

An itemized breakdown of costs is presented in Table 481. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one full-time and one half time operator is required.

Reduction Benefits: BOD: 97.5 percent
SS: 95.2 percent

A cost efficiency curve is presented in Figure 375.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 1 - Frozen Prepared Dinners.

A model plant representative of subcategory B 1 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 140 kkg (150 ton) per day.

Alternative B 1-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from 0.140 kkg per day plant is 1100 cu m (0.3 MG) per day. The BOD waste load is 16.7 kg/kkg (33.4 lb/ton), the suspended solids load is 12.5 kg/kkg (25 lb/ton), and the soil and grease load is 16.7 kg/kkg (33.4 lb/ton).

DRAFT

TABLE 480

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-IX
(PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1...CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
G...CAUSTIC NEUTRALIZATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER
R...AEROBIC DIGESTOR
Y...HOLDING TANK
U...SPRAY IRRIGATION
V...HAULING
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	1955180.00
2. LAND	13490.00
3. ENGINEERING	195520.00
4. CONTINGENCY	195520.00
TOTAL	2359710.00

YEARLY OPERATING COSTS:

1. LABOR	49980.00
2. POWER	389890.00
3. CHEMICALS	8010.00
4. MAINTENANCE&SUPPLIES	356610.00
TOTAL	804490.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	804490.00
2. YEARLY INVESTMENT COST RECOVERY	94390.00
3. DEPRECIATION	117310.00
TOTAL	1016190.00

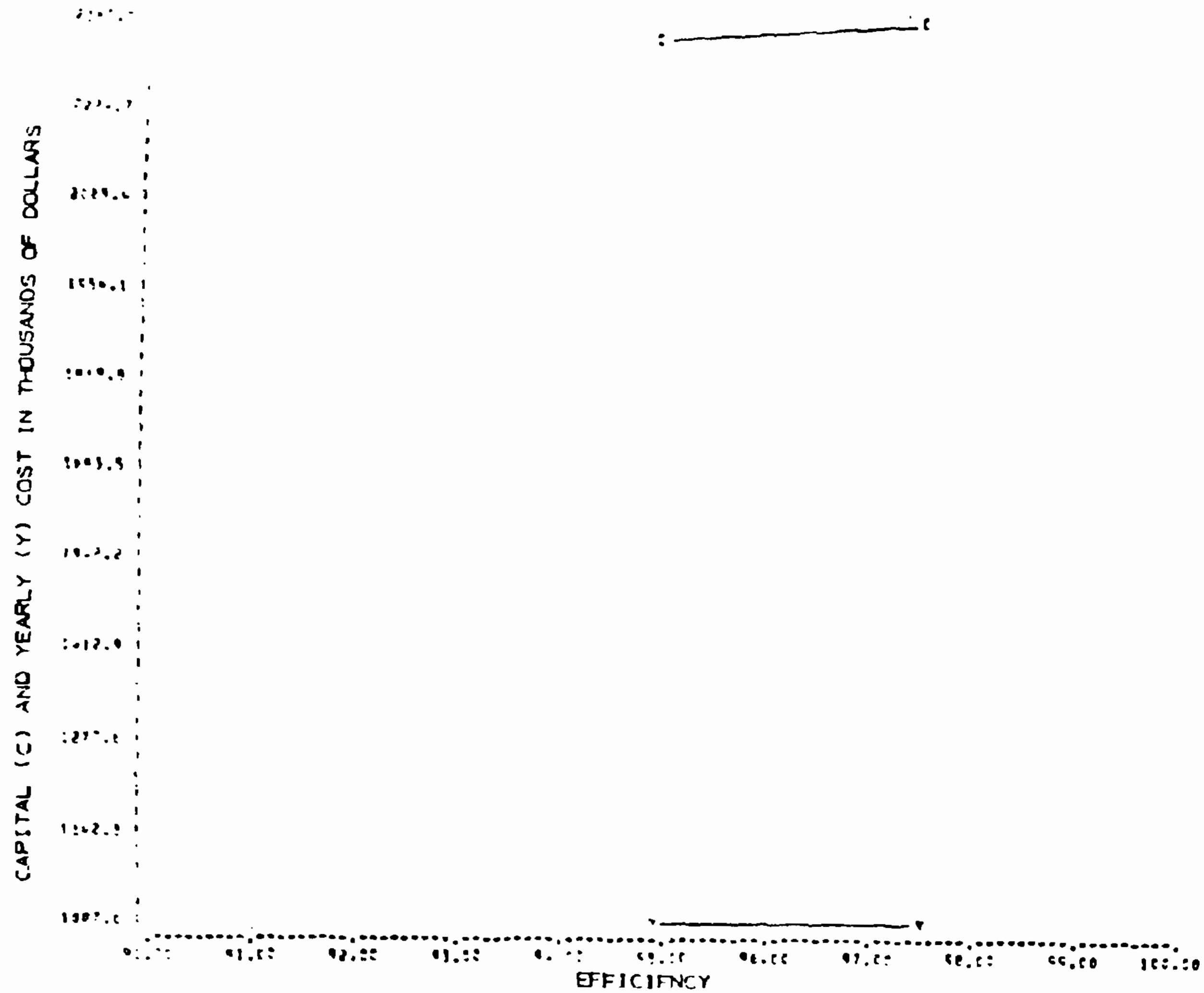


FIGURE 374

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 36, ALT. V, IX

DRAFT

DRAFT

TABLE 481

ITEMIZED COST SUMMARY FOR ALTERNATIVE A36-X
(PECTIN)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
C...EQUALIZATION BASIN
L...AERATED LAGOON
V...HAULING
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1. CONSTRUCTION	621510.00
2. LAND	8660.00
3. ENGINEERING	62150.00
4. CONTINGENCY	62150.00
5. PVC LINER	21020.00
TOTAL	775490.00

YEARLY OPERATING COSTS:

1. LABOR	18740.00
2. POWER	231160.00
3. CHEMICALS	0.0
4. MAINTENANCE&SUPPLIES	347500.00
5. PVC LINER	970.00
TOTAL	598370.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	598370.00
2. YEARLY INVESTMENT COST RECOVERY	31020.00
3. DEPRECIATION	38340.00
TOTAL	667730.00

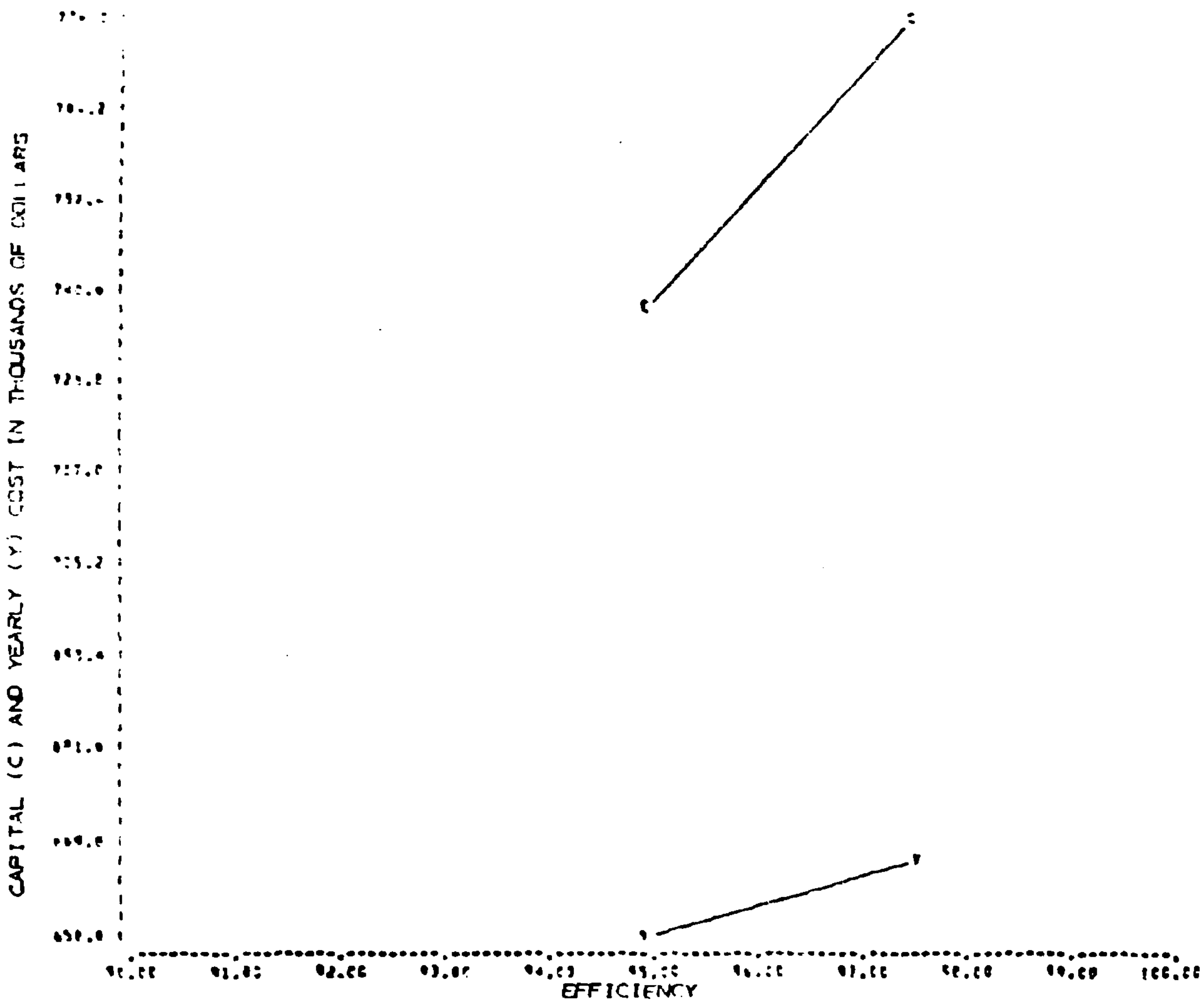


FIGURE 375

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY A 36, ALT. VI, X

DRAFT

Costs: 0
Reduction Benefits: None

Alternative B 1-II - This alternative provides a pumping station, flow equalization, dissolved air flotation, and vacuum filtration and sludge.

The resulting BOD waste load is 6.7 kg/kkg (13.4 lb/ton), the suspended solids load is 2.5 kg/kkg (5.0 lb/ton), and the oil and grease load is 3.3 kg/kkg (6.7 lb/ton).

Costs: Total investment cost: $244,020
Total yearly cost: $ 85,680

An itemized breakdown of costs is presented in Table 482. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 60.0 percent
SS: 80.0 percent
O&G: 80.0 percent

Alternative B 1-III - This alternative provides in addition to Alternative B 1-II a complete-mix activated sludge system with sludge thickening for the waste activated sludge. Addition vacuum filter capacity is included.

The resulting BOD waste load is 0.57 kg/kkg (1.3 lb/ton), the suspended solids load is 0.75 kg/kkg (1.5 lb/ton), and the oil and grease load is 1.0 kg/kkg (2.0 lb/ton).

Costs: Total investment cost: $606,680
Total yearly cost: $169,940

An itemized breakdown of costs is presented in Table 483. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 96.0 percent
SS: 94.0 percent
O&G: 94.0 percent

Alternative B 1-IV - This alternative provides in addition to Alternative B 1-III a dual media filter.

The resulting BOD waste load is 0.33 kg/kkg (0.66 lb/ton), the suspended solids load is 0.25 kg/kkg (0.50 lb/ton), and the oil and grease load is 0.50 kg/kkg (1.0 lb/ton).

Costs: Total investment cost: $652,580
Total yearly cost: $183,010

An itemized breakdown of costs is presented in Table 484. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further

DRAFT

TABLE 482

ITEMIZED COST SUMMARY FOR ALTERNATIVE B1-II.
(FROZEN PREPARED DINNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...60.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	199880.00
	2. LAND	4160.00
	3. ENGINEERING	19990.00
	4. CONTINGENCY	19990.00
	TOTAL	244020.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	18460.00
	3. CHEMICALS	14900.00
	4. MAINTENANCE&SUPPLIES	18080.00
	TOTAL	63930.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	63930.00
	2. YEARLY INVESTMENT COST RECOVERY	9760.00
	3. DEPRECIATION	11990.00
	TOTAL	85680.00

DRAFT

TABLE 483

ITEMIZED COST SUMMARY FOR ALTERNATIVE B1-III
(FROZEN PREPARED DINNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER

INVESTMENT COSTS:

1. CONSTRUCTION	491680.00
2. LAND	16660.00
3. ENGINEERING	49170.00
4. CONTINGENCY	49170.00
TOTAL	606680.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	44130.00
3. CHEMICALS	21280.00
4. MAINTENANCE&SUPPLIES	25770.00
TOTAL	116170.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	116170.00
2. YEARLY INVESTMENT COST RECOVERY	24270.00
3. DEPRECIATION	29500.00
TOTAL	169940.00

DRAFT

TABLE 484

ITEMIZED COST SUMMARY FOR ALTERNATIVE B1-IV
(FROZEN PREPARED DINNERS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:	
1. CONSTRUCTION	529940.00
2. LAND	16660.00
3. ENGINEERING	52990.00
4. CONTINGENCY	52990.00
TOTAL	652580.00
YEARLY OPERATING COSTS:	
1. LABOR	24990.00
2. POWER	52370.00
3. CHEMICALS	21280.00
4. MAINTENANCE&SUPPLIES	26470.00
TOTAL	125110.00
TOTAL YEARLY COSTS:	
1. YEARLY OPERATING COST	125110.00
2. YEARLY INVESTMENT COST RECOVERY	26100.00
3. DEPRECIATION	31800.00
TOTAL	183010.00

DRAFT

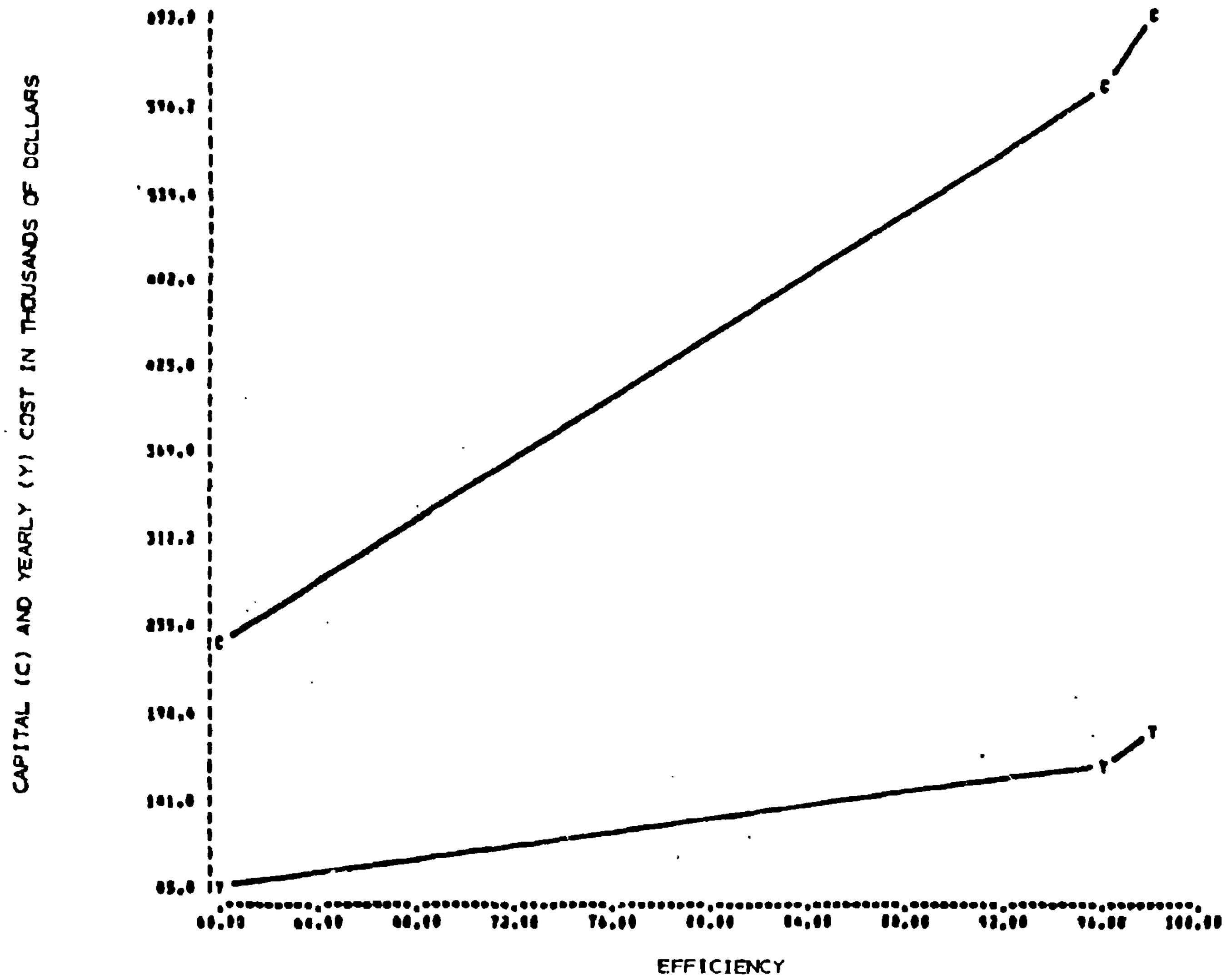


FIGURE 376

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY B1, ALT. IV

assumed that two operators are required.

Reduction Benefits: BOD: 98.0 percent
SS: 98.0 percent
O&G: 97.0 percent

A cost efficiency curve is presented in Figure 376.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 2 - Frozen Breaded and Battered Specialities

A model plant representative of subcategory B 2 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 27 kkg (30 tons) of product per day.

Alternative B 2-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 27 kkg per day plant is 189 cu m (0.05 MG) per day. The BOD waste load is 27.8 kg/kkg (55.6 lb/ton), the suspended solids load is 27.8 kg/kkg (55.6 lb/ton), and the oil and grease load is 2.8 kg/kkg (5.6 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative B 2-II - This alternative consists of flow equalization, dissolved air flotation, and vacuum sludge filtration.

The resulting BOD waste load is 11.1 kg/kkg (22.2 lb/ton), the suspended solids load is 5.56 kg/kkg (11.1 lb/ton) and the oil and grease load is 0.56 kg/kkg (1.1 lb/ton).

Costs: Total investment cost: $129,770
Total yearly cost: $ 38,670

An itemized breakdown of costs is presented in Table 485. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one-half time operator is required.

Reduction Benefits: BOD: 60.0 percent
SS: 80.0 percent
O&G: 80.0 percent

Alternative B 2-III - This alternative provides in addition to Alternative B 2-II an activated sludge system, additional vacuum filtration capacity, and sludge thickening.

The resulting BOD waste load is 1.11 kg/kkg (2.22 lb/ton), the suspended solids load is 1.11 kg/kkg (2.22 lb/ton), and the oil and grease load is

DRAFT

TABLE 485

ITEMIZED COST SUMMARY FOR ALTERNATIVE 82-II
(FROZEN BREADED AND BATTERED SPECIALTIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 60.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
S...VACUUM FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	104670.00
	2. LAND	4160.00
	3. ENGINEERING	10470.00
	4. CONTINGENCY	10470.00
	TOTAL	129770.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	6030.00
	3. CHEMICALS	4680.00
	4. MAINTENANCE&SUPPLIES	10240.00
	TOTAL	27200.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	27200.00
	2. YEARLY INVESTMENT COST RECOVERY	5190.00
	3. DEPRECIATION	6280.00
	TOTAL	38670.00

0.22 kg/kkg (0.44 lb/ton).

Costs: Total investment cost: $239,580
Total yearly cost: $ 63,640

An itemized breakdown of costs is presented in Table 486. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 96.0 percent
SS: 96.0 percent
O&G: 92.0 percent

Alternative B 2-IV - This alternative provides dual media filtration in addition to the treatment modules of B 2-III.

The resulting BOD waste load is 0.56 kg/kkg (1.1 lb/ton), the suspended solids load is 0.56 kg/kkg (1.1 lb/ton), and the oil and grease load is 0.11 kg/kkg (0.22 lb/ton).

Costs: Total investment cost: $257,830
Total yearly cost: $ 69,020

An itemized breakdown of costs is presented in Table 487. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98.0 percent
SS: 98.0 percent
O&G: 96.0 percent

A cost efficiency curve is presented in Figure 377.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 3 - Frozen Bakery Products.

A model plant representative of subcategory B 3 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, four alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 114 kkg (125 tons) of product per day.

Alternative B 3-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 114 kkg per day plant is 114 cu m (0.3 MG) per day. The BOD waste is 40 kg/kkg (80 lb/ton), the suspended solids load is 30 kg/kkg (60 lb/ton), and the oil and grease load is 10 kg/kkg (20 lb/ton).

Costs: 0
Reduction Benefits: None

DRAFT

TABLE 486

ITEMIZED COST SUMMARY FOR ALTERNATIVE B2-III
(FROZEN BREADED AND BATTERED SPECIALTIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

P...PUMPING STATION
C...EQUALIZATION BASIN
J...AIR FLOTATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
C...SLUDGE THICKENER

INVESTMENT COSTS:		
	1. CONSTRUCTION	192710.00
	2. LAND	8330.00
	3. ENGINEERING	19270.00
	4. CONTINGENCY	19270.00
	TOTAL	239580.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	12460.00
	3. CHEMICALS	4680.00
	4. MAINTENANCE&SUPPLIES	12870.00
	TOTAL	42500.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	42500.00
	2. YEARLY INVESTMENT COST RECOVERY	9580.00
	3. DEPRECIATION	11560.00
	TOTAL	63640.00

DRAFT

TABLE 487

ITEMIZED COST SUMMARY FOR ALTERNATIVE B2-IV
(FROZEN BREADED AND BATTERED SPECIALTIES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
- P...PUMPING STATION
- C...EQUALIZATION BASIN
- J...AIR FLOTATION
- S...VACUUM FILTRATION
- K...ACTIVATED SLUDGE
- G...SLUDGE THICKENER
- B...PUMPING STATION
- N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	207920.00
	2. LAND	8330.00
	3. ENGINEERING	20790.00
	4. CONTINGENCY	20790.00
	TOTAL	257630.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	15000.00
	3. CHEMICALS	4680.00
	4. MAINTENANCE&SUPPLIES	14070.00
	TOTAL	46240.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	46240.00
	2. YEARLY INVESTMENT COST RECOVERY	10310.00
	3. DEPRECIATION	12470.00
	TOTAL	69020.00

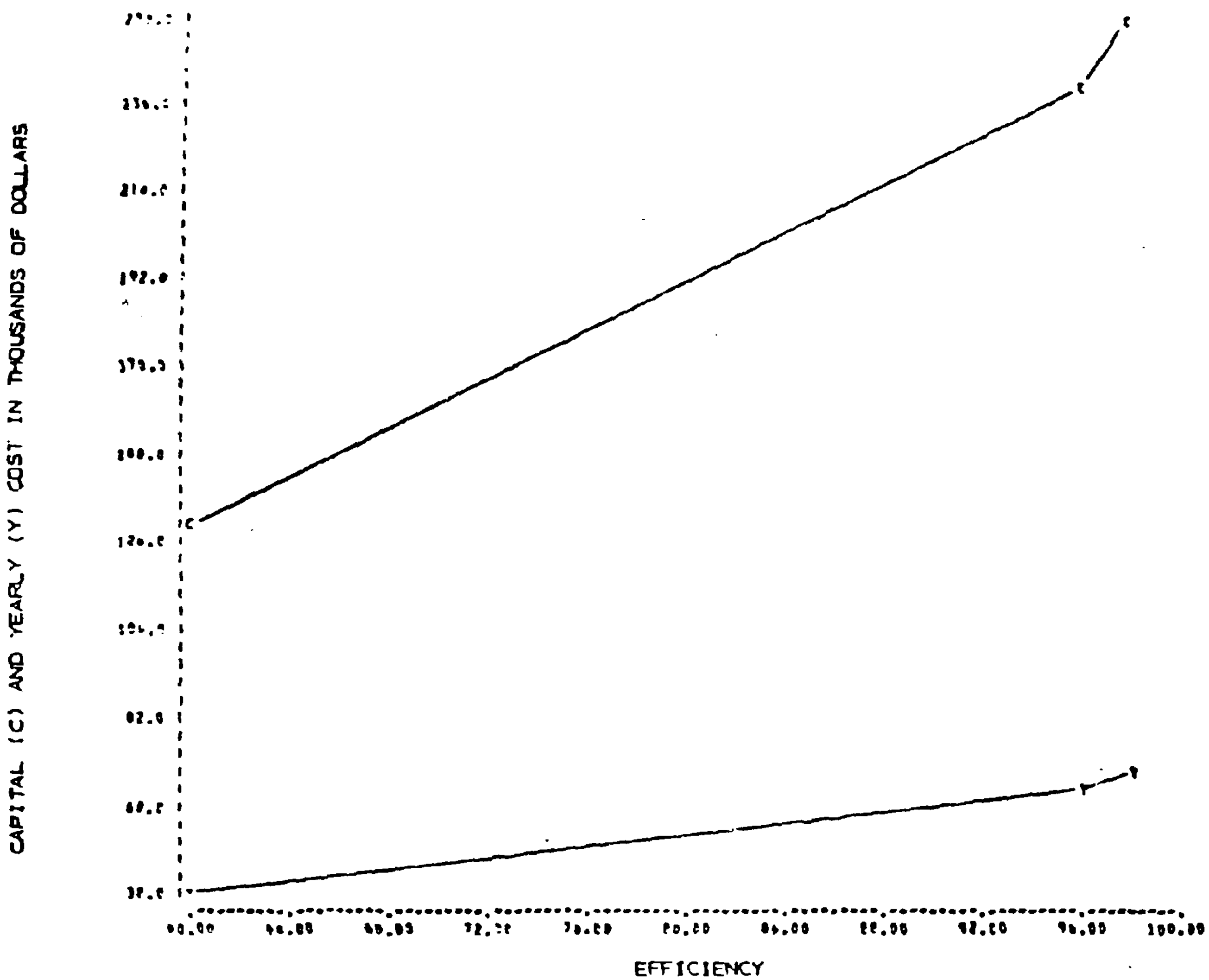


FIGURE 377

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY B2, ALT. IV

DRAFT

Alternative B 3-II - This alternative provides a pumping station, flow equalization, dissolved air flotation and vacuum filtration of sludge.

The resulting BOD waste load is 16 kg/kkg (32 lb/ton), the suspended solids load is 6.0 kg/kkg (12 lb/ton) and the oil and grease load is 2.0 kg/kkg (4.0 lb/ton).

Costs: Total investment cost: $247,190
Total yearly cost: $ 89,500

An itemized breakdown of costs is presented in Table 488. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 60.0 percent
SS: 80.0 percent
O&G: 80.0 percent

Alternative B 3-III - This alternative provides in addition to Alternative B 3-II a complete-mix activated sludge system with sludge thickening for waste activated sludge. Since the wastewater is nutrient deficit, addition of nitrogen and phosphorus is provided.

The resulting BOD waste load is 1.6 kg/kkg (3.2 lb/ton), the suspended solids load is 1.8 kg/kkg (3.2 lb/ton), and the oil and grease load is 0.6 kg/kkg (1.2 lb/ton).

Costs: Total investment cost: $804,610
Total yearly cost: $251,790

An itemized breakdown of costs is presented in Table 489. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits: BOD: 96.0 percent
SS: 94.0 percent
O&G: 94.0 percent

Alternative B 3-IV - This alternative provides in addition to Alternative B 3-III a dual media filter.

The resulting BOD waste load is 0.8 kg/kkg (1.6 lb/ton), the suspended solids load is 0.6 kg/kkg (1.2 lb/ton), and the oil and grease load is 0.3 kg/kkg (0.6 lb/ton).

Costs: Total investment cost: $850,820
Total yearly cost: $265,250

An itemized breakdown of costs is presented in Table 490. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

DRAFT

TABLE 488

ITEMIZED COST SUMMARY FOR ALTERNATIVE B3-II (FROZEN BAKERY PRODUCTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...60.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	202530.00
	2. LAND	4160.00
	3. ENGINEERING	20250.00
	4. CONTINGENCY	20250.00
	TOTAL	247190.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	18600.00
	3. CHEMICALS	17020.00
	4. MAINTENANCE&SUPPLIES	19350.00
	TOTAL	67460.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	67460.00
	2. YEARLY INVESTMENT COST RECOVERY	9890.00
	3. DEPRECIATION	12150.00
	TOTAL	89500.00

DRAFT

TABLE 489

ITEMIZED COST SUMMARY FOR ALTERNATIVE B3-III
(FROZEN BAKERY PRODUCTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...96.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
G...VACUUM FILTRATION
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER

INVESTMENT COSTS:		
	1. CONSTRUCTION	656630.00
	2. LAND	16660.00
	3. ENGINEERING	65660.00
	4. CONTINGENCY	65660.00
	TOTAL	804610.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	66180.00
	3. CHEMICALS	52020.00
	4. MAINTENANCE&SUPPLIES	37020.00
	TOTAL	180210.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	180210.00
	2. YEARLY INVESTMENT COST RECOVERY	32180.00
	3. DEPRECIATION	39400.00
	TOTAL	251790.00

DRAFT

TABLE 490
ITEMIZED COST SUMMARY FOR ALTERNATIVE B3-IV
(FROZEN BAKERY PRODUCTS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION
H...NITROGEN ADDITION
I...PHOSPHORUS ADDITION
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:		
	1. CONSTRUCTION	695140.00
	2. LAND	16660.00
	3. ENGINEERING	69510.00
	4. CONTINGENCY	69510.00
	TOTAL	850820.00
YEARLY OPERATING COSTS:		
	1. LABOR	24990.00
	2. POWER	74770.00
	3. CHEMICALS	52020.00
	4. MAINTENANCE&SUPPLIES	37730.00
	TOTAL	189510.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	189510.00
	2. YEARLY INVESTMENT COST RECOVERY	34030.00
	3. DEPRECIATION	41710.00
	TOTAL	265250.00

DRAFT

Reduction Benefits: BOD: 98.0 percent
SS: 98.0 percent
O&G: 97.0 percent

A cost efficiency curve is presented in Figure 378.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 4 - Tomato - Cheese - Starch

A model plant representative of Subcategory B 4 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 36 kkg (40 tons) of finished product per day.

Alternative B 4-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 36 kkg per day plant is 378 cu m (0.1 MG) per day. The BOD waste load is 7.3 kg/kkg (14.6 lb/ton), the suspended solids load is 4.17 kg/kkg (8.34 lb/ton), and the oil and grease load is 2.8 kg/kkg (4.2 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative B 4-II - This alternative provides a pumping station, flow equalization, dissolved air flotation, and vacuum filtration of sludge.

The resulting BOD waste load is 4.4 kg/kkg (8.8 lb/ton), the suspended solids load is 1.2 kg/kkg (2.4 lb/ton), and the oil and grease load is 0.84 kg/kkg (1.7 lb/ton).

Costs: Total investment cost: $149,340
Total yearly cost: $ 43,060

An itemized breakdown of costs is presented in Table 491. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 40 percent
SS: 70 percent
O&G: 70 percent

Alternative B 4-III - This alternative provides in addition to Alternative B 4-II a complete mix activated sludge system with sludge thickening of the waste activated sludge. Additional vacuum filter capacity is included.

The resulting BOD waste load is 0.44 kg/kkg (0.88 lb/ton), the suspended solids load is 0.42 kg/kkg (0.84 lb/ton), and the oil and grease load is 0.28 kg/kkg (0.56 lb/ton).

Costs: Total investment cost: $297,240
Total yearly cost: $ 79,340

DRAFT

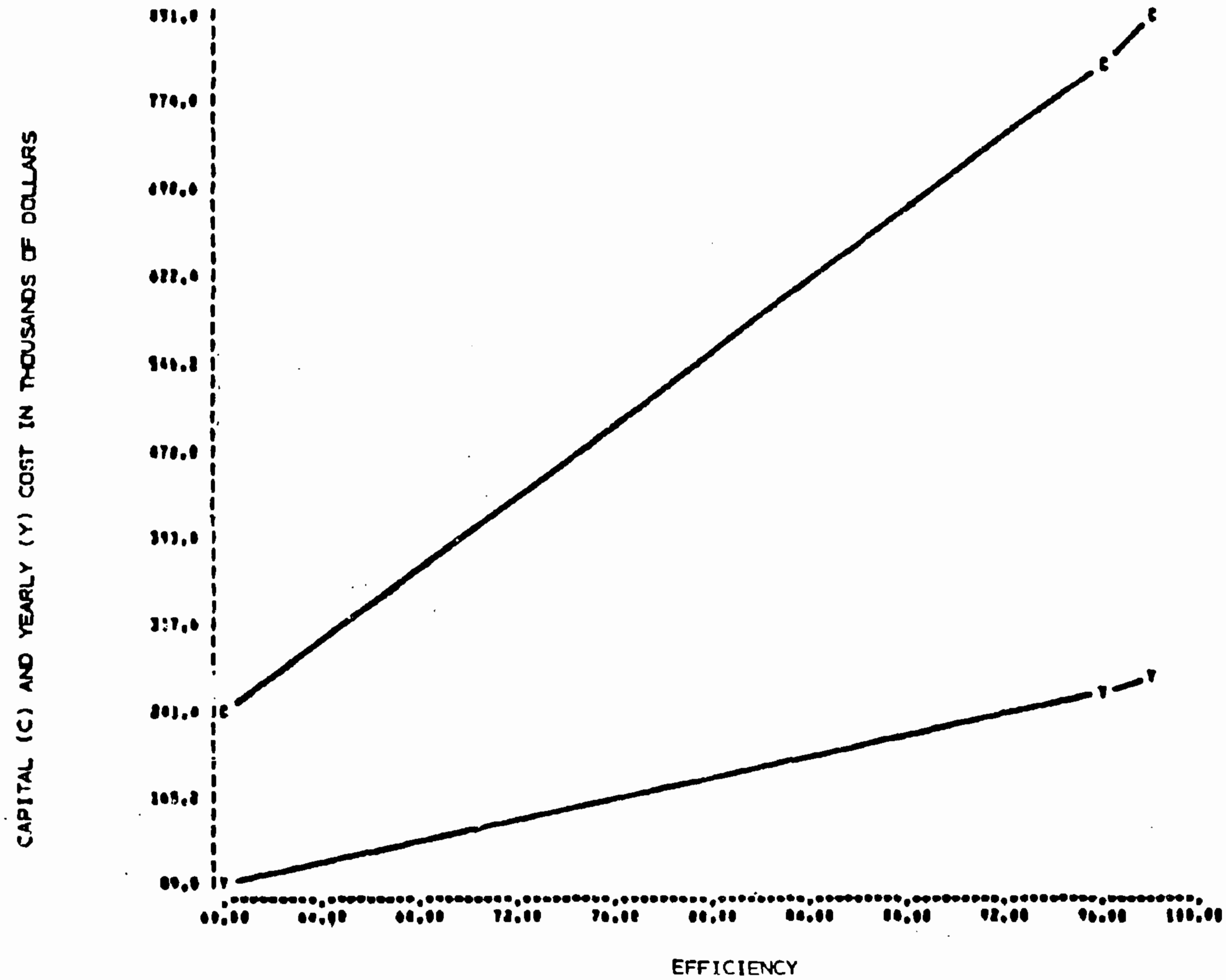


FIGURE 378

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY B3, ALT. IV

DRAFT

TABLE 491

ITEMIZED COST SUMMARY FOR ALTERNATIVE B4-II (TOMATO-CHEESE-STARCH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...40.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
B...PUMPING STATION
J...AIR FLOTATION
B...PUMPING STATION
S...VACUUM FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	120980.00
	2. LAND	4160.00
	3. ENGINEERING	12100.00
	4. CONTINGENCY	12100.00
	TOTAL	149340.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	6350.00
	3. CHEMICALS	2180.00
	4. MAINTENANCE&SUPPLIES	8810.00
	TOTAL	29830.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	29830.00
	2. YEARLY INVESTMENT COST RECOVERY	5970.00
	3. DEPRECIATION	7260.00
	TOTAL	43060.00

An itemized breakdown of costs is presented in Table 492. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that two operators are required.

Reduction Benefits:	BOD:	94	percent
	SS:	90	percent
	O&G:	90.	percent

A cost efficiency curve is presented in Figure 379.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory B 9 - Chili Pepper and Paprika

A model plant representative of Subcategory B 9 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 104 kkg (115 ton) of raw material per day.

Alternative B 9-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 104 kkg per day plant is 1900 cu m (0.5 MG) per day. The BOD waste load is 14.5 kg/kkg (29.0 lb/ton), and the suspended solids load is 9.1 kg/kkg (18.1 lb/ton).

Costs:	0
Reduction Benefits:	None

Alternative B 9-II - This alternative consists of a control house, a pumping station, flow equalization, a complete mix activated sludge system, sludge thickening vacuum filtration and sludge storage.

The resulting BOD waste load is 1.02 kg/kkg (2.04 lb/ton), and the suspended solids load is 1.09 kg/kkg (2.18 lb/ton).

Costs:	Total investment cost:	$481,600
	Total yearly cost:	$130,770

An itemized breakdown of costs is presented in Table 493. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits:	BOD:	93.0 percent
	SS:	88.0 percent

Alternative B 9-III - This alternative provides dual media filtration in addition to the treatment modules of Alternative B 9-II.

The resulting BOD waste load is 0.58 kg/kkg (1.16 lb/ton), and the suspended solids load is 0.55 kg/kkg (1.10 lb/ton).

DRAFT

TABLE 492

ITEMIZED COST SUMMARY FOR ALTERNATIVE B4-III (TOMATO-CHEESE-STARCH)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 94.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

C...EQUALIZATION BASIN
F...PUMPING STATION
J...AIR FLOTATION
F...PUMPING STATION
S...VACUUM FILTRATION
K...ACTIVATED SLUDGE
G...SLUDGE THICKENER

INVESTMENT COSTS:

1. CONSTRUCTION	237290.00
2. LAND	12490.00
3. ENGINEERING	23730.00
4. CONTINGENCY	23730.00
TOTAL	297240.00

YEARLY OPERATING COSTS:

1. LABOR	24990.00
2. POWER	14120.00
3. CHEMICALS	2700.00
4. MAINTENANCE&SUPPLIES	11400.00
TOTAL	53210.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	53210.00
2. YEARLY INVESTMENT COST RECOVERY	11690.00
3. DEPRECIATION	14240.00
TOTAL	79340.00

DRAFT

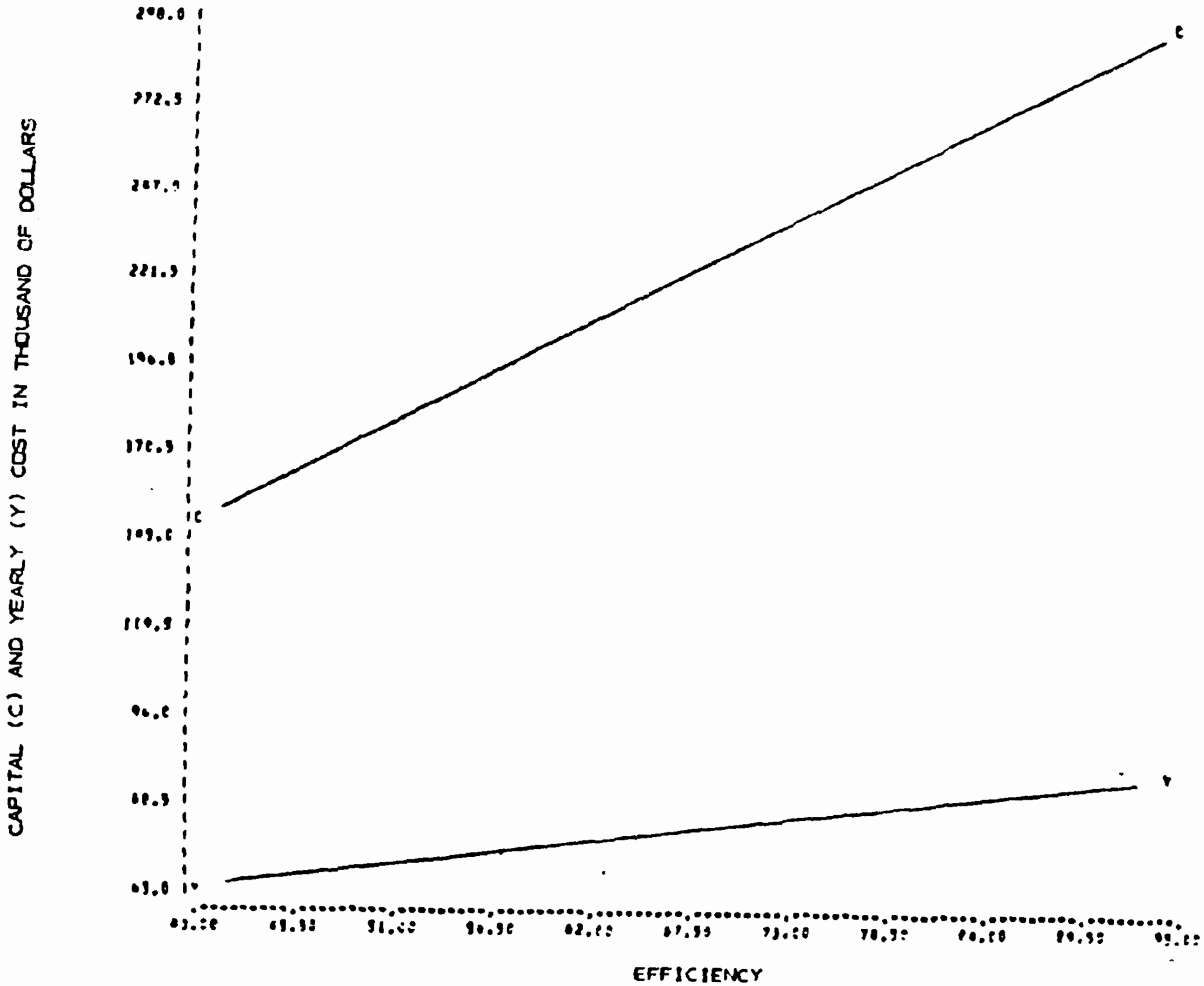


FIGURE 379

[illegible]

DRAFT

TABLE 493

ITEMIZED COST SUMMARY FOR ALTERNATIVE B9-II
(CHILI PEPPER AND PAPRIKA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 92.5 PERCENT BOD REDUCTION

TREATMENT MODULES:
B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
Q...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	372180.00
	2. LAND	34980.00
	3. ENGINEERING	37220.00
	4. CONTINGENCY	37220.00
	TOTAL	481600.00
YEARLY OPERATING COSTS:		
	1. LABOR	37480.00
	2. POWER	33310.00
	3. CHEMICALS	3740.00
	4. MAINTENANCE&SUPPLIES	14650.00
	TOTAL	89180.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	89150.00
	2. YEARLY INVESTMENT COST RECOVERY	19260.00
	3. DEPRECIATION	22330.00
	TOTAL	130770.00

Costs: Total investment cost: $523,790
Total yearly cost: $140,590

An itemized breakdown of costs is presented in Table 494. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 96 percent
SS: 94 percent

A cost efficiency curve is presented in Figure 380.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 4 - Egg Processing

A model plant representative of Subcategory C 4 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, three alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 30 kkg (34 ton) of eggs per day.

Alternatice C 4-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 30 kkg per day plant is 200 cu m (0.05 MG) per day. The BOD waste load is 23 kg/kkg (46 lb/ton), and the suspended solids load is 5.4 kg/kkg (10.8 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative C 4-II - This alternative provides a two-cell aerated lagoon with a 45 day detention time.

The resulting BOD waste load is 1.15 kg/kkg (2.3 lb/ton), and the suspended solids load is 0.81 kg/kkg (1.6 lb/ton).

Costs: Total investment cost: $246,090
Total yearly cost: $ 48,270

An itemized breakdown of costs is presented in Table 495. It is assumed that land costs $410 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 95 percent
SS: 85 percent

Alternative C 4-III - This alternative adds a dual media filter to Alternative C 4-II.

DRAFT

TABLE 494

ITEMIZED COST SUMMARY FOR ALTERNATIVE B9-III
(CHILI PEPPER AND PAPRIKA)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 96.2 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
S...VACUUM FILTRATION
Y...HOLDING TANK
2...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	407350.00
2.	LAND	34980.00
3.	ENGINEERING	40730.00
4.	CONTINGENCY	40730.00
TOTAL		523790.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	38750.00
3.	CHEMICALS	3740.00
4.	MAINTENANCE&SUPPLIES	15230.00
TOTAL		95200.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	95200.00
2.	YEARLY INVESTMENT COST RECOVERY	20950.00
3.	DEPRECIATION	24440.00
TOTAL		140590.00

DRAFT

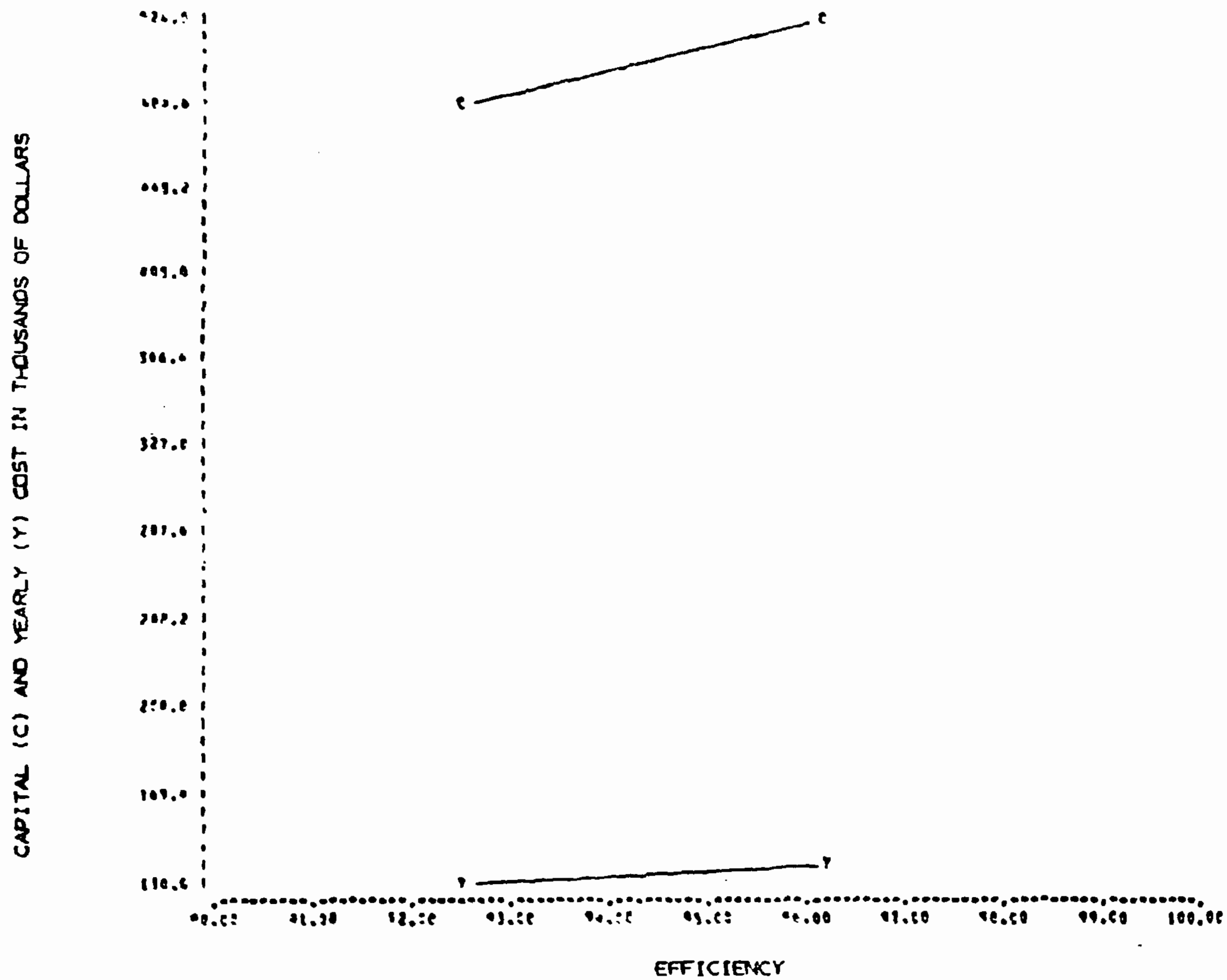


FIGURE 380

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY B9, ALT. III

DRAFT

TABLE 495

ITEMIZED COST SUMMARY FOR ALTERNATIVE C4-II
(EGG PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
L...AERATED LAGOON
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	195330.00
	2. LAND	4160.00
	3. ENGINEERING	19530.00
	4. CONTINGENCY	19530.00
	5. PVC LINER	7540.00
	TOTAL	246090.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	10910.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	2660.00
	5. PVC LINER	270.00
	TOTAL	26330.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	26330.00
	2. YEARLY INVESTMENT COST RECOVERY	9840.00
	3. DEPRECIATION	12100.00
	TOTAL	48270.00

The resulting BOD waste load is 0.69 kg/kkg (1.38 lb/ton), and the suspended solids load is 0.16 kg/kkg (0.32 lb/ton).

Costs: Total investment cost: $275,200
Total yearly cost: $ 55,940

An itemized breakdown of costs is presented in Table 496. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 97 percent
SS: 97 percent

A cost efficiency curve is presented in Figure 381.

Alternative C 4-IV - This alternative provides an anaerobic lagoon with 10 days retention and an aerated lagoon with 6 days retention.

The resulting BOD waste load is 0.46 kg/kkg (0.92 lb/ton), and the suspended solids load is 0.54 kg/kkg (1.1 lb/ton).

Costs: Total investment cost: $176,810
Total yearly cost: $ 32,270

An itemized breakdown of costs is presented in Table 497. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 98 percent
SS: 90 percent

Alternative C 4-V - This alternative adds dual media filtration to Alternative C 4-IV.

The resulting BOD waste load is 0.23 kg/kkg (0.46 lb/ton), and the suspended solids load is 0.11 kg/kkg (0.22 lb/ton).

Costs: Total investment cost: $205,920
Total yearly cost: $ 39,360

An itemized breakdown of costs is presented in Table 498. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required.

Reduction Benefits: BOD: 99 percent
SS: 98 percent

A cost efficiency curve is presented in Figure 382.

DRAFT

TABLE 496

ITEMIZED COST SUMMARY FOR ALTERNATIVE C4-III (EGG PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

L...AERATED LAGOON
L...AERATED LAGOON
P...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	219580.00
2.	LAND	4160.00
3.	ENGINEERING	21960.00
4.	CONTINGENCY	21960.00
5.	PVC LINER	7540.00
	TOTAL	275200.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	14520.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	4100.00
5.	PVC LINER	270.00
	TOTAL	31380.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	31380.00
2.	YEARLY INVESTMENT COST RECOVERY	11010.00
3.	DEPRECIATION	13550.00
	TOTAL	55940.00

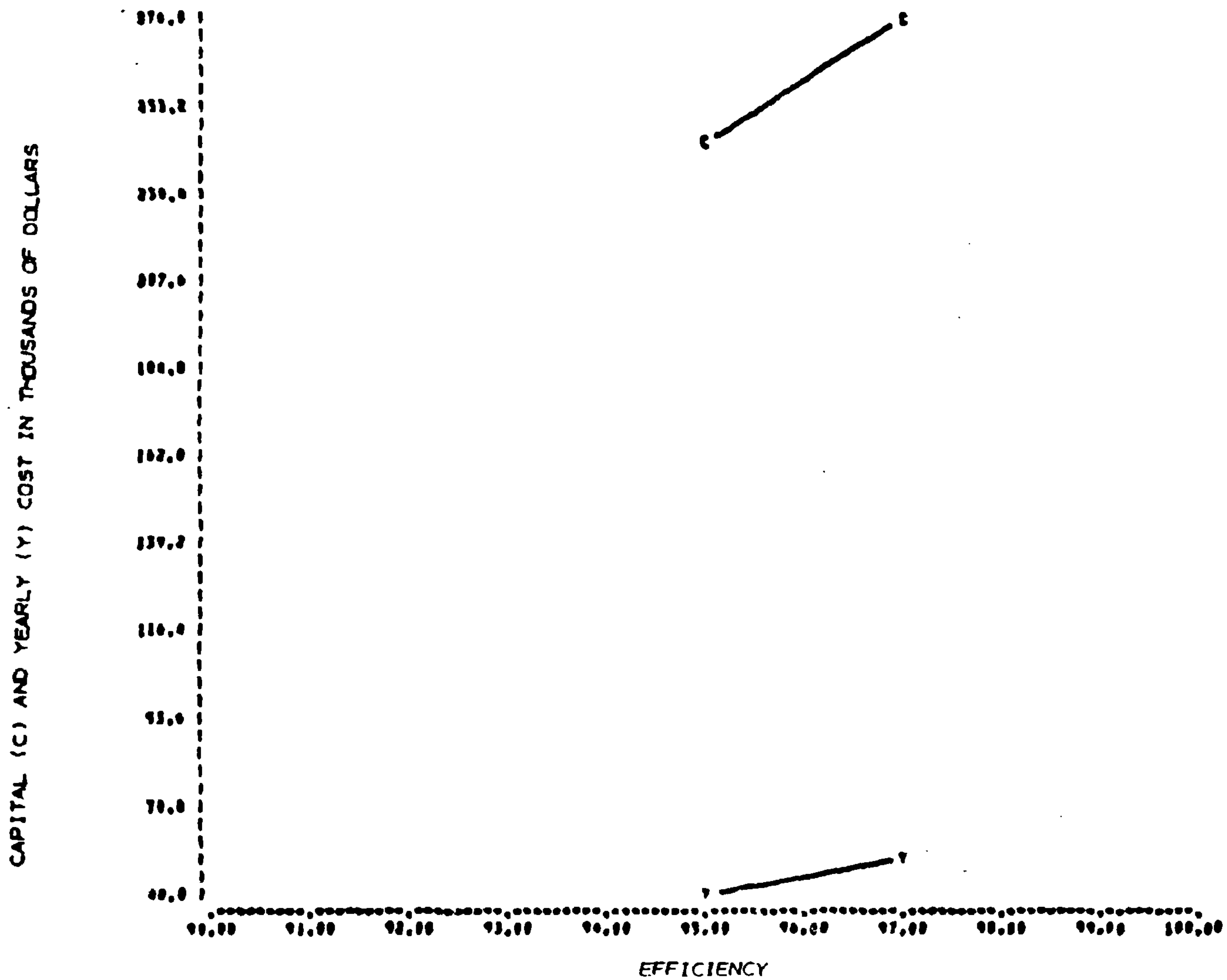


FIGURE 381

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C4, ALT. III

DRAFT

TABLE 497

ITEMIZED COST SUMMARY FOR ALTERNATIVE C4-IV (EGG PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
M...SETTLING POND
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	139440.00
	2. LAND	4160.00
	3. ENGINEERING	13940.00
	4. CONTINGENCY	13940.00
	5. PVC LINER	5330.00
	TOTAL	176810.00
YEARLY OPERATING COSTS:		
	1. LABOR	12490.00
	2. POWER	2200.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1430.00
	5. PVC LINER	450.00
	TOTAL	16570.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	16570.00
	2. YEARLY INVESTMENT COST RECOVERY	7070.00
	3. DEPRECIATION	8630.00
	TOTAL	32270.00

DRAFT

TABLE 498

ITEMIZED COST SUMMARY FOR ALTERNATIVE C4-V (EGG PROCESSING)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 99.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

M...SETTLING POND
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATN

INVESTMENT COSTS:

1.	CONSTRUCTION	163690.00
2.	LAND	4160.00
3.	ENGINEERING	16370.00
4.	CONTINGENCY	16370.00
5.	PVC LINER	5330.00
	TOTAL	205920.00

YEARLY OPERATING COSTS:

1.	LABOR	12490.00
2.	POWER	5820.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	2870.00
5.	PVC LINER	450.00
	TOTAL	21630.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	21630.00
2.	YEARLY INVESTMENT COST RECOVERY	8240.00
3.	DEPRECIATION	10090.00
	TOTAL	39960.00

DRAFT

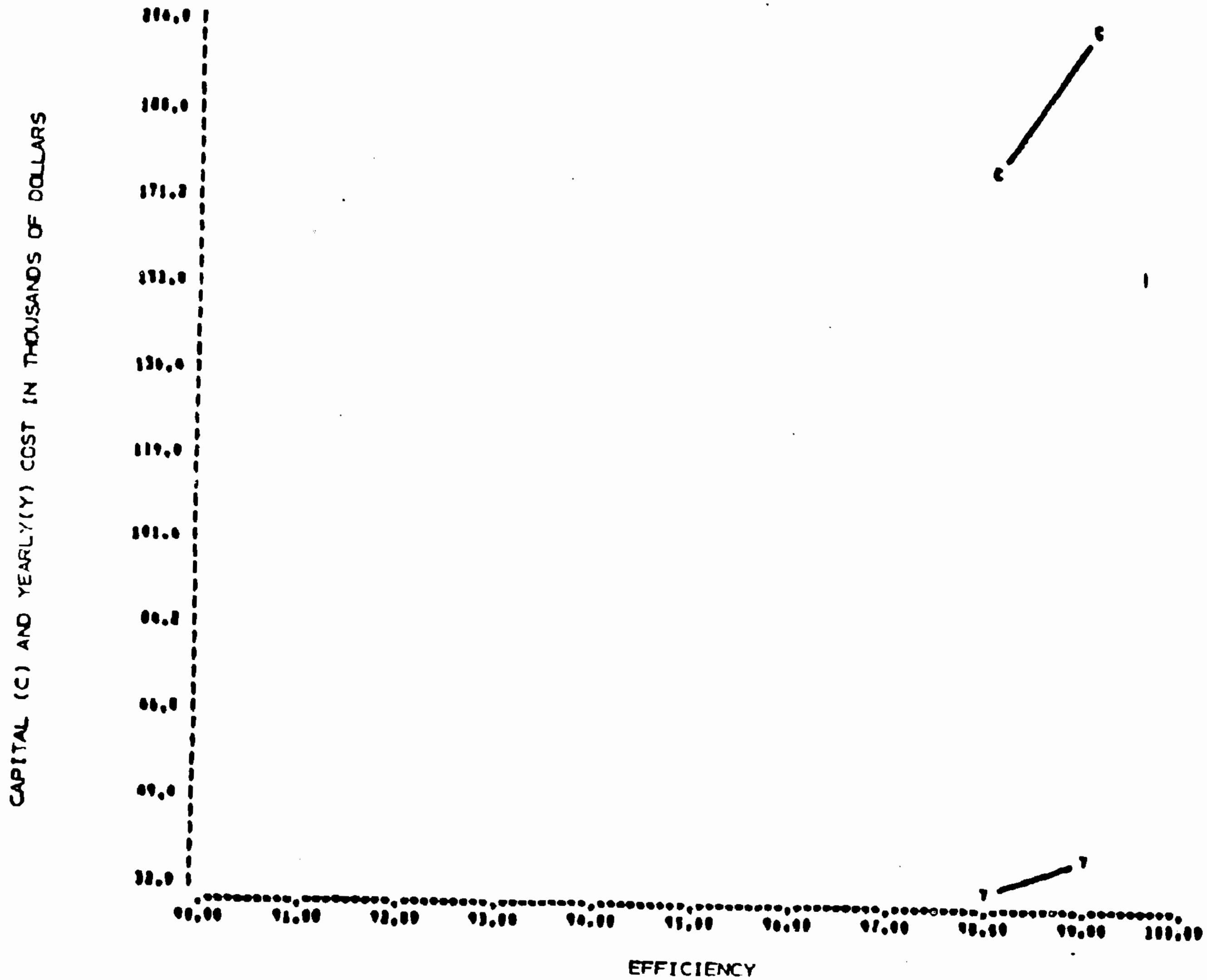


FIGURE 382

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C4, ALT. V

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 5 - Shell Eggs

A model plant representative of Subcategory C 5 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, five alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which processes 12.5 kkg (14 ton) of eggs per day.

Alternative C 5-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 12.5 kkg per day plant is 13 cu m (0.0035 MG) per day. The BOD waste load is 1.56 kg/kkg (3.1 lb/ton), and the suspended solids load is 0.52 kg/kkg (1.0 lb/ton).

Costs: 0
Reduction Benefits: None

Alternative C 5-II - This alternative provides a two-cell aerated lagoon with a retention time of 45 days.

The resulting BOD waste load is 0.078 kg/kkg (0.15 lb/ton), and the suspended solids load is 0.078 kg/kkg (0.15 lb/ton).

Costs: Total investment cost: $233,760
Total yearly cost: $ 32,620

An itemized breakdown of costs is presented in Table 499. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 95 percent
SS: 85 percent

Alternative C 5-III - This alternative adds dual media filtration to Alternative C 5-II.

The resulting BOD waste load is 0.047 kg/kkg (0.094 lb/ton), and the suspended solids load is 0.021 kg/kkg (0.042 lb/ton).

Costs: Total investment cost: $248,010
Total yearly cost: $ 36,880

An itemized breakdown of costs is presented in Table 500. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 97 percent
SS: 96 percent

A cost efficiency curve is presented in Figure 383.

DRAFT

TABLE 499

ITEMIZED COST SUMMARY FOR ALTERNATIVE C5-II
(SHELL EGGS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
L...AERATED LAGOON
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	186290.00
	2. LAND	2670.00
	3. ENGINEERING	18630.00
	4. CONTINGENCY	18630.00
	5. PVC LINER	7540.00
	TOTAL	233760.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	3050.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	2150.00
	5. PVC LINER	270.00
	TOTAL	11720.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	11720.00
	2. YEARLY INVESTMENT COST RECOVERY	9350.00
	3. DEPRECIATION	11550.00
	TOTAL	32620.00

TABLE 500

ITEMIZED COST SUMMARY FOR ALTERNATIVE C5-III (SHELL EGGS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN (PLL)PN
DESIGN EFFICIENCY... 97.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

P...PUMPING STATION
L...AERATED LAGOON
L...AERATED LAGOON
P...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:

1.	CONSTRUCTION	198160.00
2.	LAND	2670.00
3.	ENGINEERING	19820.00
4.	CONTINGENCY	19820.00
5.	PVC LINER	7540.00
	TOTAL	248010.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	3980.00
3.	CHEMICALS	0.0
4.	MAINTENANCE&SUPPLIES	4190.00
5.	PVC LINER	270.00
	TOTAL	14690.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	14690.00
2.	YEARLY INVESTMENT COST RECOVERY	9920.00
3.	DEPRECIATION	12270.00
	TOTAL	36680.00

DRAFT

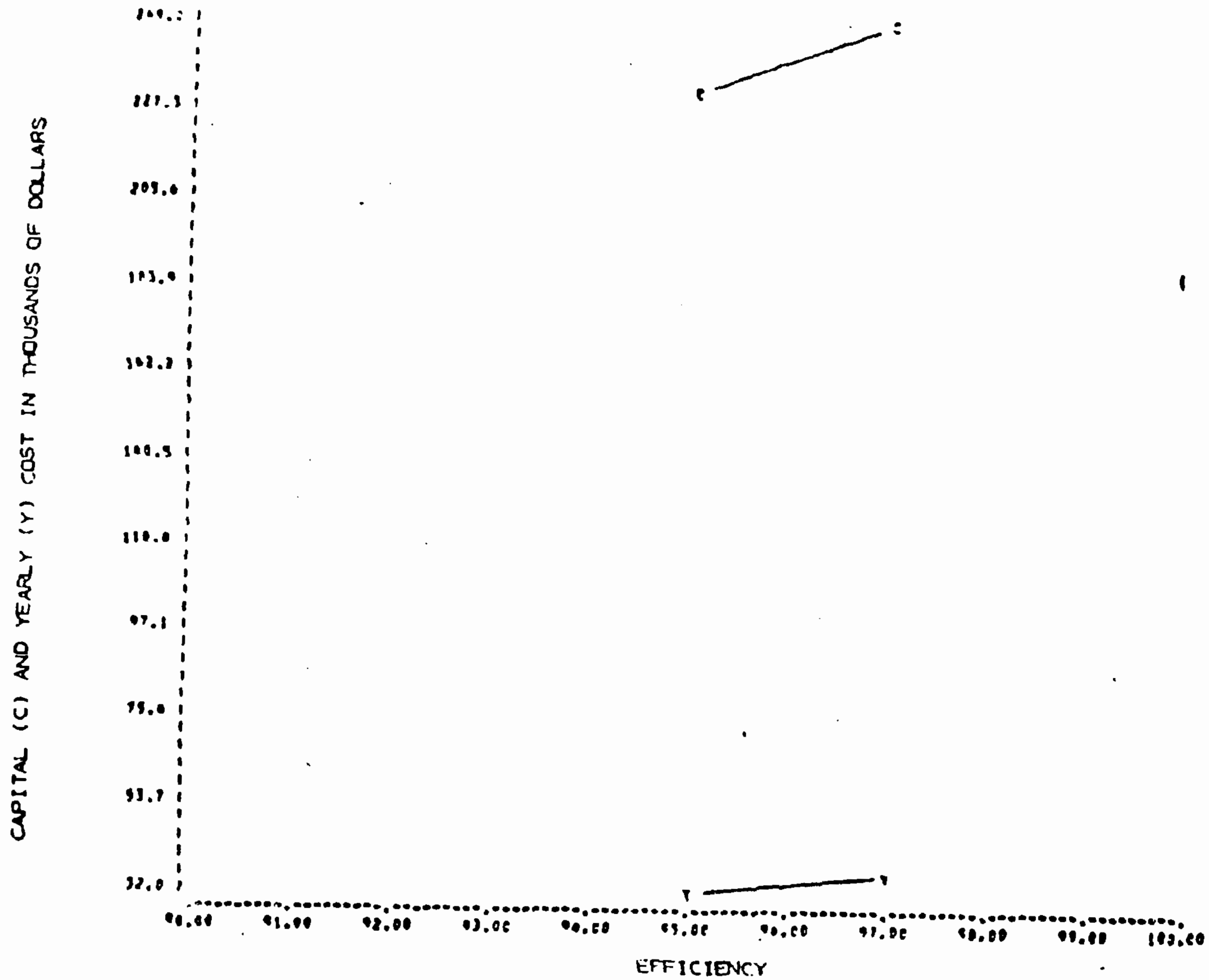


FIGURE 383

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C5, ALT. III

Alternative C 5-IV - This alternative consists of an anaerobic lagoon with 10 days retention and an aerobic lagoon with 6 days retention.

The resulting BOD waste load is 0.031 kg/kkg (0.062 lb/ton), and the suspended solids load is 0.052 kg/kkg (0.10 lb/ton).

Costs:	Total investment cost:	$137,640
	Total yearly cost:	$ 22,010

An itemized breakdown of costs is presented in Table 501. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits:	BOD:	98 percent
	SS:	90 percent

Alternative C 5-V - This alternative adds dual media filtration to Alternative C 5-IV.

The resulting BOD waste load is 0.016 kg/kkg (0.032 lb/ton), and the suspended solids load is 0.01 kg/kkg (0.02 lb/ton).

Costs:	Total investment cost:	$151,890
	Total yearly cost:	$ 26,250

An itemized breakdown of costs is presented in Table 502. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits:	BOD:	99 percent
	SS:	98 percent

A cost efficiency curve is presented in Figure 384.

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory C 12 - Prepared Sandwicnes

A model plant representative of Subcategory C 12 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, two alternatives were selected as being applicable.

Alternative C 12-I - This alternative assumes no treatment and no reduction in the waste load.

Costs:	0
Reduction Benefits:	None

Alternative C 12-II - This alternative provides a holding tank and truck hauling of all wastewater. It is assumed that hauling cost is $100 (1974) per haul and that there are five hauls per week.

DRAFT

TABLE 501

ITEMIZED COST SUMMARY FOR ALTERNATIVE C5-IV (SHELL EGGS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN BML
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
M...SETTLING POND
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	109030.00
	2. LAND	2670.00
	3. ENGINEERING	10900.00
	4. CONTINGENCY	10900.00
	5. PVC LINER	4140.00
	TOTAL	137640.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	1960.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	1390.00
	5. PVC LINER	150.00
	TOTAL	9750.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	9750.00
	2. YEARLY INVESTMENT COST RECOVERY	5510.00
	3. DEPRECIATION	6750.00
	TOTAL	22010.00

DRAFT

TABLE 502

ITEMIZED COST SUMMARY FOR ALTERNATIVE C5-V
(SHELL EGGS)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 90.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
M...SETTLING POND
L...AERATED LAGOON
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRATION

INVESTMENT COSTS:		
	1. CONSTRUCTION	120900.00
	2. LAND	2670.00
	3. ENGINEERING	12090.00
	4. CONTINGENCY	12090.00
	5. PVC LINER	4140.00
	TOTAL	151890.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	2890.00
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	3420.00
	5. PVC LINER	150.00
	TOTAL	12710.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	12710.00
	2. YEARLY INVESTMENT COST RECOVERY	6080.00
	3. DEPRECIATION	7460.00
	TOTAL	26250.00

1451

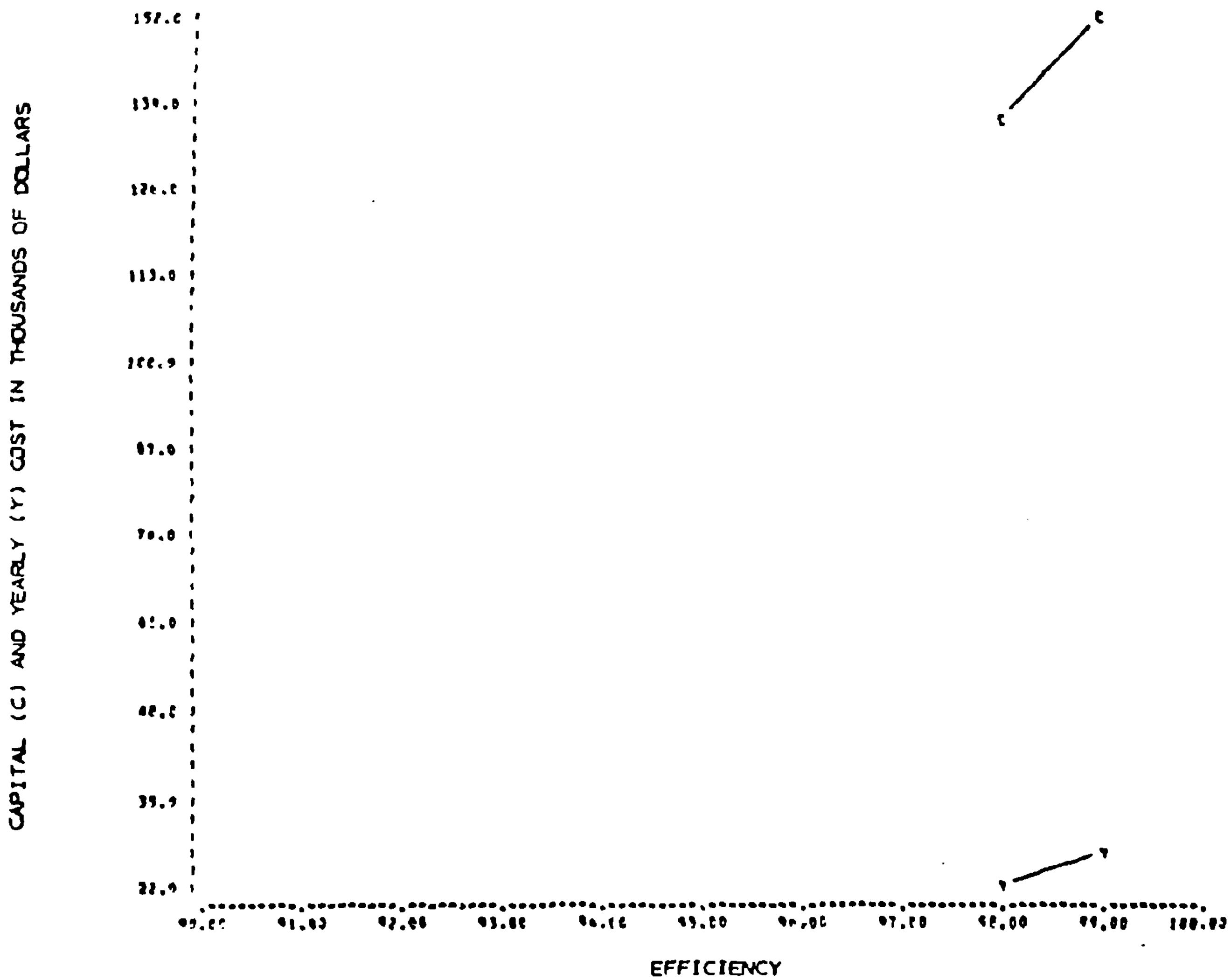


FIGURE 384

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY C5, ALT. V

DRAFT

Costs: Total investment cost: $11,540
Total yearly cost: $22,960

An itemized breakdown of costs is presented in Table 503.

Reduction Benefits: BOD: 100 percent
SS: 100 percent
O&G: 100 percent

Cost and Reduction Benefits of Alternative Treatment Technologies for Subcategory D 4 - Vinegar

A model plant representative of Subcategory D 4 was developed in Section V for the purpose of applying control and treatment alternatives. In Section VII, seven alternatives were selected as being applicable engineering alternatives. These alternatives provide for various levels of waste reductions for the model plant which produces 78 cu m (20,000 gal) of vinegar per day.

Alternative D 4-I - This alternative assumes no treatment and no reduction in the waste load. It is estimated that the effluent from a 78 cu m per day plant is 90.8 cu m (0.024 MG) per day. The BOD waste load is 1.92 kg/cu m (16.0 lb/1000 gal), and the suspended solids load is 5.38 kg/cu m (10.8 lb/1000 gal).

Costs: 0
Reduction Benefits: None

Alternative D 4-II - This alternative provides a pumping station, flow equalization, caustic neutralization, nitrogen addition, and an aerated lagoon.

The resulting BOD waste load is 0.096 kg/cu m (0.8 lb/1000 gal), and the suspended solids load is 0.43 kg/cu m (3.6 lb/1000 gal).

Costs: Total investment cost: $172,400
Total yearly cost: $ 44,360

An itemized breakdown of costs is presented in Table 504. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 95 percent
SS: 92 percent

Alternative D 4-III - This alternative replaces the aerated lagoon of Alternative D 4-II with a complete mix activated sludge system and provides sludge thickening, aerobic digestion, and truck hauling.

The resulting BOD waste load is 0.06 kg/cu m (0.5 lb/1000 gal), and the suspended solids load is 0.27 kg/cu m (2.25 lb/1000 gal).

DRAFT

TABLE 503

ITEMIZED COST SUMMARY FOR ALTERNATIVE C12-II
(PREPARED SANDWICHES)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...*100 PERCENT BOD REDUCTION

TREATMENT MODULES:
Y...HOLDING TANK

INVESTMENT COSTS:		
	1. CONSTRUCTION	9620.00
	2. LAND	0.0
	3. ENGINEERING	960.00
	4. CONTINGENCY	960.00
	TOTAL	11540.00
YEARLY OPERATING COSTS:		
	1. LABOR	0.0
	2. POWER	0.0
	3. CHEMICALS	0.0
	4. MAINTENANCE&SUPPLIES	21920.00
	TOTAL	21920.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	21920.00
	2. YEARLY INVESTMENT COST RECOVERY	460.00
	3. DEPRECIATION	580.00
	TOTAL	22960.00

DRAFT

TABLE 504

ITEMIZED COST SUMMARY FOR ALTERNATIVE D4-II
(VINEGAR)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:
B...PUMPING STATION
G...CAUSTIC NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON

INVESTMENT COSTS:		
	1. CONSTRUCTION	137970.00
	2. LAND	2920.00
	3. ENGINEERING	13800.00
	4. CONTINGENCY	13800.00
	5. PVC LINER	3910.00
	TOTAL	172400.00
YEARLY OPERATING COSTS:		
	1. LABOR	6250.00
	2. POWER	14990.00
	3. CHEMICALS	5060.00
	4. MAINTENANCE&SUPPLIES	2630.00
	5. PVC LINER	60.00
	TOTAL	28990.00
TOTAL YEARLY COSTS:		
	1. YEARLY OPERATING COST	28990.00
	2. YEARLY INVESTMENT COST RECOVERY	6900.00
	3. DEPRECIATION	8470.00
	TOTAL	44360.00

Costs: Total investment cost: $206,560
Total yearly cost: $ 77,530

An itemized breakdown of costs is presented in Table 505. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97 percent
SS: 95 percent

Alternative D 4-IV - This alternative adds sand drying beds to Alternative D 4-III.

The resulting BOD waste load is 0.058 kg/cu m (0.48 lb/1000 gal), and the suspended solids load is 0.27 kg/cu m (2.25 lb/1000 gal).

Costs: Total investment cost: $245,210
Total yearly cost: $ 86,050

An itemized breakdown of costs is presented in Table 506. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 97 percent
SS: 95 percent

Alternative D 4-V - This alternative adds dual media filtration to Alternative D 4-IV.

The resulting BOD waste load is 0.038 kg/cu m (0.32 lb/1000 gal), and the suspended solids load is 0.16 kg/cu m (1.3 lb/1000 gal).

Costs: Total investment cost: $271,660
Total yearly cost: $ 92,930

An itemized breakdown of costs is presented in Table 507. It is assumed that land costs $41,000 per hectare ($16,600 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 98 percent
SS: 97 percent

A cost efficiency curve is presented in Figure 385.

Alternative D 4-VI - This alternative consist of Alternative D 4-II plus a pumping station, pipeline, and spray irrigation field. This alternative results in no discharge of polluted wastewater.

Costs: Total investment cost: $225,870
Total yearly cost: $ 50,950

DRAFT

TABLE 505

ITEMIZED COST SUMMARY FOR ALTERNATIVE D4-III
(VINEGAR)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
G...CAUSTIC NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTOR

INVESTMENT COSTS:

1. CONSTRUCTION	149920.00
2. LAND	26660.00
3. ENGINEERING	14990.00
4. CONTINGENCY	14990.00
TOTAL	206560.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	8020.00
3. CHEMICALS	5060.00
4. MAINTENANCE&SUPPLIES	9720.00
TOTAL	60280.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	60280.00
2. YEARLY INVESTMENT COST RECOVERY	8260.00
3. DEPRECIATION	8990.00
TOTAL	77530.00

DRAFT

TABLE 506

ITEMIZED COST SUMMARY FOR ALTERNATIVE D4-IV (VINEGAR)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 95.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

P1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
G...CAUSTIC NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
O...SLUDGE THICKENER
R...AEROBIC DIGESTOR
T...SAND DRYING BEDS

INVESTMENT COSTS:

1. CONSTRUCTION	190740.00
2. LAND	16330.00
3. ENGINEERING	19070.00
4. CONTINGENCY	19070.00
TOTAL	245210.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	8020.00
3. CHEMICALS	5060.00
4. MAINTENANCE&SUPPLIES	14240.00
TOTAL	64800.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	64800.00
2. YEARLY INVESTMENT COST RECOVERY	9810.00
3. DEPRECIATION	11440.00
TOTAL	86050.00

DRAFT

TABLE 507

ITEMIZED COST SUMMARY FOR ALTERNATIVE D4-V (VINEGAR)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY... 98.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B1..CONTROL HOUSE
B...PUMPING STATION
C...EQUALIZATION BASIN
G...CAUSTIC NEUTRALIZATION
H...NITROGEN ADDITION
K...ACTIVATED SLUDGE
S...SLUDGE THICKENER
F...AEROBIC DIGESTOR
T...SAND DRYING BEDS
B...PUMPING STATION
N...DUAL MEDIA PRESSURE FILTRAIN

INVESTMENT COSTS:

1.	CONSTRUCTION	212770.00
2.	LAND	16330.00
3.	ENGINEERING	21280.00
4.	CONTINGENCY	21280.00
TOTAL		271560.00

YEARLY OPERATING COSTS:

1.	LABOR	37480.00
2.	POWER	10620.00
3.	CHEMICALS	5060.00
4.	MAINTENANCE&SUPPLIES	16130.00
TOTAL		69290.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	69290.00
2.	YEARLY INVESTMENT COST RECOVERY	10870.00
3.	DEPRECIATION	12770.00
TOTAL		92930.00

DRAFT

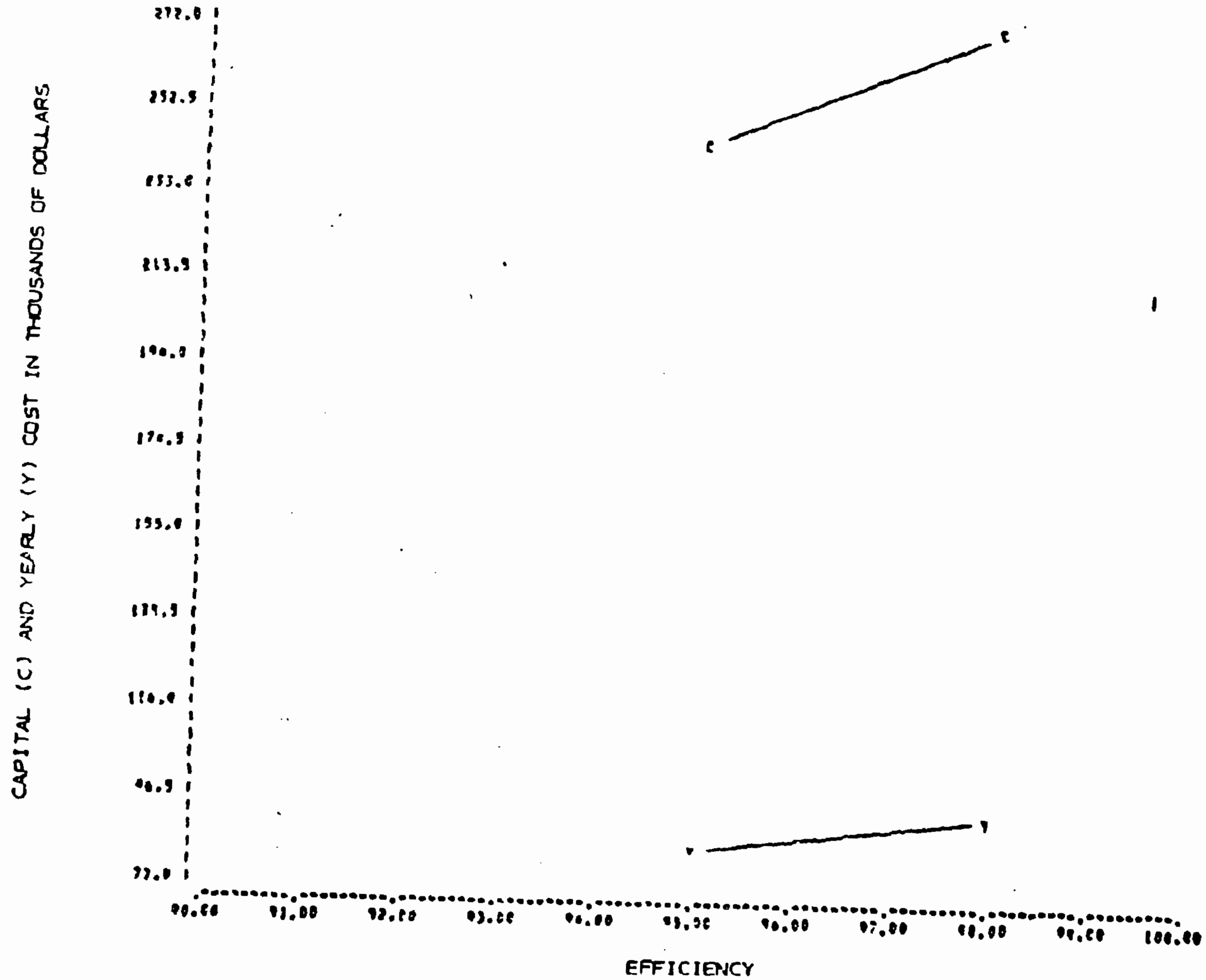


FIGURE 385

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D4, ALT. V

DRAFT

TABLE 508

ITEMIZED COST SUMMARY FOR ALTERNATIVE D4-VI
(VINEGAR)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

B...PUMPING STATION
G...CAUSTIC NEUTRALIZATION
H...NITROGEN ADDITION
L...AERATED LAGOON
U...SPRAY IRRIGATION

INVESTMENT COSTS:

1.	CONSTRUCTION	175590.00
2.	LAND	11250.00
3.	ENGINEERING	17560.00
4.	CONTINGENCY	17560.00
5.	PVC LINER	3910.00
	TOTAL	225870.00

YEARLY OPERATING COSTS:

1.	LABOR	6250.00
2.	POWER	15950.00
3.	CHEMICALS	5060.00
4.	MAINTENANCE&SUPPLIES	3870.00
5.	PVC LINER	60.00
	TOTAL	31190.00

TOTAL YEARLY COSTS:

1.	YEARLY OPERATING COST	31190.00
2.	YEARLY INVESTMENT COST RECOVERY	9030.00
3.	DEPRECIATION	10730.00
	TOTAL	50950.00

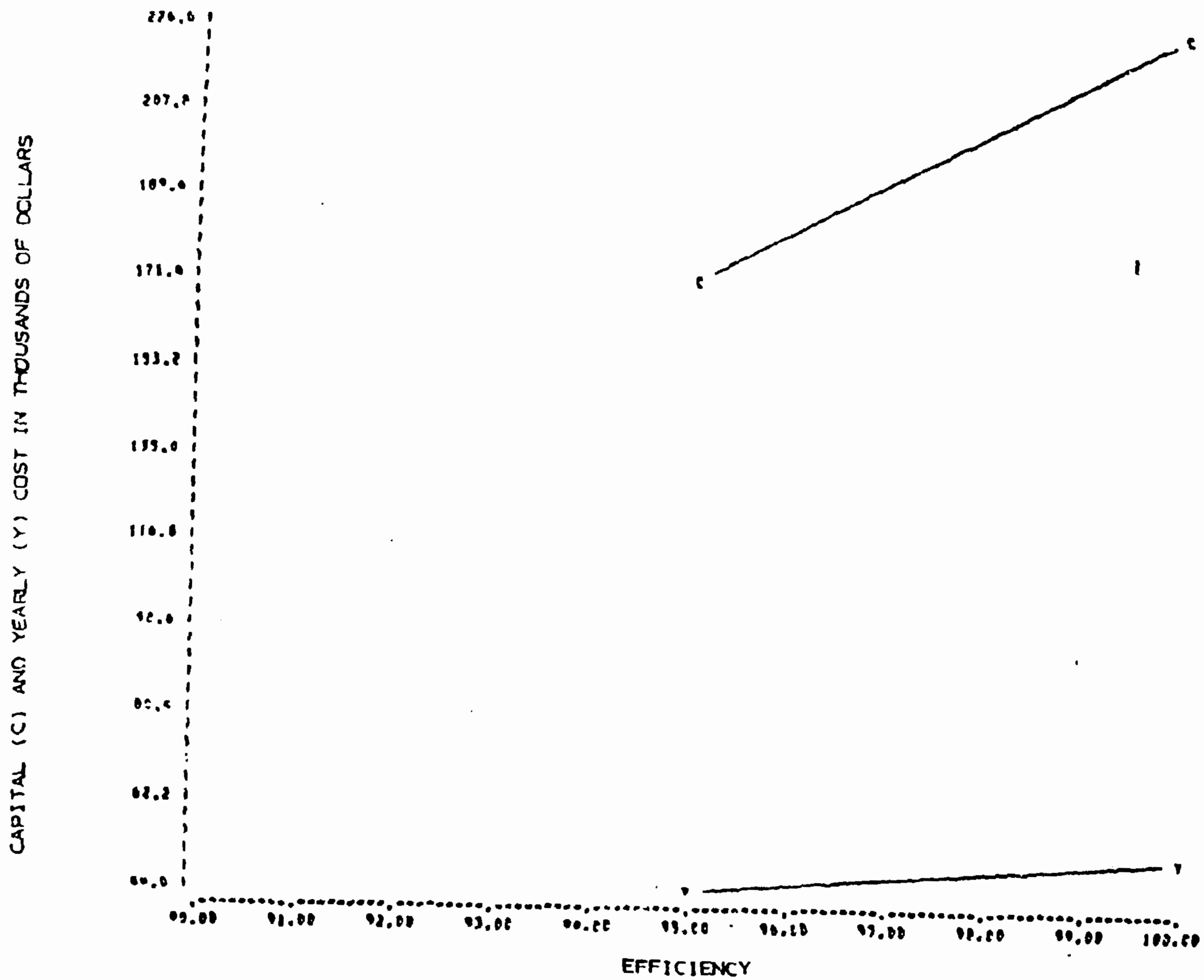


FIGURE 386

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D4, ALT. VI

DRAFT

1401

DRAFT

TABLE 509

ITEMIZED COST SUMMARY FOR ALTERNATIVE D4-VII (VINEGAR)

ITEMIZED COST SUMMARY FOR WASTEWATER TREATMENT CHAIN
DESIGN EFFICIENCY...100.0 PERCENT BOD REDUCTION

TREATMENT MODULES:

- B1..CONTROL HOUSE
- B...PUMPING STATION
- C...EQUALIZATION BASIN
- G...CAUSTIC NEUTRALIZATION
- H...NITROGEN ADDITION
- K...ACTIVATED SLUDGE
- L...SLUDGE THICKENER
- R...AEROBIC DIGESTOR
- U...SPRAY IRRIGATION

INVESTMENT COSTS:

1. CONSTRUCTION	187530.00
2. LAND	11000.00
3. ENGINEERING	18750.00
4. CONTINGENCY	18750.00
TOTAL	236030.00

YEARLY OPERATING COSTS:

1. LABOR	37480.00
2. POWER	8970.00
3. CHEMICALS	5060.00
4. MAINTENANCE&SUPPLIES	10970.00
TOTAL	62480.00

TOTAL YEARLY COSTS:

1. YEARLY OPERATING COST	62480.00
2. YEARLY INVESTMENT COST RECOVERY	9440.00
3. DEPRECIATION	11250.00
TOTAL	83170.00

DRAFT

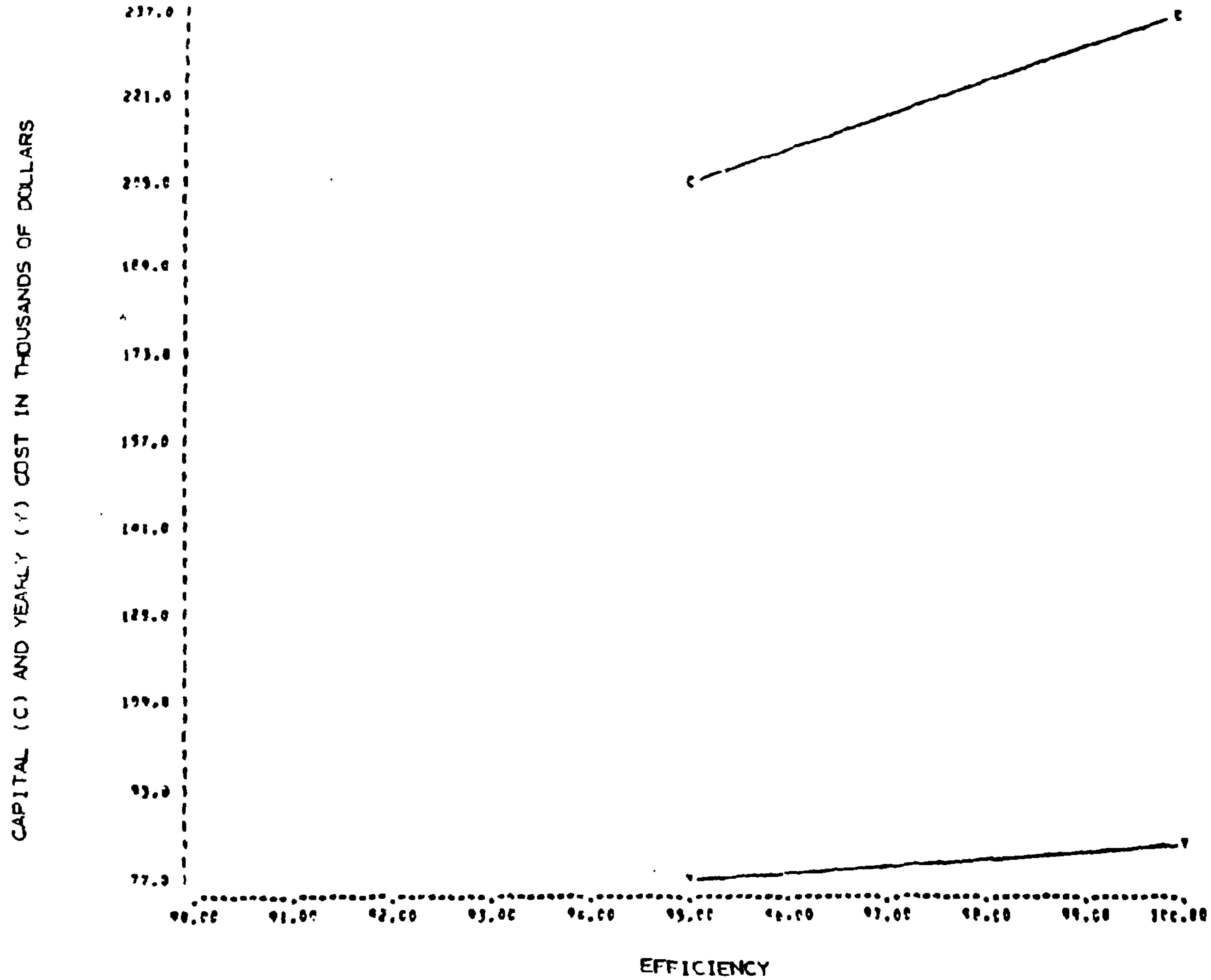


FIGURE 387

INVESTMENT AND YEARLY COSTS FOR SUBCATEGORY D4, ALT. VII

An itemized breakdown of costs is presented in Table 508. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that one operator is required one-half time.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

A cost efficiency curve is presented in Figure 386.

Alternative D 4-VII - This alternative consists of Alternative D 4-III plus a pumping station, pipeline, and spray irrigation field. This alternative results in no discharge of polluted wastewaters.

Costs: Total investment cost: $236,030
Total yearly cost: $ 83,170

An itemized breakdown of costs is presented in Table 509. It is assumed that land costs $4100 per hectare ($1660 per acre). It is further assumed that three operators are required.

Reduction Benefits: BOD: 100 percent
SS: 100 percent

A cost efficiency curve is presented in Figure 387.

RELATED ENERGY REQUIREMENTS OF ALTERNATIVE TREATMENT TECHNOLOGIES

The major energy requirement for the alternative treatment technologies is for aeration. Generally, aerated lagoons require greater levels of electricity because of mixing than do equivalent activated sludge systems.

Table 510 presents a summary of the power use and associated cost for each of the treatment alternatives.

NON-WATER QUALITY ASPECTS

The generation of sludge and the accompanying necessity for handling and disposal is an inherent part of wastewater treatment, and is perhaps the most perplexing problem associated with treatment. A common method of sludge disposal is application to the land. This may be done in a variety of ways. When sludge volumes are relatively small, discharge into shallow trenches may only be required. Larger flows of liquid sludge may be spread on land by gravity flow or by spraying, either from trucks or pipe networks. Dried sludge may be spread by dump trucks.

It is fortunate in the miscellaneous foods and beverages industry that wastewater sludges usually are free of inorganic ions that could cause groundwater contamination under adverse disposal procedures or be harmful to agricultural crops. With proper application, such sludges can improve soil structure and benefit crops.

TABLE 510

YEARLY ELECTRICAL USE AND COST ASSOCIATED WITH ALTERNATIVE TREATMENT DESIGNS

Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)	Alternative	Power Used (kW-hr)	Yearly Cost (Thousands of Dollars)
(Vegetable Oil Processing and Refining)					
A1-I	0	0	A6-I	0	0
A1-II	146,364	4.83	A6-II	64,848	2.14
A1-III	211,818	6.99	A6-III	787,879	26.00
A1-IV	321,212	10.60	A6-IV	979,697	32.33
A1-V	386,667	12.76	A6-V	1,110,909	36.66
A1-VI	64,242	2.12	A6-VI	2,775,455	91.59
A1-VII	146,970	4.85	A6-VII	2,967,273	97.92
A1-VIII	205,455	6.78	A6-VIII	3,098,485	102.25
A2-I	0	0	A7-I	0	0
A2-II	0	0	A7-II	116,364	3.84
A3-I	25,758	0.85	A7-III	1,415,758	46.72
A3-II	0	0	A7-IV	1,666,667	55.00
A3-III	3,030	0.10	A7-V	1,925,455	63.54
A4-I	29,697	0.98	A7-VI	4,977,273	164.25
A4-II	0	0	A7-VII	5,228,182	172.53
A4-III	25,152	0.83	A7-VIII	5,486,970	181.07
A5-I	0	0	A8-I	0	0
A5-II	45,152	1.49	A8-II	100,303	3.31
A5-III	465,152	15.35	A8-III	1,048,182	34.59
A5-IV	619,697	20.45	A8-IV	1,276,061	42.11
A5-V	712,727	23.52	A8-V	1,489,091	49.14
A5-VI	1,420,909	46.89	A8-VI	3,609,091	119.10
A5-VII	1,575,455	51.99	A8-VII	3,836,970	126.62
A5-VIII	1,668,485	55.06	A8-VIII	4,050,000	133.65

TABLE 510 (CONTINUED)

Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)	Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)
(Vegetable Oil Processing and Refining)					
A9-I	0	0	A12-I	0	0
A9-II	128,788	4.25	A12-II	131,212	4.33
A9-III	1,525,455	50.34	A12-III	1,459,090	48.15
A9-IV	1,[illegible],848	59.23	A12-IV	[illegible],732,121	57.16
A9-V	2,090,000	68.97	A12-V	2,034,242	67.13
A9-VI	5,873,333	193.82	A12-VI	6,205,758	204.79
A9-VII	6,143,030	202.72	A12-VII	6,478,788	213.80
A9-VIII	6,437,979	212.45	A12-VIII	6,780,909	223.77
A10-I	0	0	A13-I	0	0
A10-II	113,030	3.73	A13-II	47,576	1.57
A10-III	1,163,030	38.38	A13-III	29,364	9.69
A10-IV	1,409,091	46.50	A13-IV	457,879	15.11
A10-V	165,758	54.70	A13-V	1,518,182	50.10
A10-VI	4,908,182	161.97	A13-VI	1,682,424	55.52
A10-VII	5,154,242	170.09	A14-I	0	0
A10-VIII	5,402,727	178.29	A14-II	183,333	6.05
A11-I	0	0	A14-III	232,424	7.67
A11-II	146,667	4.84	A14-IV	303,636	10.02
A11-III	1,816,364	59.94	A14-V	414,545	13.68
A11-IV	2,113,030	69.73	A14-VI	463,333	15.29
A11-V	2,460,606	81.20	A14-VII	534,850	17.65
A11-VI	6,993,030	230.77	A15-I		0.83
A11-VII	7,289,394	240.55	A15-II	0	0
A11-VIII	7,636,970	252.02	A15-III	0	0

TABLE 510 (CONTINUED)

Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)	Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)
	(Beverages)				
A16-I	0	0	A17-VII	50,640,000	1671.12
A16-II	20,569,091	678.78	A17-VIII	43,338,778	1430.18
A16-III	21,117,576	696.88	A17-IX	44,927,273	1482.60
A16-IV	22,067,273	728.22	A17-X	47,966,970	1582.91
A16-V	13,891,212	458.41	A17-XI	---	---
A15-VI	14,439,697	476.51	A17-XII	---	---
A16-VII	15,3[illegible]9,394	507.85	A17-XIII	---	---
A16-VIII	13,040,909	430.35	A18-I	0	0
A16-IX	13,589,394	448.45	A18-II	9,760,000	322.08
A16-X	14,539,091	479.79	A18-III	10,105,151	333.47
A16-XI	13,005,152	429.17	A18-IV	10,843,333	357.83
A16-XII	13,553,636	447.27	A18-V	5,026,364	165.87
A16-XIII	14,503,333	478.61	A18-VI	5,371,212	177.25
A17-I	0	0	A18-VII	6,109,394	201.61
A17-II	68,463,636	2259.30	A18-VIII	4,719,091	155.73
A17-III	70,051,818	2311.71	A18-IX	5,064,242	167.12
A17-IV	73,091,818	2412.03	A18-X	5,802,424	191.48
A17-V	46,011,818	1518.39	A18-XI	4,690,303	154.78
A17-VI	47,630,303	1570.81	A18-XII	5,035,455	166.17
			A18-XIII	5,773,636	190.53
			A19-I	0	0
			A19-II	12,167,878	401.54
			A19-III	12,346,969	407.45
			A19-IV	11,902,727	62.79

TABLE 510 (CONTINUED)

Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)	Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)
A19-V	2,081,818	68.70	A22-B-I	0	0
A19-VI	1,876,364	61.92	A22-B-II	2,506,061	82.70
A19-VII	2,055,455	67.83	A22-B-III	2,635,152	86.96
A20-I	0	0	A22-B-IV	598,788	19.76
A20-II	733,030	25.51	A22-B-V	727,878	24.02
A20-III	873,636	28.83	A22-B-VI	666,667	22.00
A20-IV	962,727	31.77	A22-B-VII	795,758	26.26
A20-V	747,272	24.66	A22-B-VIII	624,242	20.60
A20-VI	847,879	27.98	A22-B-IX	674,242	22.25
A20-VII	937,273	30.93	A23-I	0	0
A20-VIII	3,118,182	102.90	A23-II	156,667	5.17
A20-IX	3,218,788	106.22	A23-III	206,667	6.82
A20-X	3,308,182	109.17	A23-IV	185,758	6.13
A21-I	0	0	A24-I	0	0
A21-II	150,303	4.96	A24-II	10,277,879	339.17
A22-A-I	0	0	A24-III	10,407,576	343.45
A22-A-II	13,130,909	433.32	A24-IV	10,225,758	337.45
A22-A-III	13,307,273	439.14	A24-V	10,355,455	341.73
A22-A-IV	2,377,273	78.45	A24-VI	10,200,000	336.60
A22-A-V	2,553,636	84.27	A24-VII	10,329,697	340.88
A22-A-VI	2,516,970	83.06	A24-VIII	13,255,455	437.43
A22-A-VII	2,693,333	88.88	A24-IX	13,384,848	441.70
A22-A-VIII	2,403,939	79.33			
A22-A-IX	2,533,030	83.59			

DRAFT

TABLE 510 (CONTINUED)

Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)	Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)
A25A-I	0	0	A28-V	2,300,606	75.92
A25A-II	0	0	A28-VI	1,014,242	33.47
A25A-III	25,455	0.84	A28-VII	836,970	27.62
A25B-I	0	0	A28-VIII	1,014,242	33.47
A25B-II	0	0	A28-IX	2,399,394	79.18
A25B-III	26,667	0.88	A28-X	1,113,030	36.73
A26-I	0	0	A28-XI	936,061	30.89
A26-II	301,212	9.94	A28-XII	1,113,030	36.73
A26-III	389,394	12.85	A28-XIII	49,091	1.62
A26-IV	275,758	9.10	A30-I	0	0
A26-V	363,939	12.01	A30-II	575,455	18.99
A26-VI	1,075,152	35.48	A30-III	503,939	16.63
A26-VII	1,163,333	38.39	*A30-IV	2,640,606	87.14
A27-I	0	0	A30-V	704,242	23.24
A27-II	350,909	11.58	A30-VI	632,727	20.88
A27-III	479,697	15.83	*A30-VII	2,769,394	91.39
A27-IV	325,455	10.74	A30-VIII	55,758	1.84
A27-V	454,242	14.99	C8-I	0	0
A27-VI	1,036,667	34.21	C8-II	157,576	5.20
A27-VII	1,165,455	38.46	C8-III	228,182	7.53
A28-I	2,122,727	70.05	C8-IV	66,970	2.21
A28-II	836,364	27.60	C8-V	137,576	4.54
A28-III	659,394	21.76	C9-I	0	0
A28-IV	836,364	27.60	C9-II	197,576	6.52
			C9-III	560,606	18.50
			C10-I	0	0
			C10-II	3,317,273	109.47
			C10-III	1,266,970	41.81
			C10-IV	3,523,333	116.27

TABLE 510 (CONTINUED)

Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars	Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars
(Bakery and Confectionery Products)					
C1-I	0	0	D2-I	0	0
C1-II	152,121	5.02	D2-II	1,510,000	49.83
C1-III	717,273	23.67	D2-III	317,576	10.48
C1-IV	901,818	29.76	D2-IV	317,576	10.48
C2-I	0	0	D2-V	474,848	15.67
C2-II	120,909	3.99	D2-VI	1,555,242	51.29
C2-III	121,212	4.00	D2-VII	361,818	11.94
C2-IV	273,636	9.03	D3-I	0	0
C2-V	65,061	2.18	D3-II	1,190,909	39.30
C2-VI	273,636	9.03	D3-III	264,242	8.72
C2-VII	292,727	9.66	D3-IV	264,242	8.72
C2-VIII	325,455	10.74	D3-V	433,636	14.31
C3-I	0	0	D3-VI	1,238,182	40.86
C3-II	205,756	6.79	D3-VII	311,515	10.28
C3-III	257,879	8.51	D5-I	0	0
C3-IV	148,485	4.90	D5-II	143,030	4.72
C7-I	0	0	D5-III	3,507,576	115.75
C7-II	66,970	2.21	D5-IV	1,043,939	34.45
C7-III	264,848	8.74	D5-V	1,043,939	34.45
C7-IV	428,788	14.15	D5-VI	1,045,455	34.50
C7-V	399,091	13.17	D5-VII	1,175,455	38.79
C7-VI	553,333	18.59	D5-VIII	3,509,394	115.81
D1-I	0	0	D6-I	0	0
D1-II	92,727	3.06	D6-II	164,242	5.42
D1-III	446,667	14.74	D6-III	4,266,061	140.78
D1-IV	446,667	14.74	D6-IV	645,152	21.29
D1-V	624,242	20.60	D6-V	645,152	21.29
D1-[illegible]	[illegible]	8.90	D6-VI	647,273	21.35
			D6-VII	8[illegible],242	28.85
			D6-VIII	4,267,879	140.84

TABLE 510 (CONTINUED)

Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)	Alternative	Power Used (kw-hr)	Yearly Cost (Thousands of Dollars)
(Pet Foods)			A31-I	29,697	0.98
B5-I	0	0	A31-II	506,061	16.70
B5-II	329,091	10.86	A31-III	444,545	14.67
B5-III	945,758	31.21	A31-IV	561,818	18.54
B5-IV	[illegible]	39.80	A31-V	562,121	18.55
B6-I	0	0	A31-VI	500,909	16.53
B6-II	453,625	14.97	A31-VII	617,879	20.39
B6-III	456,061	15.05	A32-I	27,879	0.92
B6-IV	[illegible]	120.41	A32-II	127,576	4.21
B6-V	3,914,545	129.18	A32-III	320,909	10.59
B7-I	0	0	A32-IV	198,182	6.54
B7-II	62,121	2.05	A32-V	363,636	12.00
B7-III	123,636	4.08	A33-I	0	0
B7-IV	210,303	6.94	A33-II	38,703,636	1277.22
B8-I	0	0	A33-III	38,881,939	1283.17
B8-II	570,000	18.81	A33-IV	39,410,606	1300.55
B8-III	1,733,939	57.22	A33-V	8,171,212	269.65
B8-IV	1,994,242	65.81	A33-VI	8,351,515	275.60
			A33-VII	6,878,182	292.98
(Miscellaneous and Specialty Products)			A33-VIII	11,563,939	331.61
			A33-IX	11,744,242	387.56
A29-I	0	0	A33-X	12,270,909	404.94
A29-II	30,303	1.00	A33-XI	23,369,696	771.20
A29-III	226,364	7.47	A33-XII	23,550,000	777.15
A29-IV	233,030	7.69	A33-XIII	24,075,666	794.53
A29-V	425,455	14.04	A33-XIV	18,454,242	608.99
A29-VI	285,758	9.43			
A29-VII	292,424	9.65			
A29-VIII	[illegible]	16.00			
A29-IX	[illegible]	11.90			
A29-X	[illegible]	12.12			
A29-XI	[illegible]	18.4[illegible]			

DRAFT

TABLE 510 (CONTINUED)

Alternative	Power Use (kw hr)	Yearly Cost (Thousands of Dollars)	Alternative	Power Use (kw-hr)	Yearly Cost (Thousands of Dollars)
A33-XV	18,634,545	614.94	B3-I	0	0
A33-XVI	19,161,212	632.32	B3-II	563,636	18.60
A33-XVII	18,251,818	602.31	B3-III	2,005,455	66.18
A33-XVIII	18,432,121	608.26	B3-IV	2,265,758	74.77
A33-XIX	18,958,787	625.64	B4-I	0	0
A33-XX	231,515	7.64	B4-II	192,424	6.35
A34-I	0	0	B4-III	427,879	14.12
A34-II	24,455	0.84	B9-I	0	0
A34-III	0	0	B9-II	1,009,394	33.31
A35-I	0	0	B9-III	1,174,242	38.75
A35-II	25,152	0.83	C4-I	0	0
A35-III	0	0	C4-II	330,606	10.91
A36-I	0	0	C4-III	110,303	14.52
A36-II	140,000	4.62	C4-IV	66,667	2.20
A36-III	11,891,212	392.41	C4-V	110,303	3.64
A36-IV	11,634,242	383.93	C5-I	0	0
A36-V	11,663,636	384.90	C5-II	92,424	3.05
A36-VI	6,853,939	226.18	C5-III	120,606	3.98
A36-VII	12,042,121	397.39	C5-IV	59,394	1.96
A36-VIII	11,785,454	388.92	C5-V	87,576	2.89
A36-IX	11,814,[illegible]48	389.89	C12-I	0	0
A36-X	7,004,848	231.16	C12-II	0	0
B1-I	0	0	D4-I	0	0
B1-II	559,394	18.46	D4-II	454,242	14.99
B1-III	1,337,273	44.13	D4-III	243,030	8.02
B1-IV	1,586,970	52.37	D4-IV	243,030	8.02
B2-I	0	0	D4-V	321,818	10.62
B2-II	182,727	6.03	D4-VI	483,333	15.95
B2-III	377,576	12.46	D4-VII	271,818	8.97
B2-IV	454,545	15.00			

Sludge disposal on land is regulated by health authorities because of possible nuisance conditions from odors and insects. The extent of such a nuisance, and even its existance, is dependent on the exact nature of the sludge and the treatment steps to which it has been subjected. It can be stated generally, although not categorically, that wastewater sludges from industries discussed in this document if applied at low dosages into a thin layer not exceeding a few inches will not create excessive nusiances even without prior treatment. However, each disposal case should be judged on the characteristics of the particular sludge involved, the proximity of the disposal site to inhabited areas (both existing and potential), and the nature of the land to which the sludge is to be applied.

The possibility of groundwater contamination must be considered when sludge is spread or sprayed onto the land and when it is deposited into lagoons. Groundwater pollution is most often associated with toxic materials and microorganisms, both of which are generally absent from the sludges under consideration, but it may also result from nitrates. Groundwater monitoring is a necessity whenever any suspicion of possible contamination exists.

Sludge lagooning should generally be considered as a sludge treatment process rather than an ultimate disposal alternative. An exception is the technique of "land filling" in which sludge is treated as solid waste and permanently deposited and covered. Land filling is relatively expensive, however, and can be considered as a viable alternative only for small sludge quantities.

The alternative to final deposition of sludge into water or onto land is incineration, but even this is not a total alternative since an inert ash (amounting to as much as 30 percent by weight of the dry solids incinerated) still requires disposal.

Sludge incineration has not been considered as either best practical or economically achievable technology in this document for any industry subcategory; however, it may be feasible in special cases. Incineration is basically expensive. In recent years it has appeared that it would become more attractive economically as the costs of other disposal methods became more expensive, but the rapidly increasing costs of energy are tending to offset that trend.

Other than economics, sludge incineration offers the disadvantages of fuel consumption and possible air pollution. The emissions generated by sludge combustion include sulfur dioxide, carbon dioxide, and inert particulates (fly ash). Fly ash can be effectively controlled by centrifugal dust collectors or wet scrubbers (which, of course, generate a wastewater stream). Wet scrubbers can also be used for control of gaseous emissions.

The most desirable method of handling sludge is one which would achieve by-product recovery, such as utilization for products such as animal feed. One brewery is investigating the use of sludge as a fish food supplement (156).

The treatment alternatives developed in Section VII are not expected to have signigicant effects on air quality if properly located and operated. Odors are always a potential problem in the treatment of organic wastes; however, the predominately aerobic systems discussed herein should not create odor problems. Nevertheless, treatment systems and disposal sites should be located an appropriate distance from (and, if possible, downwind from) habitations.

Spray irrigation of wastewaters or sludges can cause problems of windblown droplets. If it is assumed that sanitary wastes have been removed, no threats to health should exist. If spray systems are not in proximity to neighbors, significant problems should not exist.

The sight of wastewater treatment facilities may be aesthetically unpleasant to some persons. However, a realization of this fact during plant design can often minimize such effects.

Noise levels should not exceed those of well-designed municipal treatment systems which are currently being approved for construction in populated areas.

SECTION IX

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE EFFLUENT LIMITATIONS GUIDELINES

The effluent limitations which must be achieved by July 1, 1977, are to specify the degree of effluent reduction attainable through the application of the Best Practicable Control Technology Currently Available. Best Practicable Control Technology Currently Available is generally based upon the average of best existing performance by plants of various sizes, ages and unit processes within the industrial category and/or subcategory. In the Miscellaneous Foods and Beverages point source category, this is based upon performance levels achieved by exemplary plants.

Consideration must also be given to:

a. The total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application;

b. The size and age of equipment and facilities involved;

c. The process employed;

d. The engineering aspects of the application of various types of control techniques;

e. Process changes;

f. Non-water quality environmental impact (including energy requirements);

g. Availability of land for use in wastewater treatment-disposal.

Best Practicable Control Technology Currently Available emphasizes treatment facilities at the end of a manufacturing process but includes the control technologies within the process itself when these are considered to be normal practice within the industry.

A further consideration is the degree of economic and engineering reliability which must be established for the technology to be "currently available." As a result of demonstration projects, pilot plants, and general use, there must exist a high degree of confidence in the engineering and economic practicability of the technology at the time of construction or installation of the control facilities.

DRAFT

EFFLUENT REDUCTIONS ATTAINABLE THROUGH THE APPLICATION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE FOR THE MISCELLANEOUS FOODS AND BEVERAGES POINT SOURCE CATEGORY

Based upon the information contained in Sections II through VIII of this document it has been determined that the degree of effluent reduction attainable through the application of the Best Practicable Control Technology currently available is as listed in Tables 511 through 515. No limitations are presently recommended for Subcategory C 6, Ice Manufacturing, because the quality of the effluent at the present time is quite good--reported at 1 mg/l BOD and 5 mg/l suspended solids. These values indicate that further pollutant reduction would be impractical.

It is further recommended that for all cases in which discharge of wastewaters is allowed, the pH of the wastewaters be in the range of 6.0 to 9.0; that no visible floating oil and grease be allowed; and, for Subcategories A 7-12, a concentration of nickel no greater than 0.02 mg/l be allowed. Technologies presently exist and have been reliably demonstrated to achieve this level. Technologies presently exist and have been reliably demonstrated to achieve this level.

IDENTIFICATION OF BEST PRACTICAL CONTROL TECHNOLOGY CURRENTLY AVAILABLE

The Best Practicable Control Technology Currently Available, as described in Section VII, is generally the equivalent of secondary biological treatment. The recommended treatment alternatives for each subcategory are indicated in Tables 511 through 515. The wastewaters from the Miscellaneous Foods and Beverages Industry are for the most part highly biodegradable as documented by existing treatment systems within the subcategories, by extensive municipal treatment case histories, and/or the nature of the wastes' characteristics.

A few exceptions hav been determined to exist for individual waste components or exceptional waste streams. In those few cases where biological treatment is not demonstrated and would not be expected to be reasonably or feasibly effective, considerable discussion has been presented in appropriate sections of this document and alternative technology presented where applicable. Noteworthly examples include the unfeasibility of biologically treating wastewater from ice manufacturing and high strength wastes such as stillage. For small volume wastes, alternative disposal such as conveying the waste to a municipal treatment plant or approved land site have been presented.

The Best Practicable Control Technology Currently Available for Subcategories A 2, A 3, A 4, A 25, A 34, A 35 C 12, E 1-6, and F 1-4 is direct land disposal or hauling to a municipal sewage system or approved land disposal site. The Best Practicable Control Technology for Subcategory A 15 is land spreading, spray irrigation, or hauling to a municipal sewage system or approved land disposal site. The Best Practicable Control Technology for Subcategory A 20 is land spreading.

DRAFT

TABLE 511

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BPCTCA)
FOR VEGETABLE OIL PROCESSING AND REFINING

SUBCATEGORY	UNITS	RECOMMENDED TREATMENT ALTERNATIVE	BOD MAX. 30-DAY AVE.	BOD MAX. DAY	SS MAX. 30-DAY AVE.	SS MAX. DAY	O&G MAX. 30-DAY AVE.	O&G MAX DAY
A 1	kg/kkg oilseed crushed	A 1- II	0.0072	0.018	0.0090	0.023	0.0054	0.0135
A 2	kg/kkg oilseed crushed	A 2- II	0.00	0.00	0.00	0.00	0.00	0.00
A 3	kg/kkg olives processed	A 3- I	0.00	0.00	0.00	0.00	0.00	0.00
A 4	kg/kkg olives processed	A 4- II	0.00	0.00	0.00	0.00	0.00	0.00
A 5	kg/kkg crude oil processed	A 5- IV	0.035	0.087	0.035	0.087	0.014	0.035
A 6	kg/kkg crude oil processed	A 6- IV	0.067	0.017	0.061	0.15	0.023	0.057
A 7	kg/kkg crude oil processed	A 7- IV	0.13	0.32	0.13	0.32	0.051	0.13
A 8	kg/kkg crude oil processed	A 8- IV	0.10	0.26	0.10	0.26	0.041	0.10
A 9	kg/kkg crude oil processed	A 9- IV	0.13	0.33	0.13	0.33	0.058	0.14
A10	kg/kkg crude oil processed	A10- IV	0.097	0.24	0.11	0.27	0.048	0.12
A11	kg/kkg crude oil processed	A11- IV	0.16	0.39	0.17	0.44	0.069	0.17
A12	kg/kkg crude oil processed	A12- IV	0.12	0.30	0.14	0.36	0.060	0.15
A13	kg/kkg finished product	A13-III	0.060	0.15	0.075	0.19	0.075	0.19
A14	kg/kkg finished product	A14-III	0.015	0.037	0.015	0.037	0.0080	0.024
A15	--------------------------	A15-III	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 512

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BPCTCA)
FOR BEVERAGES

SUBCATEGORY	UNITS	RECOMMENDED TREATMENT ALTERNATIVE	BOD MAX. 30-DAY AVE.	BOD MAX. DAY	SS MAX. 30-DAY AVE.	SS MAX DAY
A16	kg/cu m beer produced	V	0.28	0.70	0.39	0.97
A17	kg/cu m beer produced	V	0.55	1.4	0.76	1.9
A18	kg/cu m beer produced	V	0.48	1.2	0.68	1.7
A19	kg/kkg barley processed	IV	0.22	0.55	0.13	0.32
A20	kg/kkg grapes crushed	II	0.77	2.3	0.11	0.34
A20	kg/cu m wine produced	II	0.28	0.83	0.41	1.2
A21	--------------------	II	0	0	0	0
A22	kg/kkg grain mashed	VI	0.26	0.65	0.32	0.80
A23	kg/kkg grain mashed	II	0.054	0.14	0.072	0.18
A24	kg/thousand proof gallons produced	II	1.2	3.0	0.69	1.7
A25	------------------	II	0	0	0	0
A26	kg/cu m finished prod.	IV	0.052	0.13	0.030	0.075
A27	kg/cu m finished prod.	IV	0.24	0.60	0.14	0.35
A28	kg/cu m finished prod.	A 28-VIII	0.0050	0.013	0.0010	0.0025
A30	kg/kkg finished prod.	A 30-II	2.0	5.0	5.5	13.0
C8	kg/kkg coffee beans	C 8-III	0.070	0.21	0.070	0.21
C9	kg/kkg coffee beans	C 9-III	0.19	0.48	0.19	0.48
C10	kg/kkg coffee beans	C 10-III	0.95	2.4	0.95	2.4
F1	--------------------	-	0	0	0	0

TABLE 513

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BPCTCA)
FOR BAKERY AND CONFECTIONERY PRODUCTS

Subcategory	Recommended Treatment Alternative	BOD Max 30-Day Ave	BOD Max Day	SS Max 30-Day Ave	SS Max Day	O&G Max 30-Day Ave	O&G Max Day
C1	C1-III	0.50	1.3	0.50	1.3	0.11	0.28
C2	C2-IV	0.050	0.15	0.050	0.15	0.030	0.090
C3	C3-II	0.060	0.18	0.060	0.18	0.040	0.12
C7	C7-V	0.1	0.25	0.10	0.25	0.050	0.13
D1	D1-IV	0.15	0.45	0.075	0.22	--	--
D2	D2-IV	0.12	0.36	0.090	0.27	--	--
D3	D3-IV	0.085	0.24	0.085	0.24	--	--
D5	D5-V	0.037	1.1	0.25	0.75	0.07	0.021
D6	D6-V	0.23	0.69	0.23	0.69	0.11	0.33

NOTE: All units in terms of kg/kkg of finished product.

TABLE 514

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BPCTCA)
FOR PET FOODS

Subcategory	Recommended Treatment Alternative	BOD Max 30-Day Ave	BOD Max Day	SS Max 30-Day Ave	SS Max Day	O&G Max 30-Day Ave	O&G Max Day
B5	B5-III	0.18	0.45	0.18	0.45	0.065	0.17
B6	B6-IV	0.51	1.28	0.51	1.28	0.51	1.28
B7	B7-III	0.0046	0.012	0.0046	0.012	0.0031	0.0080
B8	B8-III	0.18	0.45	0.18	0.45	0.028	0.075

NOTE: All value in terms or kg/kkg finished product.

TABLE 515

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BPCTCA)
FOR MISCELLANEOUS AND SPECIALTY PRODUCTS

Subcategory	Units	Recommended Treatment Alternative	BOD Max. 30-day Ave.	BOD Max. Day	SS Max. 30-day Ave.	SS Max. Day	O&G Max. 30-day Ave.	O&G Max. Day
A 29	kg/cu m finished product	A 29-III	0.041	0.10	0.012	0.030	-	-
A 31	kg/kkg finished product	A 31-II	2.34	5.85	0.63	1.58	0.63	1.26
A 32	kg/kkg finished product	A 32-II	0.025	0.063	0.071	0.18	0.043	0.086
A 33	kg/kkg finished product	A 33-XIV	3.23	6.46	1.62	3.24	-	-
A 34	kg/kkg finished product	A 34-III	0	0	0	0	0	0
A 35	kg/kkg finished product	A 35-III	0	0	0	0	0	0
A 36	kg/kkg finished product	A 36-III	208.5	417	175.1	350	-	-
B 1	kg/kkg finished product	B 1-III	0.78	1.95	0.78	1.95	0.29	0.73
B 2	kg/kkg finished product	B 2-III	0.81	2.03	0.81	2.03	0.23	0.57
B 3	kg/kkg finished product	B 3-III	1.07	2.68	1.07	2.68	0.46	1.14
B 4	kg/kkg finished product	B 4-III	2.38	5.94	2.38	5.94	1.59	3.97
B 9	kg/kkg of raw material	B 9-II	0.65	1.63	0.65	1.63	0.43	1.08
C 4	kg/kkg of raw material	C 4-II	1.3	3.9	1.3	3.9	0.13	0.39
C 5	kg/kkg of raw material	C 5-II	0.080	0.24	0.80	0.24	0.020	0.060
D 4	kg/cu m of finished prod.	D 4-IV	0.060	0.18	0.030	0.29	-	-
E 1-6	---------------------	-	0	0	0	0	0	0
F 2-4	---------------------	-	0	0	0	0	0	0

ENGINEERING ASPECTS OF CONTROL TECHNOLOGY

Since the wastewaters generated by the miscellaneous foods and beverages industry are for the most part highly biodegradable, biological treatment is the most applicable technology. As developed in Section VII, activated sludge and aerobic lagooning are the most applicable types of biological treatment employed. Commonly, high-strength industrial waste requires modifications of the activated sludge design as applied to treatment of municipal waste. These modifications include longer detention times, completely mixed basins, and larger secondary clarifiers. The complete-mix system is preferred over other activated sludge systems for food and beverage waste because it is less susceptible to shock loads (the completely mixed basin partially smooths out organic load variations), oxygen utilization rate is constant throughout the basin, and lined earthen basins can be used for economy.

The longer detention time is necessary because of the high BOD concentrations: it is not uncommon for a complete-mix system to require several days of aeration, but it nevertheless should not be confused with an extended aeration system.

A primary disadvantage of any activated sludge system is operational difficulty. Operators must be well trained specialists; the not uncommon industrial practice of assigning personnel from the maintenance department or the chemistry lab to "take care" of the wastewater treatment plant has in many instances led to chronically poor treatment efficiencies.

Even with the best operation, however, a biological system is susceptible to periodic upsets. Perhaps the most common problem is "sludge bulking" in which rising sludge in final clarifiers causes floating matter to be discharged in the plant's effluent. The floating material can considerably increase BOD and suspended solids concentrations in the effluent.

Sludge bulking can often result from poor operation allowing inadequate aeration or nutrient levels, improper food to microorganism ratio, or improper sludge age. It is essential that operators maintain frequent (at least daily) testing of the dissolved oxygen levels, suspended solids concentrations, and nutrient concentrations in the aeration basin, the nutrient concentrations in the effluent, and, of course, the sludge volume index. But since upsets will invariably occur, even with the best operation and most constant monitoring, it is to be expected that upon occasion biological systems will far exceed the maximum daily levels recommended in this document.

A second problem associated with biological systems is sludge generation. The sludge from an activated sludge system can be expected to have a solids content normally ranging from 0.5 to 1.5 percent. In this document it has been conservatively assumed that the sludge has a solids content of 0.5 percent; it should be realized that in many cases the concentration will be higher and the sludge volume generated considerably lower.

The disposal of sludge, as discussed in Section VIII, can be a serious problem. Land disposal (lagooning, land spreading, spray irrigation) is the most common disposal method and usually the most cost effective. The feasibility of land disposal of sludge (or wastewater for that matter) is essentially one of economics--the availability of suitable land reasonably close to the treatment plant. Pumping of sludge to disposal areas up to ten miles from the treatment plant is usually justifiable, and trucking of dewatered sludge even farther is common. In some specific cases, however, sludge disposal may produce severe hardships on particular plants.

As discussed in Section VII, a variety of treatment modules other than those discussed in this document may be employed in the miscellaneous foods and beverage industry. For particular installations, other modules could be more cost effective. This can only be determined on a case by case basis.

One of the most cost effective methods for wastewater treatment/disposal is crop irrigation. The limitations on the use of such disposal must be determined based on the nature of the wastewater as well as the nature of the crop to be irrigated. It should be noted that in some instances nutrient addition might be necessary since many of the discharges from miscellaneous foods and beverages industries are nutrient deficient. If such is the case, a significant cost could be incurred.

Again, due to the fact that the treatment technologies developed in this document are required to be applicable to all areas of the country, all earthen basins recommended in this report have been lined with PVC liner. It is to be expected that a number of the installations affected by this study are located in areas where soil and geologic conditions make such lining unnecessary. For this reason, the cost of lining has been shown as a separate item in the cost tables of Section VIII.

Land costs have been shown as a discrete cost item for the same reason. Of all factors associated with the cost analysis, land cost is certainly the most variable. It has been generally assumed that non-land restrictive treatment systems (e.g., activated sludge, vacuum filtration) are required in highly industrialized areas of minimal land availability and that land costs $41,000 per hectare ($16,600 per acre). Non-land restrictive treatment trains have been assumed to be located in semi-rural areas with land costs of $4100 per hectare ($1660 per acre). In a few cases, where treatment trains are intermediate between land restrictive and non-land restrictive, a cost of $20,500 per hectare ($8300 per acre) has been assumed.

In reality, land costs can vary from a few hundred dolalrs per hectare to several million depending on plant location.

DRAFT

Evaporation has been c[illegible] as a viable alternative for treating high strength wastes in the rum and yeast industries. Evaporative concentration offers the advantage of reducing pollutant and hydraulic loads to biological treatment while at the same time producing potentially saleable by-products. In addition, recovery equipment requires less operating space than biological systems.

Evaporators must be designed and sized to fit the needs of individual users. Some major factors that determine equipment selection, and therefore capital and operating costs, include: (1) volume and initial concentration of feed solution, (2) final by-product concentration, (3) physical properties of the liquor to be treated, and (4) availability of required utilities. Currently available facilities ranging in size from small pilot plants to installations providing 204,000 kg/hr (450,000 lb/hr) evaporation must be sized both on the volume of water and the quantity of solids to be handled. The more concentrated the influent material, the less water removal and therefore less energy required to concentrate to a desired value. For a given influent volume, the final concentrate volume depends on the initial percentage of solids in the influent. An evaporator that concentrates a 2 percent solids material to 30 percent solution removes over 90 percent of the initial water while evaporating a 2 percent solution to only 15 percent removes over 80 percent of the water. High concentration frequently requires specialized equipment depending on the physical characteristics of the liquid. Physical characteristics (156) of evaporator liquor that influence equipment design, sizing, and operation include viscosity, undissolved solids, temperature sensitivity, and boiling point elevation.

All plants within each subcategory studied utilize similar basic production processes. Although there are deviations in equipment and production procedures, these deviations do not significantly alter the characteristics of the wastewater generated. Application of the best technology currently available does not require major changes in existing industrial processes for the subcategories studied. Water conservation practices, improved housekeeping and product handling practices, and improved maintenance programs can be incorporated at virtually all plants within a given subcategory.

The technology to achieve these recommended effluent limitations is practiced within the subcategories under study or can be readily transferred from technology in other industries. The concepts are proven, available for implementation, and applicable to the wastes in question. However, up to two years may be required from design initiation to plant start-up. The waste treatment techniques are also broadly applied within many other industries. The technology required may necessitate improved monitoring of waste discharges and of waste treatment components on the part of some plants, and may require more extensive training of personnel in the operation and maintenance of waste treatment facilities. However, these procedures are currently practiced in some plants and are common practice in many other industries.

COSTS OF APPLICATION

The costs of obtaining the effluent reductions set forth herein are itemized in Section VIII. The investment and yearly costs of the recommended treatment alternatives are summarized in Table 516.

NON-WATER QUALITY ENVIRONMENTAL IMPACT

The primary non-water quality environmental impact of the alternative treatment technologies, as summarized in Section VIII, is the generation of sludges requiring ultimate land disposal. Available technology, however, if properly applied can assure that land disposal systems are maintained, commensurate with soil tolerances and in such a manner as to prevent ground water contamination.

FACTORS TO BE CONSIDERED IN APPLYING EFFLUENT GUIDELINES

The above assessment of what constitutes the Best Practicable Control Technology Currently Available is predicted on the assumption of a degree of uniformity among plants within each subcategory that does not necessarily exist in all cases. One of the more significant variations that must be taken into account in applying limitations is availability of land for retention and/or treatment of wastewater. While the control technologies described herein have been formulated in most cases for minimal land requirements, individual cases of extreme lack of land may present difficulties in applying even these technologies. In other cases, the degree of land availability may dictate one treatment alternative over another, or allow treatment costs to be considerably less than those presented.

In the case of multi-product plants, an important point to consider is that the summation of the parts may not necessarily make up the theoretical whole. A plant, for example, that processes products covered under several of the subcategories covered in this document could be theoretically expected to meet a cumulative limitation; however, quite often the cumulative wastewater from such a plant will exceed the calculated quantity.

There are several subcategories in which no correlation may exist between the final effluent and the unit of production on a short term basis due to the batch natur of the process or to the cleanup periods. For example, distillers (Sub tegories A22, A23, and A24) may not mash grain for periods of one to five days while fermentation, distillation, etc., are still contributing to the waste effluent. The same case exists for malt beverage breweries (Subcategories A16, A17, and A18) and wineries (Subcategories A20 and A21). In such cases, it is recommended that the plant capacity, measured on a long term basis, be utilized in applying the effluent limitations.

DRAFT

TABLE 515

SUMMARY OF INVESTMENT AND YEARLY COSTS FOR TREATMENT ALTERNATIVES (BPCTCA)

Subcategory	Recommended Treatment Alternative	Total Investment Cost	Total Yearly Cost
(Vegetable oil processing and refining)			
A 1	A 1-II	$ 172,650	$ 32,580
A 2	A 2-II	19,450	1,510
A 3	A 3-I	40,850	5,460
A 4	A 4-II	254,970	49,530
A 5	A 5-IV	386,850	91,380
A 6	A 6-IV	497,190	116,050
A 7	A 7-IV	718,630	164,520
A 8	A 8-IV	628,590	140,210
A 9	A 9-IV	743,140	171,620
A 10	A 10-IV	646,270	146,640
A 11	A 11-IV	813,980	191,110
A 12	A 12-IV	722,000	166,810
A 13	A 13-III	295,200	70,200
A 14	A 14-III	217,340	44,070
A 15	A 15-III	0	1,200
(Beverages)			
A 16	V	3,730,960	1,029,500
A 17	V	11,377,110	3,107,230
A 18	V	1,056,780	440,710
A 19	IV	709,240	176,410
A 20	II	414,130	116,400
A 21	II	381,640	52,310
A 22	VI	839,260	221,570
A 23	II	133,720	28,200
A 24	II	2,644,060	698,640
A 25	II	14,670	153,470
A 26	IV	210,270	47,070
A 27	IV	264,550	61,140
A 28	A 28-VII	393,000	109,130
A 30	A 30-II	358,430	97,010
C 8	C 8-II	181,710	78,600
C 9	C 9-III	319,720	109,440
C 10	C 10-III	625,620	220,010

TABLE 516 (CONT'D)

Subcategory	Recommended Treatment Alternative	Total Investment Cost	Total Yearly Cost
(Bakery and Confectionery Products)			
C 1	C 1-III	$1,001,190	$389,640
C 2	C 2-IV	262,420	69,300
C 3	C 3-II	195,350	52,510
C 7	C 7-V	281,170	101,490
D 1	D 1-IV	425,670	116,120
D 2	D 2-IV	319,750	101,670
D 3	D 3-IV	248,350	82,920
D 5	D 5-V	954,170	227,630
D 6	D 6-V	581,990	144,720
(Pet Foods)			
B 5	B 5-III	511,100	125,490
B 6	B 6-IV	889,940	398,130
B 7	B 7-III	125,910	34,380
B 8	B 8-III	717,810	194,050
(Miscellaneous and Special Products)			
A 29	A 29-III	143,380	37,280
A 31	A 31-II	264,500	59,290
A 32	A 32-II	157,360	40,610
A 33	A 33-V	2,262,380	686,240
A 34	A 34-III	12,800	2,400
A 35	A 35-III	12,710	1,560
A 36	A 36-III	2,315,170	1,032,870
B 1	B 1-III	606,680	169,940
B 2	B 2-III	239,580	63,640
B 3	B 3-III	804,610	251,790
B 4	B 4-III	297,240	54,350
B 9	B 9-II	481,600	130,770
C 4	C 4-II	246,090	48,270
C 5	C 5-II	233,760	32,620
C 12	C 12-II	11,540	22,960

DRAFT

Another factor to be considered is that a biological treatment system requires a period of stabilization up to several weeks before optimum efficiency can be expected. During this start-up period, large variations in both BOD and suspended solids concentrations can be expected in the discharge.

Variations in the effluent may also be expected due to upsets of a biological treatment system. The maximum daily limitations recommended herein do not make allowance for such upsets. When upsets occur, these parties responsible for treatment plant operation should immediately report the occurence to the appropriate authorities, take the necessary steps to correct the situation, and report the probable cause of the upset.

Climatic conditions may also affect biological systems. Although the treatment systems developed herein were done so for relatively cold winters (the equivalent of upper New York State), decreased biological activity can be normally expected during winter months. In extremely cold climates (e.g., North Dakota, Alaska), added cost may be necessary for the heating of treatment systems.

DRAFT

SECTION X

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE EFFLUENT LIMITATIONS GUIDELINES

The effluent limitations which must be achieved by July 1, 1983, are to specify the degree of effluent reduction attainable through the application of the best available technology economically achievable. The best available technology economically achievable is not based upon an average of the best performance within an industrial category, but is to be determined by identifying the very best control and treatment technology employed by a specific point source within the industrial category or subcategory, or where it is readily transferable from one industrial process to another. A specific finding must be made as to the availability of control measures and practices to eliminate the discharge of pollutants, taking into account the cost of such elimination.

Consideration must also be given to:

1. The age of equipment and facilities involved;

2. The process employed;

3. The engineering aspects of the application of various types of control techniques;

4. Process change;

5. Cost of achieving the effluent reduction resulting from application of the best economically achievable technology;

6. Non-water quality environmental impact (including energy requirements).

In contrast to the best practicable control technology currently available the best economically achievable technology assesses the availability in all cases of in-process controls as well as control or additional treatment techniques employed at the end of a production process.

Those plant processes and control technologies which at the pilot plant semi-works, or other level, have demonstrated both technological performances and economic viability at a level sufficient to reasonably justify investing in such facilities may be considered in assessing the best available economically achievable technology. The best available economically achievable technology is the highest degree of control technology that has been achieved or has been demonstrated to be capable of being designed for plant scale operation up to and including "no discharge" of pollutants. Although economic factors are considered in this development, the costs for this level of control are intended to be the top-of-the-line of current technology subject to limitations imposed by economic and engineering feasibility. However, the best available technology economically achievable may be characterized by some technical risk with respect to performance and with respect to certainty of costs. Therefore, the best available technology economically achievable may necessitate some industrially sponsored development work prior to its application.

EFFLUENT REDUCTIONS ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Based upon the information contained in Sections III through VIII of this document, it has been determined that the degree of effluent reduction attainable through the application of the best available technology economically achievable is as listed in Tables 517 through 521 .

Recommendations concerning pH, temperature, floating oil and grease, and nickel are the same as presented in Section IX.

IDENTIFICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The Best Available Technology Economically Achievable for the miscellaneous foods and beverage industry, as described in Section VII, is generally the equivalent of tertiary physical/chemical treatment. The recommended treatment alternatives are indicated in Tables 517 through 521 .

ENGINEERING ASPECTS OF CONTROL TECHNOLOGY

The engineering aspects of this level of technology are the same as discussed in Section IX.

COSTS OF APPLICATION

The costs of obtaining the effluent reductions set forth herein are itemized in Section VIII. The investment and yearly costs of the recommended treatment alternatives are summarized in Table 522 .

NON-WATER QUALITY ENVIRONMENTAL IMPACT

The non-water quality environmental impact of this level of technology is the same as that discussed in Section IX.

FACTORS TO BE CONSIDERED IN APPLYING EFFLUENT GUIDELINES

As indicated above, the technology for this level is characterized by some technical risk with respect to performance and certainty of cost; it is expected that development work will be necessary prior to its application. Other factors to be considered include those discussed in Section IX.

DRAFT

TABLE 517

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BATEA) FOR VEGETABLE OIL PROCESSING & REFINING

Subcategory	Units	Recommended Treatment Alternative	BOD Max. 30-day Ave.	BOD Max. Day	SS Max. 30-day Ave.	SS Max. Day	O&G Max. 30-day Ave.	O&G Max. Day
A 1	kg/kkg oilseed crushed	III	0.0036	0.090	0.0045	0.011	0.0027	' 0068
A 2	" "	II	0	0	0	0	0	0
A 3	kg/kkg olives processed	I	0	0	0	0	0	0
A 4	" "	II	0	0	0	0	0	0
A 5	kg/kkg crude oil processed	V	0.021	0.052	0.017	0.043	0.0070	0.017
A 6	" "	V	0.035	0.087	0.030	0.075	0.012	0.030
A 7	" "	V	0.076	0.19	0.063	0.16	0.025	0.062
A 8	" "	V	0.051	0.13	0.051	0.13	0.020	0.050
A 9	" "	V	0.073	0.18	0.073	0.18	0.029	0.073
A 10	" "	V	0.048	0.12	0.056	0.14	0.024	0.060
A 11	" "	V	0.076	0.19	0.087	0.22	0.035	0.087
A 12	" "	V	0.060	0.15	0.072	0.18	0.030	0.075
A 13	kg/kkg finished product	IV	0.030	0.075	0.037	0.092	0.037	0.092
A 14	" "	IV	0.0080	0.020	0.0080	0.020	0.004	0.12
A 15		I	0	0	0	0	0	0

DRAFT

1492

TABLE 518

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BATEA) FOR BEVERAGES

Subcategory	Units	Recommended Treatment Alternative	BOD Max. 30-day Ave.	BOD Max. Day	SS Max. 30-day Ave.	SS Max. Day	O&G Max. 30-day Ave.	O&G Max. Day
A 16	kg/cu m beer produced	VI	0.14	0.35	0.19	0.48	----	----
A 17	" "	VI	0.27	0.67	0.38	0.95	----	----
A 18	" "	VI	0.24	0.60	0.34	0.85	----	----
A 19	kg/kkg barley processed	V	0.11	0.27	0.065	0.16	----	----
A 20	kg/kkg grapes crushed	III	0.38	1.1	0.054	0.16	----	----
A 20	kg/cu m wine produced	III	0.14	0.14	0.19	0.56	----	----
A 21		II	----	----	----	----	----	----
A 22	kg/kkg grain mashed	VII	0.13	0.32	0.16	0.40	----	----
A 23	" "	III	0.027	0.062	0.036	0.09	----	----
A 24	kg/1000 proof gal produced	III	0.58	1.55	0.35	0.86	----	----
A 25		II	0	0	0	0	----	----
A 26	kg/cu m finished product	V	0.026	0.065	0.015	0.037	----	----
A 27	" "	V	0.12	0.30	0.070	0.17	----	----

DRAFT

TABLE 51B (CON'T)

Subcategory	Units	Recommended Treatment Alternative	BOD Max. 30-day Ave.	BOD Max. Day	SS Max. 30-day Ave.	SS Max. Day	O&G Max. 30-day Ave.	O&G Max Day
A 28	kg/cu m finished product	XI	0.0025	0.0063	0.00050	0.0013	----	----
A 30	kg/kkg finished product	V	1.0	2.5	1.0	2.5	----	----
C 8	kg/kkg coffee buns	III	0.030	0.009	0.030	0.09	0.020	0.06
C 9	" "	III	0.10	0.25	0.10	0.25	0.050	0.13
C 10	" "	IV	0.25	0.60	0.25	0.60	0.16	0.40
F 1			0	0	0	0	0	0

TABLE 519

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BATEA) FOR BAKERY AND CONFECTIONERY PRODUCTS

		BOD		SS		O&G	
Subcategory	Recommended Treatment Alternative	Max. 30-day Ave.	Max. Day	Max. 30-day Ave.	Max. Day	Max. 30-day Ave.	Max. Day
C 1	IV	0.25	0.65	0.25	0.65	0.04	0.10
C 2	V	0.030	0.090	0.030	0.090	0.020	0.060
C 3	III	0.030	0.090	0.030	0.090	0.020	0.060
C 7	VI	0.050	0.13	0.050	0.13	0.030	0.080
D 1	VI	0.075	0.22	0.040	0.12	----	----
D 2	V	0.080	0.24	0.045	0.13	----	----
D 3	V	0.030	0.090	0.035	0.10	----	----
D 5	VII	0.075	0.22	0.035	0.10	----	----
D 6	VII	0.045	0.13	0.060	0.18	0.01	0.03

NOTE: All units in terms of kg/kkg finished product.

TABLE 520

RECOMMENDED EFFLUENT LIMITATIONS GUIDELINES (BATEA) FOR PET FOOD

Subcategory	Recommended Treatment Alternative	BOD Max. 30-day Ave.	BOD Max Day	SS Max. 30-day Ave.	SS Max. Day	O&G Max. 30-day Ave.	O&G Max. Day
B 5	IV	0.09	0.23	0.09	0.23	0.033	0.085
B 6	V	0.26	0.64	0.26	0.64	0.26	0.64
B 7	IV	0.0023	0.0060	0.0023	0.0060	0.0016	0.0040
B 8	IV	0.090	0.23	0.090	0.23	0.014	0.038

NOTE: All units in terms of kg/kkg finished product.

TABLE 521

RECOMMENDED EFFLUENT LIMITATIONS. GUIDELINES (BATEA) FOR MISCELLANEOUS AND SPECIALITY PRODUCTS

Subcategory	Units	Recommended Treatment Alternative	BOD Max. 30-day Ave.	BOD Max. Day	SS Max. 30-day Ave	SS Max. Day	O&G Max. 30-day Ave.	O&G Max. Day
A 29	kg/cu m finished product	VI	0.020	0.050	0.0062	0.016	----	----
A 31	kg/kkg finished product	V	1.1	2.7	0.31	0.78	0.31	0.62
A 32	" "	IV	0.11	0.26	0.014	0.035	0.014	0.028
A 33	" "	VI	1.6	3.2	0.81	1.6	----	----
A 34	" "	III	0	0	0	0	0	0
A 35	" "	III	0	0	0	0	0	0
A 36	" "	VII	104	209	83.4	167	----	----
B 1	" "	IV	0.39	0.98	0.39	0.98	0.15	0.37
B 2	" "	IV	0.41	1.0	0.41	1.0	0.12	0.29
B 3	" "	IV	0.54	1.3	0.54	1.3	0.23	0.57
B 4	" "	III	1.2	3.0	1.2	3.0	0.80	3.0
B 9	kg/kkg raw material	III	0.33	0.82	0.33	0.82	0.22	0.54
C 4	" "	V	0.21	0.63	0.21	0.63	0.07	0.21
C 5	" "	IV	0.030	0.090	0.030	0.090	0.010	0.030

TABLE 521 (CON'T)

Subcategory	Units	Recommended Treatment Alternative	BOD Max. 30-day Ave.	BOD Max. Day	SS Max. 30-day Ave.	SS Max. Day	O&G Max. 30-day Ave.	O&G Max. Day
C 12		II	0	0	0	0	0	0
D 4	kg/cu m finished product	V	0.040	0.12	0.020	0.050	----	----
E 1-6		----	0	0	0	0	0	0
F 2-4		----	0	0	0	0	0	0

TABLE 522

SUMMARY OF INVESTMENT AND YEARLY COSTS FOR TREATMENT ALTERNATIVES (BATEA)

Subcategory	Recommended Treatment Alternative	Total Investment Cost	Total Yearly Cost
(Vegetable Oil Processing and Refining)			
A 1	III	$ 189,060	$ 37,680
A 2	II	19,450	1,510
A 3	I	40,350	5,460
A 4	II	254,970	49,530
A 5	V	459,900	117,120
A 6	V	620,340	148,780
A 7	V	1,004,970	216,450
A 8	V	856,530	183,240
A 9	V	1,075,830	229,000
A 10	V	919,530	199,530
A 11	V	1,214,140	256,440
A 12	V	1,063,760	225,270
A 13	IV	327,930	79,280
A 14	IV	259,260	62,190
A 15	III	0.0	1,200
(Beverages)			
A 16	VI	3,870,380	1,062,060
A 17	VI	11,778,750	3,201,290
A 18	VI	1,594,850	461,230
A 19	V	761,830	187,330
A 20	III	434,350	122,300
A 21	II	381,640	52,310
A 22	VII	884,220	232,060
A 23	III	149,750	32,940
A 24	III	2,671,130	705,710
A 25	II	14,670	153,470
A 26	V	227,790	52,630
A 27	V	288,560	67,840
A 28	[illegible]	474,860	137,000
A 30	V	382,030	103,680
C 8	III	207,430	85,260
C 9	III	319,720	109,440
C 10	IV	5,956,320	1,321,270

Subcatego

(Bakery & Confectio Products)

C 1
C 2
C 3
C 7
D 1
D 2
D 3
D 5
D 6

(Pet Foods)

B 5
B 6
B 7
B 8

(Misc. a Spec. Pr

A 29
A 31
A 32
A 33
A 34
A 35
A 36
B 1
B 2
B 3
B 4
B 9
C 4
C 5
C 12
D 4

DRAFT

TABLE 522 (CONT'D)

Subcategory	Recommended Treatment Alternative	Total Investment Cost	Total Yearly Cost
(Bakery and Confectionery Products)			
C 1	IV	1,036,100	399,420
C 2	V	291,510	76,970
C 3	III	211,550	57,310
C 7	VI	313,890	110,570
D 1	VI	276,080	79,650
D 2	V	352,020	102,230
D 3	V	281,420	92,150
D 5	VII	605,250	207,990
D 6	VII	686,580	168,720
(Pet Foods)			
B 5	IV	557,310	138,950
B 6	V	956,910	410,850
B 7	IV	153,030	41,450
B 8	IV	913,950	213,510
(Misc. and Spec. Products)			
A 29	VI	160,180	42,240
A 31	V	281,050	64,180
A 32	IV	183,100	47,270
A 33	VI	2,308,260	696,940
A 34	III	12,800	2,400
A 35	III	12,710	1,560
A 36	VII	2,352,740	1,041,740
B 1	IV	652,580	183,010
B 2	IV	257,930	69,020
B 3	IV	850,820	265,250
B 4	III	297,240	54,350
B 9	III	523,790	140,590
C 4	V	205,920	39,960
C 5	IV	137,640	22,010
C 12	II	11,540	22,960
D 4	V	271,660	92,930

SECTION XI

NEW SOURCE PERFORMANCE STANDARDS

This level of technology is to be achieved by new sources. The term "new source" is defined in the Act to mean "any source, the construction of which is commenced after ... publication of proposed regulations prescribing a standard of performance ... new source technology shall be evaluated by adding to the ... underlying the identification of best available technology ... achievable a determination of what higher levels of pollution control are available through the use of improved production ... and/or treatment techniques. Thus, in addition to considering the ... in-plant and end-of-process control technology, identified ... available technology economically achievable, new source technology is to be based upon an analysis of how the level of effluent may be reduced by ... the production process itself. Alternative processes, operating ... or other alternatives must be considered. However, the end result of the analysis will be to identify effluent standards which reflect levels of control achievable through the use of improved production processes (as well as control technology), rather than prescribing a particular type of process or technology which must be employed. A further determination which must be made for new source technology is whether a standard permitting no discharge of pollutants is practicable.

At least the following factors should be considered with respect to production processes which are to be analyzed in assessing new source technology:

1. The type of process employed and process changes;
2. Operating methods;
3. Batch as opposed to continuous operations;
4. Use of alternative raw materials and mixes of raw materials;
5. Use of dry rather than wet processes (including substitution of recoverable solvents for water); and
6. Recovery of pollutants as by-products.

NEW SOURCE PERFORMANCE STANDARDS FOR THE MISCELLANEOUS FOODS AND BEVERAGES POINT SOURCE CATEGORY

Based upon the information contained in Sections III through VIII of this document, it has been determined that the degree of effluent reduction obtainable for new sources is as follows:

Subcategories A 1 - 15	--	the same as that developed in Section IX.
Subcategory A - 16	--	maximum 30-day average and maximum day BOD and suspended solids, respectively 0.070, 0.17, 0.097, 0.24 kg/cu m beer produced.
Subcategories A 17 - 18	--	not applicable since, by definition, there can be no new sources within these subcategories.
Subcategory A 20	--	maximum 30-day average and maximum day BOD and suspended solids, respectively: 0.23, 0.69, 0.031, and 0.093 kg/kkg grapes crushed.
Subcategory A 21	--	maximum 30-day average and maximum day BOD and suspended solids, respectively: 0.083, 0.025, 0.11, and 0.34 kg/cu m wine produced.
Subcategory A 29	--	maximum 30-day average and maximum day BOD and suspended solids, respectively: 0.012, 0.03, 0.0040, 0.010 kg/cu m finished flavors produced.
All other subcategories	--	the same as that developed in Section X.

PRETREATMENT CONSIDERATIONS

In general, wastewaters from the miscellaneous foods and beverage industry contain no constituents that are considered to be incompatible with a well designed and operated municipal wastewater treatment plant, nor any constituents that would pass through such a system.

Potential problems which could occur include (1) slug loads due to wide variations of flow and/or waste strength with time, (2) acidic or caustic wastes, (3) excessive oil and grease concentrations, and (4) inadequate dilution in the municipal system for particular high strength wastes. Each of these problems must be considered on a case by case basis in terms of both the nature of the industrial wastewater and the capacity of the municipal system.

The problem of slug loads can usually be alleviated by the use of flow equalization prior to discharge. Adjustment of pH may be necessary if the pH of the raw wastewater is below 6.0 or above 9.0, although a given municipality may have requirements differing from this. In any industrial operation oil and grease contamination is a possibility and, if in-plant measures are inadequate to prevent its occurence in the plant's effluent, facilities for oil skimming may have to be provided.

In the case of vegetable and animal fats and oils, virtually all plants having these constituents in their wastewaters currently provide skimming, gravity separation, and, in some cases, dissolved air flotation before discharge to municipal sewers.

Those industries which generate wastewaters with significant concentrations of vegetable or animal fats and oils include vegetable oil processing and refining; coffee production; bakery and confectionery production (specifically Subcategories C 1, C 2, C 3, C 7, D 5, and D 6); Pet Food production; and Subcategories A 31, A 32, B 1, B 2, B 3, B 4, B 9, and C 5.

In the case of extremely high strength industrial waste being discharged to a relatively small municipal system, considerable pretreatment (even to the extent of equivalent secondary treatment) may be necessary. A careful accessment must be made of the dilution capacity of a municipal system before discharging such an industrial waste to it.

Of all the industries considered herein, only ice manufacturing and olive oil processing yielded concentrations of dissolved solids and/or chlorides appreciably above those levels found in municipal sewage. Whether a municipality should accept high dissolved solids or chlorides must be decided on a case by case basis.

DRAFT

SECTION XII

ACKNOWLEDGEMENTS

This document was prepared by Environmental Science and Engineering, Inc. (ESE), of Gainesville, Florida. The Project Director was Mr. John D. Crane, P.E.

The study involved the services of four additional offices. SCS Engineers of Long Beach, California (SCSL) was responsible for data collection, definition of the industry, wastewater characterization, development of control and treatment technology, and recommendations of guidelines for pet food, frozen specialties, chili pepper and paprika, dehydrated soup, and macaroni products. SCS Engineers of Reston, Virginia, (SCSR) held similar responsibilities for coffee, bakery products, eggs, manufactured ice, prepared sandwiches, and chicory. Environmental Associates, Inc. (EAI) of Corvallis, Oregon, was responsible for candy and confectionery products, chocolate products, chewing gum, vinegar, popcorn, molasses, honey, and sweetening syrups, and provided assistance in the study of the California wine industry. Reynolds, Smith & Hills (RSH) of Jacksonville, Florida, provided much of the preliminary work for cost analyses. Also, Dr. Richard H. Jones, P.E., of Gainesville provided consultation in the development of basic treatment design assumptions. Cost analyses for all subcategories were performed by ESE. Computerized data handling services were provided by EAI.

The key personnel on the ESE team included Mr. David R. Swift who managed the vegetable oil processing and refining segment of the study; Mr. James B. Cowart who managed the malt beverage, malt, distilled spirits, wine, and soft drink industries; Mr. Edward M. Kellar who managed much of the field work for ESE in addition to assuming responsibilities for peanut butter and yeast; Mr. Wayne Pandorf who was responsible for pectin, olive oil, tea, and various other products; Mr. Daniel P. Casali who managed ESE's in-house data handling and computerized cost analysis systems; and Mr. Jack B. Sosebee who directed the laboratory analyses of all wastewater samples collected for the project.

The Project Manager for SCSL was Mr. J. Curtis Schmidt, P.E., and his principal assistant was Mr. Kenneth LaConde. The Project Manager for SCSR was Mr. E. T. Conrad, P.E., who was assisted by Messrs. Gary L. Mitchell, David H. Bauer, Richard W. Corvlin, and Thomas A. Wimmer. The Project Manager for EAI was Mr. Dennis W. Taylor; Mr. Michael D. Swayne and Mr. James H. Reiman developed and operated EAI's computerized data handling system.

Invaluable technical direction and guidance were provided by the Effluent Guidelines Division of EPA. Appreciation is particularly expressed to the Project Officer, Mr. Richard V. Watkins, P.E., and to the Assistant Project

DRAFT

Officers, Messrs. David Alexander and Gary Fischer, for their dedication, encouragement, and technical and administrative assistance.

Acknowledgement is also due to numerous plant managers, plant engineers, and other industry personnel without whose cooperation and assistance in site visits and information gathering, the project could not have been completed.

The list of industry officials who spent considerable time in traveling to and attending meetings throughout the country, in gathering and providing information, and in critiquing the work as it developed; and government c[illegible]ls, both federal and local, who provided assistance, is far too l[illegible]e included in this section. But special recognition and appreciat[illegible] due to the following:

Mr. Dwight [illegible]gquist, Henningsen Foods, Inc.

Mr. F. M. Bloomberg, Riceland Foods, who contributed considerable input to the process description for soybean oil degumming.

Mr. Salvatore Cannavc, L. A. Dreyfus Company

Mr. Marion Clower, Joseph E. Seagram and Sons, Inc.

Mr. Hugh Cook and Mr. Ted Weller, California Wine Institute.

Mr. Jo[illegible] Eck, Fleischmann Distilling Company.

Mr. Giles S. Farmer, Ande[illegible]son-Clayton Foods, who gave invaluable assistance in preparation of the process descriptions for edible oils.

Dr. Paul Hess, Hershey Foods.

Mr. Bernard Hurst, James B. Beam Distilling Company

Mr. Harry Korab and the members of the Effluent Control Committee, National Soft Drink Association.

Dr. Hans Lineweaver, USDA, Western Region Research Laboratory, Berkely, California.

Miss Jacqueline McCurdy, Distilled Spirits Council of the United States.

Mr. Paul Peters, ITT Continental Bakeries.

Dr. A. C. Rice, Taylor Wine Company, who organized a technical committee to represent the New York Wine Industry.

Mr. Jim Rullman, Schenley Distillers.

DRAFT

Dr. Edward Segel and the members of the Effluent Committee, United States Brewers Association.

The staffs of all offices involved--secretaries, technicians, and engineers--deserve special recognition and appreciation for an effort requiring dedication, hard work, and long hours to produce a massive amount of work in an incredibly short period of time.

DRAFT

REFERENCES

1. Handbook For Monitoring Industrial Wastewater, U.S. Environmental Protection Agency (August 1973).

2. Census of Manufactures, (1972) Industry Series, U.S. Department of Commerce, Bureau of the Census, MC72(P)-20A-2, Washington, D.C., March, 1974.

3. Egg Products, United States Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, Pou 2-5 (7-74), Washington, D.C., July 26, 1974.

4. Gorman, J., Seymour Foods, Inc., Personal Communication (December 19, 1974).

5. Preliminary Report 1972 Census of Manufactures Industry Series, Bread, Cake, and Related Products, United States Department of Commerce, MC72(P)-20E-1, Washington, D.C., January 1972.

6. Gerrish, D., Secretary, American Bakers Association, Personal Communication (September 19, 1974).

7. Bergquist, H., Chief Chemist, S. B. Thomas Baking Company, Personal Communication (November 26, 1974).

8. Creed, J., Executive Vice President, Biscuit and Cracker Manufacturers' Association, Personal Communication (December 26, 1974).

9. Pieper, W.E., Secretary, Biscuit and Cracker Manufacturers' Association, Personal Communication (October 11, 1974).

10. Lees, R., Jackson, E. B., Sugar Confectionery and Chocolate Manufacture, Leonard Hills Books, Aylesbury, Great Britain, 1973.

11. Soderquist, M. R., "Activated Carbon Renovation of Spent Cherry Brine," JWPCF, 43 (8) (August, 1971).

12. Cook, M. K., "Manufacture of Chewing Gum", L. A. Drefus Company.

13. Dunning, W. 1956, "Unit Operations in a Mechanical Extractions Mill", Journal of the American Oil Chemists' Society, 133(10).

14. USDA Marketing Research Report 1972.

15. U.S. Dept. of Commerce 1974 Statistics.

16. Smith, A. K., "Practical Considerations in Commerical Utilization of Oilseeds," Journal of the American Oil Chemists' Society, 48 (January, 1971).

DRAFT

17. Winner, S., 1974, "The Changing Face of the Soybean Market", Soybean Digest Blue Book, March 1974.

18. Doty, H.O., and Lawler, J. V., 1971, "Present and Potential Markets for Safflower Oil," Fats and Oils Situation (June, 1974).

19. Cofield, E. P., 1951, "Solvent Extraction of Oilseed," Chemical Engineering (Jan. 1951).

20. Brennan, P. J., 1963, "Making the Most out of Cottonseed Processing" Chemical Engineering (Jan. 1963).

21. Rockwell, C. R., 1971, "Dust Control", Journal of the American Oil Chemists' Society (Jan. 1971).

22. Hutchin's, R. P., 1968, "Processing Control of Crude Oil Production from Oilseeds," Journal of American Oil Chemists' Society (November 1968).

23. Encyclopedia of Chemical Processing Equipment, "Solvent Extraction Equipment," Reinhold Publishing Corporation, New York, N. Y.

24. Markley, K. S., Soybeans and Soybean Products, Interscience, Pub., N.Y.

25. Kingsbaker, C. L., 1970, Solvent Extraction Techniques for Soybeans and Oilseeds: Resolventizing and Toasting", Journal of the American Oil Chemists' Society (October, 1970).

26. Bloomberg, F. Personal Communication (1974).

27. Food Fats and Oils, Institute of Shortening and Edible Oils, Inc., 4th Edition, Washington, D.C., August, 1974.

28. USDA, Foreign Agricultural Service Statistics 1972, as reported in the Soybean Digest Blue Book, American Soybean Association, Hudson, Iowa (March 1974).

29. 1970 Directory, The Edible Oil Industry in the United States, Institute of Shortening and Edible Oils, Inc., Washington, D.C., 1970.

30. Sanders, J. H., "Processing of Food Fats - A Review", Journal of Food Technology, 13(1) (1959).

31. 1974 Modern Brewery Age Blue Book.

32. U.S. Industrial Outlook, 1975, U.S. Dept. of Commerce.

33. Skinner, C., General Manager, Barley and Malt Institute, Personal Communication (1974).

34. Economic Research Report by the Wine Advisory Board, 1972 - Wine Industry Statistical Report No. 21, 22, 23, 24, January, March, April, and August 1974.

35. Amerine, M. A., et. al., The Technology of Wine Making, AVI Publishing Company, Inc., 1972.

36. Boruff, C. S., Blaine, R. K., "Ind. Wastes - Grain Distillery Feeds and Wastes." Sewage and Ind. Wastes, (Oct., 1953).

37. Hiat, "Anaerobic Degredation of Rum Distillery Waste," Masters Thesis, Clemson University (December, 1972).

38. 1973 Salls Survey of the Soft Drink Industry, National Soft Drink Association.

39. Parker, M. E., Elements of Food Engineering, Volume I, Reinhold Publishing Corporation, New York, 1952.

40. Jacobs, M. B., Synthetic Food Adjuncts, D. Van Nostrand Company Inc., New York, 1947.

41. Annual Coffee Statistics, Pan American Coffee Bureau, New York, New York (1972).

42. Sullivan, Richard, Secretary, National Coffee Association, Personal Communication (December 16, 1974).

43. Coffee Drinking in the United States, Pan American Coffee Bureau, New York, New York, Winter (1974).

44. Payne, M., President, National Ice Association, Personal Communication (September 19, 1974).

45. ASHRAE Handbook & Products Directory, 1974 Applications, American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., New York, N.Y. (1974).

46. Durst, J. R., Edible Oils and Fats, Food Processing Review No. 5, Noyes Development Corporation, Park Ridge, New Jersey, 1969.

47. Manley, R. B., Honey Production in the British Isles, Bradley & Sons, L.T.D., The Crown Press, 1936.

48. Woodroof, J. G., Peanuts: Production, Processing, Products, AVI Publishing Co., Inc., 1973.

49. U. S. Standards for Grades of Peanut Butter, Agricultural Marketing Service, USDA, March 23, 1962.

DRAFT

50. Commodities Yearbook, 1974.

51. White, J., Yeast Technology, John Wiley & Sons, Inc., New York, 1954.

52. "The A-B's of Liquid Farming," Anheuser-Busch, Inc., Esso Oilways (May 1957).

53. Seng, W. C., "Recovery of Fatty Materials From Edible Oil Refinery Effluents," Environmental Protection Technology Series.

54. Becker, K. W., "Control of Pollutants from Air and Water for the Oilseeds Industry," Blaw-Knox Chemical Plants, Inc., Report E-2517 Rev. 2-70.

55. Francois, R., "Measures Against Water Pollution in Industries Producing Edible Oils and Fats," Pure Applied Chemistry, 29, (1972).

56. "1974 Brewery Effluent Wastewater," USBA, Inc., Washington, D. C., (November 1974).

57. LeSeeleur, L. A., "A Perspective on Brewery Effluents," Technology Quarterly of the Master Brewers Association of America, 5, (1) (January 197[illegible]).

58. Stein, J. L., et. al., "Concentration of Brewery Spent Grain Liquor Using a Submerged Combustion Evaporator," Proceedings of the 4th National Symposium on Food Processing Wastes (December 1973).

59. O'Rourke, J. T., Tomlinson, H. D., "Extreme Variations in Brewery Waste Characteristics and Their Effect on Treatment," 17th Industrial Waste Conference, Purdue (1962).

60. "Biological Treatability Studies and Process Design of a Brewery Wastewater," AWARE (October 1971).

61. Ruf, H. W., et. al., "Malt House Waste Treatment Studies In Wisconsin," Sewage Works Journal, 7, (3) (May 1935).

62. Isaac, P. G., "Malting Effluents," Effluent and Water Treatment Journal (November 1969).

63. Simpson, J. R., "Treatment and Disposal of Effluents," Brewers' Journal (August-September 1967).

64. Crawford, C. M., E and J Gallo Winery, Modesto California, Personal Communication (September 1974).

65. Pearson, E. A., et. al., "Treatment and Utilization of Winery Wastes," Proceedings of the 10th Industrial Waste Conference, Purdue (May 1955).

DRAFT

66. 702 Forms, Bureau of Alcohol, Tobacco, and Firearms.

67. Skofis, E., Chief Chemist, Roma Winery, Modesto, California, Personal Communication (1974).

68. Coast Laboratories, "Progress Report to the Wine Institute," (November 30, 1946).

69. Schroeder, W. D., et. al., "Biological Treatment of Winery Stillage," Proceedings of the 4th National Symposium on Food Processing Wastes (December 1973).

70. Blaine, R. K., Van Lanen, J. M., "Application of Waste-to-Product Ratios in the Fermentation Industries," Biotechnology and Bioengineering, IV, (2) (1962).

71. Unpublished In-Plant Study, American Distilling Company.

72. Rullman, J., Staff Engineer, Schenley Distillers, Personal Communication (1974).

73. "Converts 220,000 Gal/Day Waste Stillage Problem Into $1,500,000/yr Feed Sales," James Beam Distillery, Food Processing (June 1973).

74. Nack, J., Production Manager, McClain, D., Chief Chemist, American Distilling Company, Personal Communication (1974).

75. Stone, L., Dr., Director of Research, Hiram Walker Distillers, Personal Communication (1974).

76. Sobolov, M., et. al., "Wastewater Treatment at Hiram Walker's New Distillery," Industrial Wastes (March/April 1973).

77. Clower, M., Chief Ecology Engineer, Seagram Distillers, "Green Company Report," Personal Communication (1974).

78. Thomas, J. L., Sanborn, D. A., "Activated Sludge - Bio-Disc Treatment of Distillery Waste," Proceedings of the 4th National Symposium on Food Processing Wastes (December 1973).

79. "Rum Distillery Slops Treatment by Anaerobic Contact Process," EPA 660/2-74-074 (1974).

80. McHaffie, A., Plant Manager, Jacquin Distillers, Personal Communication (1974).

81. Shirley, D., Plant Manager, Florida Distillers, Personal Communication (1974).

DRAFT

82. General Foods Corporation, Report on Raw Wastewater Characteristics (January 1975).

83. Entenmann, C., Owner, Entenmann's Bakery, Inc., Personal Communication (December 18, 1974).

84. McKee, J., Executive Vice President, McKee Baking Company, Personal Communication (October 21, 1974).

85. Havens and Everson, Consulting Engineers, "Waste Solvent Separation and Disposal," Gum Case Division, Beach Nut, Inc., Preliminary Design and Cost Estimate, N.Y., N.Y. (October 1971).

86. Rudolfs, W., Trubnick, E. H., "Treatment of Compressed Yeast Wastes," Industrial and Engineering Chemistry, 42, (4) (April 1950).

87. Koziorowski, B., Kucharski, J., Industrial Waste Disposal, (Chapter 29, The Fermentation Industry, Section 4, Yeast Factories), Pergammon Press, N. Y., 1972.

88. Siderwicz, W., "A Waste Survey of the Egg Breaking Industry," Thesis, Cornell University, Ithaca, N. Y. (1974).

89. Schultz, J., Unpublished Data (1974).

90. "Policy on Subsurface Emplacement of Fluids by Well Injection," A policy statement issued by the Environmental Protection Agency with accompanying "Recommended Data Requirements for Environmental Evaluation of Subsurface Emplacement of Fluids by Well Injection," Washington, C. C. (February 1973).

91. Ukeles, R., "Growth of Pure Cultures of Marine Phytoplankton in the Presence of Toxicants," Journal of Applied Microbiology, 10 (1962).

92. Proposed Criteria for Water Quality, Volume I, U. S. Environmental Protection Agency, Washington, D. C., October 1973.

93. Public Health Service Drinking Water Standards, Revised, 1962, U. S. Department of Health, Education, and Welfare, U. S. Public Health Service Publication 956, Washington, D. C., 1962.

94. Metcalf & Eddy, Inc., Wastewater Engineering, McGraw-Hill Book Company, N. Y., 1972.

95. Fair, G. M., et. al., Water and Wastewater Engineering, Volume II, John Wiley & Sons, Inc., N. Y., 1968.

96. Clark, J. W., et. al., Water Supply and Pollution Control, International Textbook Company, Scranton, 1971.

97. Nemerow, N. L., Theories and Practices of Industrial Waste Treatment, Addison-Wesley Publishing Company, Reading, Mass., 1963.

98. Eckenfelder, W. W., Jr., Water Quality Engineering for Practicing Engineers, Barnes & Noble, Inc., N. Y., 1970.

99. Grinkevich, A., "Pretreatment of Vegetable Oil Refinery Wastewater," Proceedings of the 5th National Symposium on Food Processing Wastes, Environmental Protection Technology Series (June 1974).

100. Loehr, R. C., "Statement Presented to the Illinois Pollution Control Board," (March 5, 1971).

101. McCarty, P. L., "Report on a Laboratory Investigation to Determine the Treatability of Edible Oil Processing and Soap Manufacturing Wastes," (1971).

102. Adams, C. E. Eckenfelder, W. W., "Letter From Consulting Engineering Firm, Associated Water and Air Resources Engineers, Inc."

103. Watson, K. S., et. al., "Joint Treatment Verses Pretreatment of Food Processing Wastes," JWPCF, 46, (8) (August 1974).

104. Foree, E. G., et. al., "The Anaerobic Filter for the Treatment of Brewery Press Liquor Waste," University of Kentucky, Lexington, Kentucky (April 1972).

105. Schwartz, H. G., Jones, R. H., "Characterization and Treatment of Brewery Wastes," Environmental Science and Engineering, Inc., Gainesville, Florida, Proceedings of the 3rd National Symposium on Food Processing Wastes, Corvalis, Oregon (1972).

106. McWhorter, T. R., Zielinski, R. J., "Waste Treatment for the Pabst Brewery at Perry, Georgia," 26th Industrial Waste Conference, Purdue (May 1971).

107. Windell, J. T., et. al., "Substitution of Brewer's Single Cell Protein into Pelleted Fish Feed," Feedstuffs (May 20, 1974).

108. Jewell, W. J., et. al., "The Use of Pure Oxygen for the Biological Treatment of Brewery Wastewaters," 26th Industrial Waste Conference, Purdue, Extension Series 140 (May 1971).

109. Eckenfelder, W. W. Plummer, A. H., "Treatment of Brewery Wastewater by High Rate Biological Process," 25th Industrial Waste Conference, Purdue (1972).

110. Lewis, H. V., Bays, J. D., "Application of Ceramic Diffusers to Pure Oxygen Treatment," Presented at the 47th Annual WCPF Conference (October 1974).

111. Ryder, R. A., "Winery Wastewater Treatment and Reclamation," Presented at the 28th Annual Waste Conference, Purdue (May 1973).

112. Tofflemire, T. J., et. al., "Unique Dual Lagoon System Solves Difficult Wine Waste Treatment Problem," Water and Wastes Engineering (December 1970).

113. Rice, A. C., Director of Research, The Taylor Wine Company, Hammonsport, N. Y., Personal Communication (1974).

114. LaBella, S. A., Thaker, I. H., "Treatment of Winery Wastes by Aerated Lagoon, Activated Sludge Process, and Rotating Biological Contactors or "RBC", 27th Industrial Waste Conference, Purdue (May 1972).

115. "Improved Distilling Material Production Methods as an Aid in Stillage Disposal," Coast Laboratories, Fresno, California.

116. "1947 Grape Stillage Disposal, July 21, 1948," Coast Laboratories, Report to the Wine Institute (July 1948).

117. Vaughn, R. H., Marsh, G. L., "The Disposal of Dessert Winery Waste," The Wine Review (November 1945).

118. Schroeder, E. D., "Pilot Scale Treatment of Wine Stillage," Draft for the Office of Research and Monitoring, Environmental Protection Agency, Washington, D. C.

119. Tofflemire, T. J., "Survey of Methods of Treating Wine and Grape Wastewater," American Journal Enol. Viticult., 23, (4) (1972).

120. "Preliminary Special Report on Land Disposal of Stillage," Coast Laboratories, Report to the Wine Institute (January 1, 1947).

121. "Progress Report," Coast Laboratories (October 31, 1946).

122. "Progress Report," Coast Laboratories (November 30, 1946).

123. "Grape Stillage Disposal by Intermittent Irrigation," Coast Laboratories, Report to the Wine Institute (June 1947).

124. York, G. K., "Land Disposal of Stillage - Analyses of Soil Core Samples," Report to the Wine Institute, Environmental Studies Committee (November 3, 1972).

DRAFT

125. York, G. K., "Land Disposal of Wineous Stillage: III. Analyses of Grounwater Supplies," Department of Food Science & Technology, University of California.

126. York, G. K., "Land Disposal of Vinous Stillage: II. Analysis of Soil Core Samples, Water and Stillage," Report to the Wine Institute Environmental Studies Committee Meeting (March 14, 1974).

127. Delker, J. S., City of Fresno "Waste Analysis for Municipal Wineries"(1971, 1973, and 1974).

128. Stander, G. J., "Treatment of Wine Distillery Wastes by Anaerobic Digestion," Proceeding of the 22nd Industrial Waste Conference, Purdue, II, (3) (July 1967).

129. Chadwick. T. H., Schroeder, E. D., "Characterization and Treatability of Pomace Stillage," JWPCF, 45, (9) (September 1973).

130. Jackson, C. J., "Whiskey and Industrial Alcohol Distillery Wastes," Institute of Sewage Purification, Part 1 (1956).

131. Ahlgren, R. M., "Engineering Study of Rum Distillery Waste Treatment for EPA," Aqua-Chem, Inc., Milwaukee, Wisconsin (July 1973).

132. Stander, G. J., "Effluents from Fermentation Industries," Parts I, II, III, and IV, Journal of the Institute of Sewage Purification, 3, (4).

133. Sen, B. P., Bhaskaran, T. R., "Anaerobic Digestion of Liquid Molasses Distillery Waste," JWPCF (October 1962).

134. Biaggi, N., "Studies of Rum Distillery Wastes in Puerto Rico," PhD Thesis, University of Michigan.

135. Burnett, W. E., "Rum Distillery Wastes: Laboratory Studies on Aerobic Treatment," Water and Sewage Works (September 1973).

136. Bhaskaran, T. R., "Utilization of Materials Derived From Molasses Distillers," Advances in Water Pollution Research, Volume 2, Pergammon Press, London, 1965.

137. Ono, H., Fermentation Research Institute, Agency of Industrial Science and Technology, Japan

138. Shea, T. G., et. al., "Investigation of Rum Distillery Slops Treatment by Anaerobic Contact Process," Proceeding of the Fifth National Sypmosium on Food Processing Wastes.

139. National Coffee Association, ad hoc Committee on Effluent Guidelines, Personal Communication (January 9, 1975).

140. Chalmers, R. K., "Treatment of Wastes From Food Manufacture and Coffee Processing," Proceedings of the 22nd Industrial Waste Conference,(2) (July 1968).

141. Russel, D., Wastewater Treatment Plant Operator, McKee Baking Company, Personal Communication (January 28, 1975).

142. Onford, H. E., "Breaking in an Industrial Waste Treatment Plant," A paper presented at the Water Pollution Control Convention, Atlanta City (March 22, 1975).

143. Eldridge, E. F., Industrial Waste Treatment Practice, McGraw-Hill Book Company, 1942.

144. Tatlock, M. W., "Treatment of Yeast Products Wastes," Proceedings of the 3rd Industrial Waste Conference, Purdue, Extension 64 (1947).

145. Buswell, A. M., "Industrial Engineering Chemistry" (1950).

146. "Complete Mix Activated Sludge Treatment of Citrus Process Wastes," Water Pollution Control Research Series 12060 EZY 08/71.

147. Hee, A., et. al., "A Study of Waste Treatment Alternatives For Egg Breaking Plants," unpublished paper, Cornell University, Ithaca, N. Y. (1974).

148. Moats, W. A., Harris, C. E., "Recovery of Egg Solids From Wastewater From Egg Grading and Breaking Plants," Agricultural Research Service, USDA, Beltsville, Maryland (1974).

149. Bulley, N. R., et. al., "Biological Treatment of Egg Processing Wastewater," Department of Agricultural Engineering, University of British Columbia, Vancouver, B. C.

150. Bailey, H. H., et. al., Progress Report No. 5, "Pilot Tests of Biological Treatment Processes Using Plastic Media and Rock Trickling Filters," unpublished data (1973).

151. Cornell University, "Egg Breaking and Processing Wastes," EPA Demonstration Project No. S-802174 (August 1974).

152. Gillert, P., Personal Communication (1974).

153. Siderwicz, W., unpublished data and Personal Communication (1974).

154. Jewell, W. J., et. al., "Egg Breaking and Processing Waste Control and Treatment," EPA Demonstration Project No. S-802174 (August 1974).

155. Maystre, T., Geyer, J. C., "Charges for Treating Industrial Wastewater in Municipal Plants," JWPCF, 42. (7) (July 1970).

156. Antony, A. P., Ahlgren, R. M., "Modern Handling Methods for Grain Effluents," Aqua-Chem, Inc., presented at the Masters Brewers Assoc. of America (June 12, 1971).

UNCITED

VEGETABLE OIL PROCESSING AND REFINING

"Deodorizing Edible Oils," Chemical Engineering (September 1946).

"Fats and Oils," USDA Marketing Research Report (1972).

"Fatty Oil Refing Process," Chemical and Process Engineering, (May 1971).

Gillies, M. T., "Shortenings, Margarines, and Food Oils," Food Technology Review, No. 10 (1974).

Goldsmith, R. L., et. al., "Treatment of Soy Whey by Membrane Processes," Proceedings of the 3rd National Symposium on Food Processing Wastes.

Hutchins, R. P., "Solvent Extraction Including Seed Pretreatment," Journal of American Oil Chemistry Society, 33, (10) (October 1956).

"The Impact of Oily Materials on Activated Sludge Systems," Hydroscience, Inc. Water Pollution Control Research Series.

"Improving Soybean Oil From Damaged Beans," Food Engineering (December 1973).

McDermott, G. N., Polkowski, L. B., "Taboos vs. Rational Approaches to Animal and Vegetable Oils and Fats in Municipal Systems," 61st Annual Meeting of American Oil and Chemistry Society, New Orleans, La. (April 1970).

McNeil, K. E., et. al., "Effluent Treatment at Farleigh Mill," Proc. Qd. Soc. Sugar Cane Technology - 41st Conference (1974).

"Now Castor Oil by Solvent Extraction," Editorial Staff Report, Chemical Industries, 64 (June 1949).

Quigley, R. E., Hoffman, E. L., "Flotation of Oily Wastes," Proceedings of the 21st Industrial Waste Conference, Purdue, 50 (2) (1966).

"Report on a Laboratory Investigation to Determine the Treatability of Edible Oil Processing and Soap Manufacturing Wastes," Proctor & Gamble, Perry L. McCarty, Consultant, Stanford, California (April 1971).

Riepma, S. F., The Story of Margarine, Public Affairs Press, Washington D. C., 1970.

Sullivan, F. E., "Non-Caustic Refining of Edible Oils and Fatty Acids," Chemical Engineering (April 15, 1974).

Sullivan, F. E., "Refining of Oils and Fats," J. Am. Oil Chemists Society (October, 1968).

Switzer, D. K., McDermott, G. N., "A Case History of Conveyance of Wastewaters From an Edible Oil Refining Plant in Municipal Sewers," Proctor & Gamble Co. (Nov., 1973).

"Tall Oil Industry," Bulletin No. 1, Tall Oil Association, N. Y.

Wallterstein, J. S., et. al., "Recovery of Proteins from Wheat Mashes with Suflite Waste Liquor," Industrial and Engineering Chemistry, 36, (8) (August, 1944).

Ziemba, J. V., "First Cottonseed Protein Plant Now On-Stream," Food Engineering (November, 1973).

BEVERAGES

Agostini, A., "Utilization of By-Products of Vines and Wines," Die Wynboer (Augustus, 1964).

Ault, R. G., "An Approach to the Problem of Brewery Effluents," Chemistry and Industry (Jan., 1969).

Bloodgood, D. E., "Industrial Wastes - The Industrial Waste Problem, II. Strawboard, Petroleum and Distillery Wastes," Sewage Works Journal (July, 1947).

Boruff, C. S., "Pollution Control Measure in the Fermentation Industry." Chemical Engineering Progress, 55, (11) (November, 1959).

Boruff, C. S., "Waste Problems in the Fermentation Industry," Sewage Works Journal (March, 1940).

Boruff, C. S., et. al., "Water for Grain Alcohol Distilleries," Industrial and Engineering Chemistry, 35, (11) (November, 1943).

Boruff, C. S., "Grain Distilleries," Industrial and Engineering Chemistry, 44 (March, 1952).

"Bottling Breakthrough Beverages at 1000 to 2000 BPM," Food Engineering (March, 1969).

DRAFT

Brookman, G. T., Kevin C. T., "The Effect of Wastewater from Gin and Vodka Production at the Hartford Plant on the MDC Sewage System," TRC Project No. 31336 (May, 1974).

Bueltman, C. G., "Bio-Oxidation of Brewery Wastes," 14th Ind. Waste Conf., Purdue (1959).

Burkhead, C. E., et. al., "Biological Treatment of Distillery Waste," Proceedings 23rd Ind. Waste Conf., Purdue (May 7-9, 1968).

Burkhead, C. E., et. al., "Pollution Abatement of a Distillery Waste," Water and Wastes Engineering (Industrial).

Carson, C. T., "Treatment of Distillery Wastes," Water and Sewage Works (July 1951).

Cooke, F. M., Berg, H. W., "Table Wine Processing Practices in the San Joaquin Valley," Reprinted from American Jorunal of Enology and Viticulture, 24, (4) (1973).

Davidson, A. B., Banks, J. F., "Anaerobic Treatment of Distillery Wastes (Pilot-Plant Studies)," Proceedings of the 4th Industrial Waste Conference, Purdue (1948).

Downing, G. G., Lewis, H. V., "Plant Brews Good Effluent," Water and Wastes Engineering (November 1972).

Ducellier, G., "Recovery of Materials from the Wastewater from Wine Distilleries by Drying the Mixture of Solid and Liquid Wastes," Water Research, 7, Pergammon Press, 1973.

Galeano, S. F., "Brewery and Distillery Wastes, Characteristics, and Treatment," (November 3, 1964).

Gillies, M. T., "Soft Drink Manufacture," Food Technology Review, 8, (1973).

Gudger, C. M., Bailes, J. C., "The Economic Impact of: Oregon's Bottle Bill," Oregon State University, Corvallis, Oregon (March 1974).

Haynes, E., et. al., "Winery Wastewater Treatment," Proceedings of the 3rd National Symposium on Food Processing Wastes.

Hodgson, A. N., Johnston, J., "Industrial Wastes: The Treatment of Winery Wastes at Gelenelg, South Australia," Sewage Works Journal, 12, (2) (March 1940).

Isaac, P. G., "Treatment and Disposal of Brewery Effluents," Brewers' Guild Journal (September 1966).

DRAFT

Jackson, C. J., "Fermentation Waste Disposal in Great Britain" The Distillers Company, LTD, London, England.

Jackson, C. J. Lines, G. T., "Measures Against Water Pollution in the Fermentation Industries," Pure Applied Chemistry, 29 (1972).

Klassen, C. W., Troemper, A. P., "Wastes from a Whiskey Distillery Sources and Characteristics," 3rd Industrial Waste Conference, Purdue, (1947).

Lines, G., "Liquid Wastes From the Fermentation Industries," Water Pollution Control (1968).

Mermelstein, N. H., "Water Purification for Beverage Processing," Food Technology (February 1972).

Mondavi, R. M., Havighorst, C. R., "Winemaking Surges Ahead," Food Engineering (February 1971).

Morgan, W. T., "Jacquin-Florida Waste Treatment Facility Pilot Plant Operation," (November 1972).

Newton, D., et. al., "Pilot Plant Studies for the Evaluation of Methods of Treating Brewery Wastes," 16th Industrial Waste Conference, Purdue (1961).

Oliver, J. H., "The Disposal of Malting and Brewery Effluents," Brewers' Guild Journal, 47, (556) (February 1961).

Trearchis, G. P., "Modern Brewery Insturmentation," Brewers' Guild Journal, 47, (556) (February 1961).

Paulette, R. G., et. al., "A Pollution Abatement Program for Distillery Wastes," JWPCF, 42, (7) (July 1970).

Porges, R., Struzeski, E. J., "Waste From the Soft Drink Bottling Industry," JWPCF, 33, (2) (February 1961).

Rao, B. S., "A Low Cost Waste Treatment Method for the Disposal of Distillery Waste (Spent Wash)," Water Research, 6, Pergamon Press, 1972.

"A Report on Bottled and Canned Soft Drinks, SIC 2086, and Flavoring Extracts and Syrups, SIC 2087," Associated Water and Air Research Engineers, Inc. (August 1971).

"Report on Investigation of Wastewater Treatment and Disposal at the Paul Masson Winery, Soledad, Califronia," Kennedy Engineers, Inc. (November 1974).

"Reuse, Recovery, Lower Pollution From Brewery," Environmental Science and Technology, 6 (June 1972).

Ridgway, J. W., et. al., "Progress on the Spary Drying of Distillers' Solubles," 3rd Industrial Waste Conference, Purdue (1947).

Shaw, P. A., "Pollution of the Mokelumne River by Winery Wastes," Sewage Works Journal, 9, (4) (July 1973).

Smith, A. J., "Waste Treatment in The Liquor Distilling Industry," National Distillers and Chemical Corporation, Cincinnati, Ohio.

"Stainless Steel Modernizes Winemaking," Food Engineering (January 1970).

Stokes, R. D., "An Evaluation of Current Practice in The Treatment of Winery Wastes," University of New South Wales, Thesis (February 1967).

Trauberman, L., "Schlitz Builds Pacesetting Brewery," Food Engineering (September 1972).

Vaughn, R. H, Marsh, G. L., "Disposal of California Winery Waste," Industrial and Engineering Chemistry, 45 (December 1953).

Von Lossberg, et. al., "Brewery Wastes and Treatment," 26th Industrial Waste Conference, Extension Series 140 (May 1971).

Wagner, P., "Wines, Grape Vines, and Climate," American Wines and Winemaking, Alfred A. Knopp, 1956.

Wallach, A., Wolman, A., "Industrial Wastes - Treatment of Distillery Wastes," Sewage Works Journal, 14, (2) (March 1942).

"Winery Innovates Waste Treatment," Food Engineering (June 1972).

Woodley, R. A., "Spray Irrigation of Fermentation Wastes," Water and Wastes Engineering, 6, (3) (March 1969).

MISCELLANEOUS AND SPECIALTY PRODUCTS

Asquew, S., McCormick and Company, Inc., Personal Communication (January 1975).

Barma, B., Kalamazoo Spice Extraction Company. Personal Communication (December 6, 1974).

Blanchard, D. B., A. C. Legg Packing Company, Inc., Personal Communication (December 1974).

Cerosky, R. F., General Foods Corporation, Kalumet Baking Powder, Personal Communication (December 16, 1974).

Frey, C. N., "History and Development of the Modern Yeast Industry," Industrial and Engineering Chemistry, 22, (11) (November 1930).

Goldstein, E., Cumberland Manufacturing Company, Personal Communication (December 9, 1974).

Janson, A., French Foods, Inc., Personal Communication (December 1974).

Kayser, W. C., Hulman and Company Manufacturers, Clabber Girl Baking Powder, Personal Communication (December 27, 1974).

Krause, H., Baltimore Spice Company, Personal Communication (December 1974).

"The Manufacture of Dried Food Yeast," Anheuser-Busch, Inc., St. Louis, Mo. (October 1951).

Masincup, R., Plant Manager, Virginia Egg Producers, Inc., Personal Communication (December 5, 1974).

Miller, H. K., "Baking Powders," Florida Agricultural Esp. Station, Bulletin No. 52 (February 1900).

Padula, A., R. C. Bigelow, Inc., Personal Communication (December 12, 1974).

"Peaunts - Culture and Uses," American Peanut Research Education Assoc., Inc. (1973).

Regos, L. C., Astor Products, Inc. Personal Communication (December 6, (1974).

Reichman, R., Farmer Brothers, Inc., Personal Communcation (December 6, (1974).

Rhee, K. C., et. al., "Recovers Protein From Peanuts," Food Engineering, (May 1973).

Schilling, A., Lawry's Foods, Inc., Personal Communication (December 4, 1974).

Tone, T., Tone Brothers, Inc., Personal Communication (December 4, 1974).

Wysocki, G., "Recovers Salable Products from Waste Yeast," Food Engineering (October 1972).

Zimmerman, D., Watkins Products, Inc., Personal Communication (December 6, 1974).

GENERAL

Anderson, D., "Developments in Effluent Treatment in The Food Industry," Water and Sewage Works, 117, (7) (July/August 1970).

DRAFT

Beck, E. C., ot. al., "Electrocoagulation Clarifies Food Wastewater," Food Technology (February 1974).

Bendixen, T. W., et. al., "Cannery Waste Treatment by Spray Irrigation-Runoff," JWPCF, 41, (3) (March 1969).

Berg, E. L., Brunner, C. A., "Pressure Filtration of Secondary Treatment Plant Effluent," Water and Wastes Engineering (October 1969).

Berthouex, P. M., Polkowski, L. B., "Optimum Waste Treatment Plant Design Under Uncertainty," JWPCF, 42, (9) (September 1970).

Bevan, D., "Disposal of Sugar Mill Wastes," Proceeding Qd. Soc. Sugar Cane Technological Conference 36 (1969).

Bevan, D., "Recycling - or Reclamation?" Proceeding Qd. Soc. Sugar Cane Tech. Conference 40 (1973).

Boyle, W. C., "Lagoons and Oxidation Ponds," JWPCF, 43 (June 1971).

Chipperfield, P. J., "Performance of Plastic Filter Media in Industrial and Domestic Waste Treatment," JWPCF, 39, (11) (November 1967).

Chipperfield, P. J., et. al., "Multiple-Stage, Plastic-Media Treatment Plant," JWPCF, 44, (10) (1972).

Cook, H., "Statement on the Proposed Policy for Establishment of Waste Discharge Requirements Within the Central Valley Region," Wine Institute (Novemer 1970).

Culp, R. L., Roderick, R. E., "The Lake Tahoe Water Reclamation Plant," JWPCF, 38, (2) (February 1966).

Cupit, J. V., "Economic Aspects of Sewage Works Design," Water Pollution Control, 68, (2) (1969).

Eckenfelder, W. W., Fr., Ford, D. L., "Economics of Wastewater Treatment," Chemical Engineering (August 25, 1969).

Eliassen, R., Dr., Tchobanoglous, G., Dr., "Advanced Treatment Processes," Chemical Engineering (October 14, 1968).

Evans, D. R., Wilson, J. C., "Capital and Operating Costs - AWT," JWPCF, 44, (1) (January 1972).

Eymann, R. H., "Micro-Filter Membrane Can Be Backwashed," Food Engineering (December 1971).

"Pretreatment of Discharges to Publicly Owned Treatment Works," Federal Guidelines, EPA, Office of Water Programs Operations, Washington, D. C.

Gilde, L. C., "Measures Taken Against Water Pollution In the Food Processing Industry," PAC 29/1-G.

Graham, R. P., "Process Modification of Avoil Pollution," Western Regional Research Laboratory, Agricultural Research Service (9/9/74).

Griffiths, J., "The Control and Treatment of Trade Effluents," Water Pollution Control (1968).

Kalinske, A. A., "Enhancement of Biological Oxidation of Organic Wastes Using Activated Carbon in Microbial Suspensions," Water and Sewage Works (June 1972).

Kraus, L. S., "Plant Operation - Sludge Digestion at Peoria, Illinois," Sewage Works Journal, 5, (4) (July 1933).

Lamp, G. E.,Jr., "Package Treatment Plant Prices," JWPCF, 46, (11) (November 1974).

Lawler, F. K. Wright, R. G., "All-Out for Process Automation," Food Engineering (November 1973).

Levin, G. V., et. al., "Pilot-Plant Tests of a Phosphate Removal Process," JWPCF, 44, (10) (October 1972).

Litchfield, J. H., "Industrial Wastes," JWPCF, 45, (6) (June 1973).

Logan, J. A., et. al., "An Analysis of the Economics of Wastewater Treatment," JWPCF, 34, (9) (September 1962).

McBeath, B. C., Eliassen, R., "Sensitivity Analysis of Activated Sludge Economics," Sanitary Engineering Division, ASCE (April 1966).

McGauhey, P. H., Krone, R. B., "Soil Mantle as a Wastewater Treatment System," SERL Report No. 67-11, University of California (December 1967).

Minturn, R. E., "Advanced Techniques for Aqueous Processing and Pollution Abatement," ORNL-NSF-EP-72 (March 1974).

Paladino, W. C., Jr., "System Engineering Assures Quality at Low Cost," Food Engineering (August 1972).

"Pollution Report," Food Engineering (June 1973).

Porges, R., Mackenthun, K. M., "Waste Stabilization Ponds: Use, Function, and Biota," Biotechnology and Bioengineering, V, (4) (1963).

"Study of the Effectiveness and Impact of the Oregon Minimum Deposit Law," Applied Decisions Systems (October 1974).

Rambow, C. S., Dr., "Industrial Wastewater Reclamation," Water and Sewage Works (November 29, 1968).

Rizzo, J. L., Schade, R. E., "Secondary Treatment with Granular Activated Carbon," Water and Sewage Works (Au 1969).

Rodgers, C. H., "Multi-Stage Evapo Cooler," Chemical Engineering. (October 1948).

Rowan, P. P., et. al., "Estimating Sewage Treatment Plant Operation and Maintenance Costs," JWPCF, 33, (2) (February 1961).

Rowse, J. A., Rowse, S. B., "Advances Fruit-Waste Treatment," Food Engineering (July 1970).

Seidler, R. J., "Continuous Aerobic Sanitation for Treatment of Food Processing Wastes and Production of Recoverable Protein," Project No. C6519.9 Submitted to CH2M (December 22, 1971).

Shah, K. L., Reid, G. W., "Techniques for Estimating Construction Costs of Waste Treatment Plants," JWPCF, 42, (5) (May 1970).

Smith, R., "Cost of Conventional and Advanced Treatment of Wastewater," JWPCF, 40, (9) (September 1968).

Swanson, C. L., "New Wastewater Treatment Processes," Civil Engineering, ASCE (September 1971).

Talley, W. J., "Cuts Waste Disposal Costs Centrifugal Wastewater Concentrator," Food Engineering (April 1973).

Thomas, D. G., "Engineering Developemt of Hyperfiltration with Dynamic Membranes," Part IV (April 1974).

Uridil, J. E., PhD, "Pollution and Industry," (February 13, 1970).

Wiley, H. W., "Proceedings of the Twenty-second Annual Convention of the Assoc. of Official Agricultural Chemists," USDA Bulletin No. 99.

Williams, R. T., "Classifying Industrial Wastewat Emissions," Water And Sewage Works (July 1974).

Willoughby, E., Patton, V. D., "Design of A Modern Meat-Packing Waste Treatment Plant," JWPCF, 40, (1) (January 1968).

Zang, J. A., et. al., "Electrodialysis in Food Processing," Chemical Engineering Progress Symposium Series 69, (1962)

"Water Quality Criteria 1972," Natl. Academy of Sciences and Natl. Academy of Engineers for the EPA, Washington, D. C., (U.S. Government Printing Office, Stock No. 5501-00520) (1972).

DRAFT

SECTION XIV

GLOSSARY

Absorption - The taking up of one substance into the body of another.

Acidulation - An edible oil refining method whereby water soluble soaps or soapstock is treated with sulfuric acid to yield free fatty acid derivatives.

Activated Carbon - Carbon particles usually obtained by carbonization of cellulosic material in the absence of air and possessing a high adsorptive capacity.

Activated Carbon Process - The removal of pollutants from a water or wastewater by the use of the adsorptive capacity of active carbon.

Activated Sludge - Sludge floc produced in raw or settled wastewater by the growth of zoogleal bacteria and other organisms in the presence of dissolved oxygen and accumulated in sufficient concentration by returning floc previously formed.

Activated Sludge Process - A biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation and wasted or returned to the process as needed.

Active Dry Yeast - A leavening agent containing 8 percent moisture used by small bakeries, blenders of ready-to-bake cake mixes, and repackagers.

Adsorption - The adherence of a gas, liquid, or dissolved material on the surface of a material.

Aerated Lagoon - A natural or artificial wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supply.

Aerobic - A condition in which free, elemental oxygen is present.

Albumin - The white of an egg.

Aldehyde - (Webster) - Any of various highly reactive compounds typefied by acetaldehyde and characterized by the group CHO.

Alkalinity - Alkalinity is a measure of the capacity of water to neutralize an acid.

DRAFT

Ammoniator- Apparatus for applying ammonia or ammonium compounds to water.

Anaerobic - A condition in which free, elemental oxygen is absent.

Anti-micotic - An agent that inhibits mold growth.
Anti-mycotic

Backwashing - The operation of cleaning a filter by reversing the flow of liquid through it and washing out matter previously captured in it.

Backset - Screened or "thin" stillage that is returned from the base of the whiskey separating column to the fermenter, as used in the distilled spirits industry.

Bakers Compressed Yeast - A leavening agent containing approximately 70 percent moisture and used by large bakeries.

Bar Rack - A screen composed of parallel bars, either vertical or inclined, placed in a waterway to catch debris.

Barometric Condenser - See Condenser, Barometric.

Barometric Leg - A long vertical pipe through which spent condenser water leaves the condenser. Serves as a source of vacuum.

Barometric Leg Water - Condenser cooling water.

Barrel - As used in the Malt Beverage Industry, a barrel contains 31 gallons.

Basin - A natural or artificially created space or structure which has a shape and character of confining material that enables it to hold water.

Bee's Wings - Small particles removed form the corn kernel edges, after separation from the cob.

Benthic Organisms - See benthos .

Benthos - Aquatic bottom - dwelling organisms.

Biochemical - Pertaining to chemical change resulting from biological action.

Bio-degrade - To biologically reduct the complexity of a chemical compound or substance by splitting off one or more groups or large component parts; decompose.

Biodegradability - The destruction or mineralization of either natural or synthetic organic materials by microorganisms.

Biological Filter - A bed of stone or other medium through which wastewater flows or trickles that depends on biological action for its effectiveness.

Biological Wastewater Treatment - Forms of wastewater treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Intermittent sand filter, contact beds, trickling filters, and activated sludge processes are examples.

BOD - Biochemical Oxygen Demand is a semiquantitative measure of biological decomposition of organic matter in a water sample. It is determined by measuring the oxygen required by microorganisms to oxidize the contaminants of a water sample under standard laboratory conditions. The standard conditions include incubation for five days at 20°C.

BOD Load - The BOD content, usually expressed in mass or weight per unit time, of wastewater.

Boiler Blowdown - See blowdown.

Biological Oxidation - The process whereby living organisms convert organic matter into a more stable or mineral form.

Bleaching - An edible oil refining process in which adsorbent materials such as Fuller's or diatomaceous earth are used to treat edible oils for color removal.

Blowdown - The water discharged from a boiler or cooling tower to dispose of accumulated salts.

Boiler Blowdown - Discharge from a boiler system designed to prevent a buildup of dissolved solids.

Boiler Feedwater - Water used to generate steam in a boiler. This water is usually condensate, except during boiler startup, when treated fresh water is normally used.

Bouillon - Evaporated seasoned meat extract.

Bowl Cake - A term used to describe natural gum base material which has been remelted and screened, prior to manufacturing of chewing gum.

Brandy - A distillate of wine produced at 189° or less proof.
(a) Neutral Brandy - is that produced at 171° to 189° proof.
(b) Beverage Brandy - is that distilled at 170° or less proof, usually 165° to 169°.

Brine - Concentrated salt solution remaining after removal of distilled product.

BTU - Quantity of heat required to raise one pound of water one degree Fahrenheit. Abbreviation for Britain Thermal Unit.

Bulking Sludge - An activated sludge that settles poorly because of a floc of low density.

Bushel - The weight of grain contained in a bushel varies by industry as follows:

(a) Barley = 22 kg (48 lb)
(b) Malt = 15 kg (34 lb)
(c) Distillers Grain = 25 kg (56 lb)

Cannery Olive Pits - Pits removed from olives which have been prepared for canning.

Caustic Refinery - A refinery method whereby edible fats or oils are treated by caustic soda to purify and remove free fatty acids, phosphatides and proteinaceous substances by converting them to water soluble soaps or "foots" called soapstock.

Capital Costs - Costs which result in the acquisition of, or the addition to, fixed assets.

Checks - Shallow ponds utilized for the evaporation and percolation of wine stillage by the method of intermittent irrigation.

Clarification - Removing undissolved materials from a liquid by settling, filtration, or flotation.

Clarifier - A unit of which the primary purpose is to reduce the amount of suspended matter in a liquid.

Coagulation - In water and wastewater treatment, the destabilization and initial aggregation of colloidal and finely divided suspended matter by the addition of a floc-forming chemical or by biological processes.

COD - Chemical Oxygen Demand. Its determination provides a measure of the oxygen demand equivalent to that portion of matter in a sample which is susceptible to oxidation by a strong chemical oxidant.

Comminute - To reduce to minute particles or fine powder; to breakup, chip, or grind; to pulverize.

Compensation Point - As commonly used, the compensation point in water refers to that intensity of light which is such that photosynthetic oxygen production during daylight hours will be sufficient to balance the oxygen consumption during the whole 24-hour period.

Composite Sample - A combination of samples taken at selected intervals to minimize the effect of the variability of individual samples. Individual samples are proportional to the flow at time of sampling.

Concentration - The amount of a given substance in a unit volume. For wastewater, normally expressed as milligrams per liter (mg/l).

Condensate - Water resulting from the condensation of vapor, as in an evaporator.

Condenser - A heat exchange device used for condensation.

Barometric: Condenser in which the cooling water and the vapors are in physical contact; the condensate is mixed in the cooling water.

Surface: Condenser in which heat is transferred through a barrier that separates the cooling water and the vapor. The condensate can be recovered separately.

Condenser Water - Water used for cooling in a condenser.

Congeners - The flavor constituents in beverage spirits.

Conditioner - Oilseeds are prepared for extraction by treating the oilseeds in a vertical stack steam cooker , known as the bean or seed "conditioner".

Cooling Tower Blowdown - See Blowdown.

Decanting - Separation of liquid from solids by drawing off the upper layer after the heavier material has settled.

Degumming - A process whereby phosphatides are removed and recovered from soybean oil.

Delinting - In the preparation of cottonseed for oil extraction, cotton fiber is removed from the seeds in two steps, first cut and second cut. The fiber is then sold to cotton felt or cellulose manufacturers. The motes, or remaining fibers, are sold for their cotton content.

Deodorization - The Treatment of fats and oils by steam distillation for the removal of trace constituents that produce undesirable flavors or odors.

Diatomaceous Earth - A viable earthy deposit composed of nearly pure silica and consisting essentially of the shells of the microscopic plants called diatoms. Diatomaceous earth is utilized as a filter media or filter aid in the canning of food and beverage processing industries.

Digestion - See Sludge Digestion.

DRAFT

Dissolved Solids - See Solids.

Distillate - Condensed vapors from the solution which form the product of distilling.

Distilling Material - Wine without sugar used in the production of wine spirits by distillation. Pomace, lees, filterwash, and unmarketable special natural wine are all sources of distilling material.

Distillation - A process of evaporation and recondensation used for separating liquids into various fractions according to their boiling points or boiling ranges.

D.O. - Dissolved Oxygen is a measure of the amount of free oxygen in a water sample. It is dependent on the physical, chemical, and biochemical activities of the water sample.

Drain Screw - A trough-like screw conveyor with orifices along the bottom of the trough to allow liquid to drain from the conveyed solid mass.

Dry Cleaning - Cleaning without the use of water.

"Effect" - In systems where evaporators are operated in series of several units, each evaporator is known as an effect.

Electrodialysis - Process for removing ionized salts from water through the use of ion-selective ion-exchange membranes.

Edible Peanuts - Those genera in high quality peanuts grown for use in such products as peanut butter, candy, salted roasted nuts, or other edible products.

Emulsifier - A surface-active agent for promoting formation and stabilization of a mixture of two incompletely miscible liquids.

Enrobe - Coating of the nougat or base bar with some type of covering, generally chocolate.

Enrobe - Cookie and snack cake bakers term for completely covering an item with a coating or icing.

Entrainment - The entrapment of liquid droplets containing contaminants in the water vapor produced by evaporation.

Equalization Basin - A holding basin in which variations in flow and composition of a liquid are averaged. Such basins are used to provide a flow of reasonably uniform volume and composition to a treatment unit.

Essential Oils - Liquids which occur naturally in many types of plants or which may be reproduced by a combination of substances in the plant upon reaction with one another in the presence of water.

Ester - An often fragrant compound formed by the reaction between an organic acid and an organic solvent usually with elimination of water.

Evaporator - A closed vessel heated by steam and placed under a vacuum. The basic principle is that syrup enters the evaporator at a temperature higher than its boiling point under the reduced pressure, or is heated to that temperature. The result is flash evaporation of a portion of the liquid

Expand - To increase in size; to enlarge by opening out or spreading.

Extrude - To shape by forcing through a specially designed opening often after a previous heating of the material or of the opening or of both.

Extrusion - A process whereby a material is forced through a small diameter opening into a desired shape.

FAC Color - Method Cc-13a-43, Fat Analysis Committee of the American Oil Chemists Society, for color measurement of oil samples.

Feed Wort - A mixture of cane and beet molasses that is diluted with water, clarified, sterilized, and pH adjusted, and used to provide carbon, sugar, and other nutrients necessary for yeast growth.

Fermentation - The production of alcohol and carbon dioxide from fermentable carbohydrates by the action of yeast.

Filter- A device or structure for removing solid or colloidal matter from a liquid. The filtering medium consists of a granular material, finely woven cloth, unglazed porcelain, or specially prepared paper.

Filter Press - In the past the most common type of filter used to separate solids from sludge. It consists of a simple and efficient plate and frame filter.

Fining - Cleaning process to clear a liquid of suspended matter.

Fines - Small peanut particles and other foreign material removed from peanut kernels during roasting , blanching, and grinding of shelled peanuts for use in peanut butter.

Finished Specific Flavors - Flavors formed by the precision compounding or blending of flavoring extracts, acids, water, sugar, coloring agents and other flavoring ingredients to specified concentration and proportions.

Fixed Beds - A filter or adsorption bed where the entire media is exhausted before any of the media is cleaned.

Flavor Change - A change in the type of product packaged in a soft drink bottling or canning plant. Such a change necessitates cleaning of all equipment associated wiht the previous product.

Flocculant - A substance that induces or promotes fine particles in a colloidal suspension to aggregate into small lumps, which are more easily removed.

Flotation - The raising of suspended matter to the surface of the liquid in a tank as scum - by aeration, the evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition - and the subsequent removal of the scum by skimming.

FOG - Fats, Oil, and Grease

Fondant - A soft, creamy confection.

Foots - See Caustic Refining

Frappe - Whipped egg albumen which has been mixed wiht sugar and glucose syrup.

Fusel Oil - An inclusive term for heavier, pungent-tasting alcohols, principally amyl and butyl alcohols.

Germicidal Treatment - Any treatment involving killing of microorganisms through the use of disinfecting chemicals.

GPD - Gallons per day.

GPM - Gallons per minute.

Heads - A distillate containing a high percentage of low-boiling components such as aldehydes.

High Wines - Beverage spirit distillates which have undergone complete distillation.

Homogenization - The blending of dissimilar substances into a smooth consistency.

Hops - The dried, conelike fruit which is boiled with wort to impart additional flavor and aroma to beer.

Humectant - A substance that promotes retention of moisture (as glycol, sorbitol).

Hydrogenation - An edible oil refining process in which hydrogen, with the aid of a nickel catalyst, is added directly to the unsaturated carbon chain of a fatty acid to 1) increase the stability of the fat to oxidative rancidity, 2) and to produce a semi-solid "plastic" quality for use in certain foods.

DRAFT

Hydrolization - The addition of H_2O to a molecule.

Hygroscopic - Tending to absorb moisture from the atmosphere.

Impoundment - A pond, lake, tank, basin, or other space which is used for storage of wastewater.

Industrial Wastes - The liquid wastes from industrial processes, as distinct from sanitary wastes.

Industrial Wastewater - Wastewater in which industrial wastes predominate.

Inedible Peanuts - Surplus or peanuts too low in quality for food use commonly crushed for oil and meal.

Ion Exchange - A chemical process in which ions from different molecules are exchanged.

Ion Exchange Resins - Resins consisting of three-dimensional hydrocarbon networks to which are attached ionizable groups.

Ketone - (Webster) - An organic compound with a carbonyl group attached to two carbon atoms.

Kitchen - Cooking and mixing area in a confectionary plant.

Knead - To work a product into a homogeneous malleable mass by pressing, squeezing, etc.

Kraus Process - A modification of the activated sludge process in which aerobically conditioned supernatant lic.or from anaerobic digesters is added to activated sludge aeration tanks to improve the settling characteristics of the sludge and to add an oxygen resource in the form of nitrates.

Lactating - Secreting milk.

Lagoon - A pond containing raw or partially treated wastewater in which aerobic or anaerobic stabilization occurs.

Land Spreading - The disposal of wastewater on land to achieve degradation by soil bacteria.

Lautering - Separation of soluble materials from spent grains.

LC50 - Median lethal dose concentration; the concentration of a test material that causes death to 50 percent of a population within a given time period.

Lecithin - A natural component of crude soybean oil containing a complex mixture of phosphatidyl ethanolamine, phosphotidyl serine, phosphotidyl inositol, and other associated substances.

Lees - The yeast, pulp, and tartarate sediment resulting from fermentation and finishing operations in the wine industry.

Low Grade Olive Oil - That olive oil which is generally obtained by subsequent (other than first pressing) pressing of whole ripe olives or which does not meet the requirements of taste, odor and free fatty acid content as determined for virgin oil.

Malting - The germination of barley to develop enzymes.

Mashtun - Vessel in which the conversion of grain starches into maltose sugar takes place.

Mashing - The process involving cooking, gelatinization of starch, and conversion, changing starch into grain sugar.

Mastication - To reduce to a pulp by crushing or kneading.

Masticator - A machine which by the use of rotating blades thoroughly mixes ingredients until they are well blended.

Mesophyllic micro-organisms - Those microorganisms growing or thriving best in an intermediate temperature environment (typically 15-35°C).

Metabolism - The sum of the processes concerned in the building up of protoplasm and its distruction incidental to life; the chemical changes in living cells by which energy is provided for the vital processes and activities and new material is assimilated to repair the waste.

MGD - Million gallons per day.

mg/l - Milligrams per liter (equals parts per million (ppm) when the specific gravity is unity).

Miscella - In the solvent extraction of oilseeds, the oil-hexane mixture is refered to as the miscella.

Mixed Liquor - A mixture of activated sludge and organic matter undergoing activated sludge treatment in the aeration tank.

Mixed Media Filtration - A combination of different materials through which a wastewater or other liquid is passed for the purpose of purification, treatment, or conditioning.

ml/l - Milliliters per liter.

Mogul - Machine which is used in the candy industry to mold and set candies into desired shapes.

Moisture - Loss in weight due to drying under specified conditions, expressed as percentage of total weight.

Moisture Content - The quantity of water present in a sludge expressed in percentage of net weight.

Molasses - A dark-colored syrup containing sugar produced as a by-product in cane and beet sugar processing and in the production of citrus concentrates.

Multiple Effect Evaporation - The operation of evaporators in a series.

Must - The juice, skin, and seeds from crushed grapes.

Municipal Sewage - The spent water of a community. See wastewater.

Natural Flavoring Extract - A solution in ethyl alcohol of proper strength of the sapid and odorous principles derived from an aromatic plant, parts of the plant, or essential oil from the plant, with or without coloring matter, conforming in name to the plant used in its preparation.

Net BOD - The amount of BOD added by a process; the difference between the BOD load of a plant's discharge and its intake.

Non-contact Wastewaters - Those wastewaters such as spent cooling water which are independent of the manufacturing process and contain no pollutants attributable to the process.

Non-dairy Coffee Creamer - A vegetable oil blend used as a dairy product substitute.

Nougat - Center of candy bar, also termed "base bar."

Nutrients - The nutrients in contaminated water are routinely analyzed to characterize the food available for micro-organisms to promote organic decomposition. They are:

Ammonia Nitrogen (NH_3), mg/l as N
Kjeldahl Nitrogen (ON), mg/l as N
Nitrate Nitrogen (NO_3), mg/l as N
Total Phosphate (TP), mg/l as P
Ortho Phosphate (OP), mg/l as P.

O & G - Oil and Grease

Olive Culls - The outer skin and meat of an olive.

Pasteurization - Partial sterilization of a substance at a specified temperature for a specified period of exposure that destroys objectionable organisms in the substance without major chemical alteration of the substance.

DRAFT

Peanut Butter - A cohesive, comminuted food product prepared from clean, sound, shelled peanuts by grinding or milling properly roasted, mature peanut kernels from which the seed coats have been removed and to which salt is added as a seasoning agent.

Pectin - A water soluble substance contained in the peel of citrus fruits which binds adjacent cell walls in plant tissues and yields a gel which is used in the preparation of fruit jellies, and to some extent in the pharmaceutical industry.

pH - pH is a measure of the negative log of hydrogen ion concentration.

Pharmaceutical Dry Yeast - A form of yeast used by the pharmaceutical industry as a protein and vitamin dietary supplement.

Plate and Frame Filter - A filtering device consisting of a "screen" fastened inside a metal frame.

Plasticiser - a) Various ingredients which are added to chewing gum bases to achieve a desired softness.
b) Agents such as vegetable oils, food emulsifiers, or even shaved ice bended into dewatered yeast to improve extrudability and ease of packaging.

Polluted Wastewaters - Those wastewaters containing measurable quantities of substances that are judged to be detrimental to receiving waters and that are attributable to the process.

Polyelectrolytes - A coagulent aid consisting of long chained organic molecules.

Pomace - The skin, pulp, and seed solids present after separation from a liquid such as juice or oil.

Post-Mix - Bulk fountain syrup prepared at the point of consumption from a stainless steel pressurized cannister.

Pre-Mix - Bulk finished beverage ready to be dispensed from a stainless steel pressurized cannister.

Precoat Filter- A type of filter in which the media is applied to an existing surface prior to filtration.

Preliminary Filter - A filter used in a water treatment plant for the partial removal of turbidity before final filtration.

Proof - Alcoholic Content of a liquid at 15°C (60°F), stated as twice the percentage of alcohol by volume (United States definition).

Proof Gallon - A standard U. S. gallon containing 50 percent alcohol by volume.

Racking - The decanting of liquid from settled residues, as used in the wine and malt beverage industries.

Raw Wastewater - Wastewater prior to treatment.

Returned Sludge - Settled activated sludge returned to mix with incoming wastewater.

Retort - A vessel in which food substances are subjected to heat, usually under pressure.

Ridge and Furrow Irrigation - A method of irrigation by which water is allowed to flow along the surface of fields.

Rotary Vacuum Filter - A rotating drum filter which utilizes suction to separate solids from the sludge produced by clarification.

Roughing Filter - (1) A wastewater filter of relatively coarse material operated at a high rate to afford preliminary treatment (2) For water treatment, see preliminary filter.

Sanitary Sewage, Sanitary Wastewater- Liquid wastes from residences or commercial establishments, as distingished from industrial wastes.

Schneckens - An older method of desolventizing oilseed meats developed in Germany where the meats oil passed through a series of steam jacketed tubes called "schneckens".

Secondary Wastewater Treatment - The treatment of sanitary sewage by biological methods after primary treatment by sedimentation, usually considered to remove 90 percent or more of the influent BOD.

Semolina - The purified middlings of durum or other hard wheat used for macaroni and other alimentary pastes.

Set - Conditioning of a product by allowing it to remain in a humidity controlled room for certain periods of time.

Settleable Solids - See Solids.

Settlings - The material which collects in the bottom portion of a clarifier.

Setting Pond - See Clarifier.

Sewerage - System of piping, with appurtenances, for collecting and conveying wastewater from source to discharge.

Skimming - The process of removing floating grease or scum from the surface of wastewater.

DRAFT

Sludge - The accumulated solids separated from wastewater during treatment.

Sludge Cake - Sludge that has been dewatered to a moisture content of 60 to 85 percent.

Sludge Dewatering - The process of removing the moisture content of a sludge to such an not air extent that the sludge is spadable.

Sludge Digestion - The process by which organic or volatile matter in sludge is gasified, liquified, mineralized, or converted to a more stable organic matter through the activities of either anaerobic or aerobic organisms.

Sludge Drying - The process of removing a large percentage of moisture from sludge by drainage or evaporation.

Sludge Thickening - The process of increasing the solids concentration of a sludge, but not to such an extent that the sludge is spadable.

Sludge handling - The transport, storage, treatment, and disposal of sludge.

Slurry - A watery mixture or suspension of insoluble matter.

Soapstock - See Caustic Refining

Solids - Various types of solids are commonly determined on water samples. These types of solids are:

Total Solids - (TS): The material left after evaporation and drying of a sample at 100° to 105°C.

Dissolved Solids - (DS): The difference between suspended solids and total solids.

Volatile Solids - (VS): Organic material which is lost when the sample is heated to 550°C.

Settleable Solids (STS): The materials which settle in an Imhoff cone in one hour.

Suspended Solids (SS): The material removed from a sample filtered through a standard glass fiber filter and dried at 103-105°C.

Spadable Sludge - Sludge that can be readily forked or shoveled, ordinarily under 75 percent moisture.

Sparkling Wine - A grape wine which has more than 1.5 atmospheres of pressure at 10°C (50°F) and less than 14 percent alcohol by volume.

Spent Beer - Residual nutrients separated from harvested yeast by centrifugal separation.

Spray Evaporation - A method of wastewater disposal in which water is sprayed into the air to expedite evaporation.

Spray Irrigation - A method of irrigation by which water is sprayed from nozzles onto a crop. In order to avoid clogging of the nozzles, the water must be relatively low in suspended solids.

Spray Pond - A basin over which water is sprayed from nozzles; generally used for reduction of water temperature.

Spirits, Fruit - A distillate of wine produced at 190° or higher proof.

Spirits, Wine - Includes beverage brandy, neutral brandy, and fruit spirits, i.e., all distillates eligible to be used in the production of dessert wines, not reduced below 140° proof.

Stabilizers - Partially hydrogenated vegetable oils or other emulsifiers added to peanut butter to improve spreadibility and prevent oil separation.

Stillage - The de-alcoholized residue discharged from the base of the still column.

Stock Yeast - A pure culture of the desired yeast strain grown for starting or "seeding" the main yeast fermentation tanks.

Sublimination - Change of matter from the solid state to the gaseous state withous passing through the liquid state.

Surface Condenser - See Condenser, Surface.

Suspended Solids - Solids found in wastewater or in the stream which in most cases can be removed by filtration. The origin of suspended matter may be man-made wastes or natural sources as from erosion.

Synthetic Flavoring Extract - A solution in ethyl alcohol of proper strength of the odorous principles derived from the combination of esters, aldehydes, ketones and other synthetic compounds.

Table Wine - A grape wine having an alcoholic content not in excess of 14 percent by volume.

Tails - A residual alcoholic distillate.

Terpenes - (Webster) - Any of various isomeric hydrocarbons $C_{10}H_{16}$ found present in essential oils and used as solvents in organic synthesis.

DRAFT

Total Solids - See Solids

Trub - Insoluble materials which collect in the brew kettle.

Turbidity - A condition in a liquid caused by the presence of fine suspended matter and resulting in the scattering and absorption of light; an analytical quantity usually reported in arbitrary turbidity units determined by measurements of light defraction.

Virgin Olive Oil - That olive oil which is generally obtained from the first pressing of whole ripe olives or which meets requirements of taste, odor and free fatty acid content as determined for virgin oil.

Volatile Solids - See Solids

Votators - A type of heat exchanger used in peanut butter production prior to deaeration and packaging.

Waste Sludge - Settled activated sludge in excess of the amount needed for return to mix with incoming wastewater.

Waste Streams - Any liquified waste material produced by an industrial process.

Waste Water - In a legal sense, water that is not needed or that has been used and is permitted to escape, or that unavoidably escapes.

Wastewater - The spent water of residences, commercial buildings, industrial plants, and institutions.

Wine Gallon - A measure of actual volume, i.e., a U.S. gallon contains 0.00378 cu m (231 cu in).

Winterization - An edible oil refining process in which oils are chilled by refrigeration to remove higher melting fractions that may produce clouding in the final product.

Wort - A mixture of maltose and water.

Yeast Cream - Mature yeast that has been removed from fermentation tanks and centrifugally separated from spent nutrients prior to dewatering.

DRAFT

CONVERSON TABLE

MULTIPLY				TO OBTAIN
acre	ac	0.4047	ha	hectares
acre-feet	ac ft	1233.49	cu m	cubic meters
British Thermal Unit	BTU	0.2520	Kg cal	Kilogram-calory
cubic feet	cu ft	0.02832	cu m	cubic meters
cubic feet/ minute	cu ft/ min	0.2832	cu m min	cubic meters/ minute
cubic feet/ second	cu ft/ sec	1.699	cu m/ min	cubic meters/ minute
cubic yards	cu yd	0.7646	cu m	cubic meters
Farenheit degrees	of	0.5555(°F-32)[1]	°C	centigrade degrees
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liters
gallon/ minute	gal/min	0.06308	l/sec	liters/ second
gallon/ton	gal/ton	4.173	l/kkg	liters/ metric ton
horsepower	hp	0.7457	kw	kilowatts
inches	in.	2.540	cm	centimeters
inches of mercury	in. Hg	0.03342	atm	atmospheres

DRAFT

ounces	oz	28.35	gm	grams
pounds	lb	0.4536	kg	kilograms
pounds/ cubic foot	lb/ cu ft	16.02	kg/ cu m	kilograms/ cubic meters
pounds/ton	lb/ton	0.5000	kg/kkg	kilograms per metric ton
million gallons/day	MGD	3.785	cu m/ day	cubic meters/ day
mile	mi	1.609	km	kilometer
pound/ square inch (gage)	psig.	0.06805[2]	atm	atmosphere
square feet	sq ft	0.09290	sq m	square meters
ton	ton	0.9072	kkg	metric tons (1000 kilograms)
yard	yd	0.9144	m	meters

1 Actual conversion, not a multiplier

2 Add 1.0 after multiplying to obtain absolute pressure

DRAFT

APPENDIX A

SIC Code_____________

MISCELLANEOUS FOODS & BEVERAGES
Telephone Survey Form A

Process Code: _______________

Date: _______________
Interviewer: _______________
Firm: _______________ Phone: _______________

Principal Products Investigated _______________

Plant: _______________

Mailing Address: _______________ Zip _______________

Plant Contacts: _______________ Titles: _______________

____

Telephone No.: _______________

Corporate Name: _______________

Address: _______________

Telephone No.: _______________

Corporate Contacts: _______________ Titles: _______________

____

Who can release plant records? _______________

1.0 PRINCIPAL PRODUCTS

Principal Products	Production Volume	Season

Quantity of Waste Effluent in Gal/Day _______________

2.0 METHOD OF WASTE EFFLUENT DISPOSAL.

_____ 2.1 Municipal-surcharge basis: _______________
Is pretreatment provided? _______________

_____ 2.2 Navigable waters--Method of treatment (check) [ ]No treatment, [ ]screening, [ ]primary settling, [ ]activated sludge, [ ]biological filter, [ ]chemical addition, [ ]aerated lagoon, [ ]stabilization pond(s), [ ]land application with runoff, other _______________

____

____ 2.3 Land Disposal--zero discharge (check) [ ]Spray irrigation, [ ]holding ponds, other ____________

3.0 HISTORICAL DATA BASE

3.1 Check the following kinds of data that are available on this plant: [ ]municipal records, [ ]state reports, [ ]data gathered by private consultant, [ ] Association questionnaires, [ ]EPA permit, [ ]Army Corps permit, [ ]published literature on plant, [ ]in-plant studies; other ____________

3.2 Document each data source as to title, date and person or agency having access to data. ____________

3.3 Is the raw waste data collected for single or combined products? ________ or materials? ________

3.4 Does matching flow volume information exist for the data base collected? ________ What is the source of flow volume information? ____________

3.5 Can the production data be easily related to the data base available? ____________

3.6 What analyses were run? (check) [ ]Flow, [ ]BOD, [ ]TSS, [ ]DSS, [ ]VSS, [ ]pH, [ ]COD, [ ]DO, [ ]TOC, [ ]Nutrients, Other ____________

3.7 Check the waste streams sampled: [ ]Cooling water, [ ]clean-up, [ ]process water, other ____________

3.8 Who did the analyses? ____________
Type of samples (check) [ ]grab samples, [ ]timed composites, [ ]flow proportioned composites, other ____________

3.9 Is cost information available on waste treatment? ________

3.10 Are treatment efficiencies available on treatment systems? ____________

4.0 Do any unique process or waste treatment systems exist at this plant? Explain ____________

5.0 REMARKS: ____________

DRAFT

APPENDIX B

Miscellaneous Foods and Beverages
Effluent Guideline Study
Processing Information

SIC Code: ____________ Date: ____________________

Firm: __________ Interviewer: ____________________

Process Code: ____________

1.0 PRINCIPLE PRODUCTS	Average Production Volume Per Day	Per Shift

1.1 Plant Operations: Hours/Day ________ Days/Year ________
Average number of working days/year ________

2.0 PROCESS DESCRIPTION

2.1 Raw Material Storage: Describe type, form, and method of storage.

2 Process Flow Diagram: Draw on page 2 a simplified process flow diagram of the plant's process line documenting all points of major wastewater flow, solid waste removal, water use, recirculation and/or recycling

2.3 Describe the Finished Product: Describe types and sizes.

PROCESS FLOW DIAGRAM

DRAFT

SIC Code: ____________________

Process Code: ________________ Date: ______________________

2.2 Draw a simplified process flow diagram of the plant's process line documenting all points of major wastewater flow, solid waste removal, water use (including non-contact cooling water) recirculation and/or recycling.

DRAFT

0 WATER USAGE AND WASTE CHARACTERIZATION

3.1 Source(s) of In-Plant Water Supply: Process water _____ Boiler Feed _____ Cooling water _____ Other __________

3.2 What is the average quantity of waste effluent discharged per day and per shift?

3.3 Is treatment provided for incoming water? If so, what portion of it is being treated and what is the nature of the treatment?

3.4 Describe the general cleanup of the plant during daily plant operations.

3.5 Describe plant modifications and/or procedures used in the past to reduce wastewater strength or volume (Draw schematic on back of this sheet.). Please include also the costs vs. cost savings of these modifications.

3.6 Describe any future process changes and their desired effects.

DRAFT

FORM C

\- Treatment Information

SIC Code: ________________ Date: ________________

Process Code: ____________

4.0 WASTES DISCHARGED TO A MUNICIPAL FACILITY

4.1 Describe pretreatment, if any. List installation costs, operation and maintenance costs, and cost savings.

____

____

____

____

____

____

If wastes are discharged to a municipal system, what is the surcharge based on? (eg. flow, BOD, SS, etc.)

____

____

____

4.3 What is approximate annual cost of disposal to municipality: ____________

5.0 WASTES DISCHARGED TO NAVIGABLE WATERS OR LAND DISPOSAL

5.1 Draw process flow diagram on page 5 of the existing end-of-line waste treatment process.

5.2 Describe the technique of disposal of solid wastes generated by the treatment process (eg. sludges, screened solids, or trucking of liquid wastes).

____

____

____

____

____

5.3 What is the number of employees and age of the present treatment facility?

____

____

DRAFT

TREATMENT FLOW DIAGRAM

SIC Code: ____________________

Process Code: ________________ Date: ____________________

5.1 Draw a flow diagram of the existing end-of-line waste treatment process (note size of lagoons, types of equipment used, acreage, how system is managed, etc).

DRAFT

5. List below the following:

1. Total initial investment cost of treatment facility (year)
2. Investment cost of each effluent treatment component (year installed)

Treatment Component	Cost	Year
____________	$ ______	______
____________	$ ______	______
____________	$ ______	______
____________	$ ______	______
____________	$ ______	______
____________	$ ______	______
TOTAL	$ ______	______

5.5 Estimated cost to construct plant today $ ____________

5.6 What are the estimated annual maintenance costs attributable to waste treatment?

Plant labor	______	Other	______
Engineering	______		______
Consulting labor	______		______
Laboratory	______		______

5.7 What are the estimated annual energy costs attributable to waste treatment?

Kilowatts per day or per unit product	______
Electricity generated or purchased	______
Cubic feet of ______ (type of fuel) consumed/day or per unit product	______
Steam in lbs./day at P.S.I.	______
Other	______

5.8 What is approximate value of nearby land ($/acre)? What is distance to nearby open land? ____________

5.9 Is zero discharge feasible for your plant? ____________

5.10 If not, what is the maximum treatment level that is feasible for your plant?

____

____

DRAFT

FORM D

Historical Data

Attach copies of all available historical data to these sheets. Separate data by individual products if possible. Include daily production figures to correspond to data. (See attached historical data form.)

6.0 DATA BASE

6.1 Copy of analyses obtained? ____________________

6.2 Is the data obtained for screened wastes?____Yes____No____Not Applicable

6.3 If the plant has screening before discharge, what are their size, type, and initial costs at installation? ____________________

6.4 Is the data obtained for samples collected after or before gravity separation or skimming? ____________________

6.5 If the plant has gravity separation and/or skimming, what are their size, types, and initial costs at installation? ____________________

6.6 Indicate by numbered arrow on the waste treatment diagram (page 5) where wastewater samples were taken for historical data. What type of sampling technique was used: ____________________

6.7 What were frequency of samples? Who did sampling? Who did analysis? Any deviations from standard chemical methods? ____________________

6.8 Is the raw waste data collected for single or combined products? ________

6.9 Does matching flow volume information exist for the data base collected?

____________________ What is the source of flow volume information? ____________________

6.10 Can the production data be easily related to the data base available?

____

7.0 Remarks: ____________________

DRAFT

APPENDIX C

DATA HANDLING SYSTEM

In order to determine the natural distribution of the major wastewater parameters, cumulative probability plots were made using computerized statistical routines. The purpose of these plots was to determine which theoretical probability model best fit the actual data.

The first model tried was the standard normal distribution. It was determined that while the normal distribution model was accurate for some data, there were many instances in which the range of data was large and tended to be skewed with a few relatively high values. Also, the normal distribution allows for negative values which in reality do not occur for the pollutant parameters being examined.

The problems of the normal distribution are eliminated by the use of a log normal distribution. This commonly used distribution has only positive values and is skewed right to allow for a few high values. Another advantage is that the set of the logarithm of values conforms to the normal distribution and standard, readily-available statistical techniques can be employed.

It was assumed that data from any one plant would approximate a normal distribution and could be described with standard statistical methods. When data from several plants were combined, in most cases the final process statistics were generated with log normal statistics. These are the statistics reported in the summary tables of Section V.

If it is desired, other minimum and maximum values can be computed for other probabilities of being exceeded by going the required number of standard deviations above or below the mean in the log domain and then taking the inverse log function of the result. The standard deviation in the log domain can be computed using Log S=Log (max/mean) where the max and mean values are given on the summary tables. For example, a simple way to obtain an estimate of the maximum which is only exceeded by above five percent of the industry segment is to compute the square of the maximum value and divide by the mean value of the summary table, since the standard deviation is about two standard deviations above the mean.

For each parameter to be printed on the summary table, the computer selects the mean values from the data base for the subject plants and first calculates the material logarithm of each value and then the arithmetic mean of the logarithms. For the "log mean" on the summary table, the inverse log function is taken on the mean logarithm of the parameter. To determine minimum and maximum values, the logarithmic standard deviation is calculated, then is added to and subtracted from the mean log. The inverse log function taken on the mean log minus one log standard deviation produces the "minimum" on the table, and plus one log standard deviation produces the "maximum". Statistically, the range covered by the minimum and maximum should contain approximately 66 percent of the true population.

Mathematically, the calculations may be expressed as follows:

$$\text{"log mean"} = \ln^{-1}\left[\frac{\Sigma(\ln x)}{n}\right]$$

$$\text{log standard deviation} = \frac{\Sigma(\text{log mean} - \ln x)^2}{n-1} \quad (0.5)$$

$$\text{"minimum"} = \ln^{-1}\left[\text{log mean} - \text{log standard deviation}\right]$$

$$\text{"maximum"} = \ln^{-1}\left[\text{log mean} + \text{log standard deviation}\right]$$

It should be noted that all calculations involve natural logarithms. The results, however, would be the same if common logarithms were used.

EXAMPLE OF DATA PROCESSING

A hypothetical processing plant from which a set of historical data was obtained, is assumed. Three sample points contributed to the total effluent from the plant: sample points 1 and 2 are different outfalls from the product preparation area, and sample point number 3 is from the packaging area. The historical data set is as follows:

	DATE	MGD	PROD'N	BOD
Sample Pt. #1	6-2-74	0.152	25.7 tons	372
	6-3-74	0.172	32.3	454
	6-4-74	0.139	18.6	792
	6-5-74	0.161	26.0	298
Sample Pt. #2	6-2-74	0.061	25.7	872
	6-3-74	0.112	32.3	903
	6-4-74	0.039	18.6	1050
	6-5-74	0.087	26.0	693
Sample Pt. #3	6-1-74	0.0072	25.7	213
	6-15-74	0.0069	32.3	562
	6-17-74	0.0038	18.6	317
	7-2-74	0.0120	26.0	459

The data represents 24 hour composites which included process and cleanup wastewaters.

Generally speaking, the three sample points must be added together to determine the total plant discharge. Two options are available, however, for carrying out the addition. In the first case, where there is reason to believe that there is a relationship between two or more sample points, the correlated points are added together prior to determining the mean. In the second case, where there is no reason to believe a relationship exists between sample points, the data from each point is averaged and the resulting means from each sample point are summed to produce the total load. A combination of the two system may be found in some plants, and this is the case for the hypothetical plant. Sample points one and two are assumed to be correlated, as they are discharges from the same sub-process. Sample point three is uncorrelated to the first two as it is a discharge from a different, relatively independent sub-process. Thus, the first two sample points will be handled by a correlated computation, and the third point will be added in as an uncorrelated point. Graphically, these computations can be depicted as follows:

Date	S.P. #1	S.P. #2		S.P. #3
6-1-74				$[BODR_3]$
6-2-74	$([BODR_1]$	$+ [BODR_1])$	$= [SUM_{12}]$	
6-3-74	$([BODR_1]$	$+ [BODR_1])$	$= [SUM_{12}]$	
6-4-74	$([BODR_1]$	$+ [BODR_1])$	$= [SUM_{12}]$	
6-5-74	$([BODR_1]$	$+ [BODR_1])$	$= [SUM_{12}]$	
6-15-74				$[BODR_3]$
6-17-74				$[BODR_3]$
7-2-74				$[BODR_3]$

$$\overline{\text{MEAN } SUM_{12}} + \overline{\text{MEAN } BODR_3} = \text{Mean BODR for plant}$$

Where BODR is the BOD ratio in kg/kkg.

The calculation of each individual daily parameter ratio is done as described in the accompanying PROGRAM PLANT DOCUMENTATION. For the data above,

Date	Sample pt. #1 FRIO (l/kkg)	Sample pt. #1 BODR (kg/kkg)	Sample pt. #2 FRIO (l/kkg)	Sample pt. #2 BODR (kg/kkg)	Sample pt. #3 FRIO (l/kkg)	Sample pt. #3 BODR (kg/kkg)
6-1-74	-	-	-	-	1170	.249
6-2-74	24700	9.19	9900	8.63	-	-
6-3-74	22200	10.1	14500	13.1	-	-
6-4-74	31200	24.7	8740	9.18	-	-
6-5-74	25800	7.69	14000	9.70	-	-
6-15-74	-	-	-	-	990	.500
6-17-74	-	-	-	-	852	.270
7-2-74	-	-	-	-	1920	.881

where FRIO is the Flow ratio in l/kkg

From the above table, the MEAN SUM OF BODR for sample points one and two is 23.1 kg/kkg. The BODR mean for sample point number three is 0.475. Thus, the total mean BOD ratio for the plant is 23.6 kg/kkg.

as the computer rounds all computations to three significant figures. All the parameter ratios are processed in the same manner. Minimum and maximum values are determined by inspecting all daily ratios and selecting the highest and lowest values of the ratio. Concentrations of the parameters are determined in all cases by dividing the parameter ratio in kg/kkg by the mean flow ratio in l/kkg. With this method, it becomes apparent that the computed concentrations are not identical to the observed values in the raw data. They are, however, close to the observed values and are useful in giving the observer an approximation of values to be found in the environment. The pH is handled differently than the other parameters. Each pH is converted back to its original hydrogen ion concentration, and the resulting values are arithmetically averaged. The mean ion concentration is then converted back to pH. Minimum and maximum values are selected from the original raw data values.

PROGRAM PLANT DOCUMENTATION

The following documents the algorithms used by Program PLANT to compute temporal statistics using time series inputs.

Definitions

Sample: A record containing the values of up to 20 parameters at one point in time* and space. The list of input parameters available is given below:

PARAMETER	UNITS	ABBREVIATION
Flow	Gal/shift	FLOW
Production	Ton/shift	PROD
Production	Gal/shift	PROG
Shift Length	Hours	SHFT
5 day BOD	mg/l	BOD
20 day BOD (Ultimate)	mg/l	BODU
COD	mg/l	COD
TOC	mg/l	TOC
Grease and Oil	mg/l	GRS
Total Kjeldahl Nitrogen	mg/l	TKN
Total Dissolved Solids	mg/l	TDS
Total Solids	mg/l	TS
Volatile Solids	mg/l	VS
Suspended Solids	mg/l	SUSP
Settleable Solids	ml/l	SETT
Screened Solids	mg/l	SCR
Total Phosphorus	mg/l	TP
Dominant Wavelength	Mu	DWL
Purity	%	PURE
Luminence	%	LUM

DRAFT

PARAMETER	UNITS	ABBREVIATION
Acidity/Alkalinity	mg/l	AA
Temperature	Deg F	TEMF
Temperature	Deg C	TEMC
Volatile Susp. Solids	mg/l	VSS
pH	pH units	pH
Flow Rate	l/sec	FLWR
Flow Ratio	l/kkg	FRIO
Detergents	mg/l	DGT
BOD Ratio	kg/kkg	BODR
SS Ratio	kg/kkg	SSR

*One point in time is considered to be a daily composite sample for all parameters.

Sample Point: A time series record containing up to 99 samples from a single point in space. One exception to this is the case where multiple sample points represent the same point in space but during different periods of time. For example, sample point No. 1 may represent composite samples of the daily process waters and sample point No. 2, composite samples of the daily cleanup which occurs during another shift or in between shifts.

Sample Group: Sample points may be considered to be correlated or independent. If the points are considered correlated, they are averaged together day by day to obtain a mathematical total composite. The group of sample points which are correlated in this manner is called a Sample Group. If the value of a parameter is missing for one sample point in one sample, the values of the parameter at the other sample points on the same day are rejected. Therefore, the correlation analysis should only be performed if all the sample points were sampled on the same day, otherwise, data will be rejected. On the other hand, if the sample points are treated as uncorrelated when they are really correlated, an inferior estimate of the average will result. Hence, a trade-off must be made between obtaining an inferior estimate because of assuming an incorrect model or because of rejecting data. A rule of thumb should be that, if data is missing or uncorrelated on more than 10 percent of a time series between two points, then they should be computed as uncorrelated sample points.

Time Statistic Algorithms: Five statistical estimators can be computed for each wastewater parameter. To clarify the following presentation, the following notation is defined.

DRAFT

Time Statistics	Symbol
number	n
mean	m
standard deviation	s
minimum	l
maximum	h

Since the computation of each time statistic is a function of the wastewater parameter, a set of algorithms are defined for each parameter. A symbol was defined for each set as follows:

Parameter	Units	Symbol
Production rate	units/day	P
Process time	hr/day	S
Flow volume	gal/day	V
Flow rate	l/sec	Q
	(gal/min)	Q'
Flow ratio	l/kkg	F
	(gal/ton)	F'
Concentration	mg/l	C
Concentration ratio	kg/kkg	R
pH	pH	H
Temperature	C	T

The symbol for each algorithm is then the matrix multiplication between each set of parameter and statistical symbols. The following notation will use the time statistic symbol to prefix the parameter symbol. For example, mP equals the mean production.

The input data sets are subscripted as follows:

i = a particular sample group
j = a particular sample point in a sample group
k = a particular sample value in the time series from a sample point

The following functions are also defined.

Count (A) = number of values in Set A

AMean (A) = $\frac{1}{\text{Count (A)}} \Sigma A$, The arithmetic mean of values in Set A

Var (A) = $\frac{1}{\text{Count(A)}-1} \Sigma (A - \text{AMean}(A))^2$, the variance of values in Set A

Max (A) = The observed maximum value in Set A

Min (A) = The observed minimum value in Set A

DRAFT

Production Algorithms (Units/day)

nP = Count (Pi)
mP = A Mean (Pi)
sP = $\sqrt{Var (Pi)}$
lP = Min (Pi)
hP = Max (Pi)

The production statistics are automatically computed from the va
of the first sample group (i=1). However, it can be computed fr
any of the groups on demand. It is assumed that the group with
largest number of samples is placed in the first position.

Process Time (shift) Algorithms (hrs/day)

nS = Count (Si)
mS = A Mean (Si)
sS = $\sqrt{Var (Si)}$
lS = Min (Si)
hS = Max (Si)

Flow Volume (mgd)

(1) nV = Count (Bi max)
(2) mV = Σ AMean (Σ Vkj)i
(3) sV = $\sum \sqrt{Var (Vi)}$ (j)
(4) lV = Σ Min (Vi)
(5) hV = Σ Max (Vi)

Notes:

(1) The number of samples for flow volume in MGD was computed usi
the sample group which contributed the largest BOD load. (Bi max)

(2) The mean flow volume is computed by summing the average flo
from each sample group i. The average flow from sample group i i
determined by averaging the sum of the daily flows from each poi

(3) The variance of the total end of pipe flow is equal to the
of the variances from the individual groups. The variance of th
first group is determined by using the sum of the daily flow fro
each point j.

(4) The combined (EOP) minimum and maximums are computed from t
sum of the minimums and maximums from each Group.

It should be noted that this mathematical combining will tend to
more extreme minimums and maximums than would be observed for th
same number of naturally combined samples.

DRAFT

Flow Rate (gal/min)

(5) nQ' = nV = blank on table

$$mQ' = a \sum_i \text{Amean} \sum_j (V/S)kg$$

$a = \frac{1}{60}$ a scale factor

$sQ' = a \sqrt{\sum \text{Var } (V/S)i}$
$lQ' = a \text{ Min } (V/S)i$
$hQ' = a \text{ Max } (V/S)i$

Flow Rate (l/sec)

Q = .0631Q'

Notes:

(5) mQ is computed similarly to mV except that the daily flow volumes are converted to flow rates by dividing by the shift lengths.

Flow Ratio (gal/ton)

F' is computed in a similar manner to Q', except that V/P is substituted for V/S and scale factor a = 1.

Flow Ratio (L/kkg)

F = 4.17 F'

Concentration (mg/l)

nC = Count (Bi max)

$mC = \frac{mR}{mF} \times 10^6$

$sC = \frac{sR}{mF} \times 10^6$

$lC = \frac{lR}{mF} \times 10^6$

$hC = \frac{nR}{mF} \times 10^6$

Concentration Ratio (kg/kkg)

R is computed the same as F' or Q', except that VC/P is substituted for V/S and the scale factor $a = 4.17 \times 10^{-6}$.

pH

nH = Count (H), i=1

mH, sH, lH, hH → Calculated similarly to V except $V\log^{-1} H$ is substituted for V and with log to the base 10 taken of the result.

DRAFT

<u>Temperature (°C)</u>

nT = Count (T), i=1

mT, sT, lT, hT ⊐ Calculated similarly to V except VT_k is substituted for V