PRELIMINARY DATA BASE FOR REVIEW OF BATEA EFFLUENT LIMITATIONS GUIDELINES, NSPS, & PRETREATMENT STANDARDS FOR THE PULP, PAPER, & PAPERBOARD POINT SOURCE CATEGORY

PREPARED FOR THE

U.S. ENVIRONMENTAL PROTECTION AGENCY

BY THE

EDWARD C. JORDAN CO., INC.
PORTLAND, MAINE 04112

CONTRACT NO. 68-01-4624

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NOTICE

This document is a CONTRACTOR'S REPORT. It includes technical information 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 Agency personnel.

The report 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 regulations to be published by EPA under Sections 301 (b) and (d), 304 (b), 306, and 307 (b) and (c) of the Federal Clean Water Act, as amended, will be based in part, on the report and the comments received on it. EPA will also be considering economic and environmental impact information that is presently being developed. Upon completion of the review and evaluation of the technical, economic, and environmental information, an EPA report will be drafted. The report will be issued concurrent with the proposed rulemaking and will set forth EPA's preliminary conclusions regarding the subject industry. The proposed rules will include effluent guidelines and standards, standards of performance, and pretreatment standards applicable to the industry. EPA is making this draft contractor's report available to encourage broad public participation early in the rule-making process.

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. 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 Waste Management
Effluent Guidelines Division
Washington, D.C. 20460

ABSTRACT

This document presents the findings of an extensive study of the pulp, paper and paperboard industry for the purpose of developing effluent limitations guidelines and standards for new and existing point sources in compliance with the Clean Water Act.

The subcategories of the pulp, paper and paperboard point source category, as refined and presented in this document, are the following:

011 Alkaline-Dissolving
012 Alkaline-Market
013 Alkaline-BCT
014 Alkaline-Fine
015 Alkaline-Unbleached
016 SemiChemical
017 Alkaline-Unbleached & Semi-Chemical
019 Alkaline-Newsprint
021 Sulfite-Dissolving
022 Sulfite-Papergrade
032 Thermo-Mechanical Pulp
033 Groundwood-CMN
034 Groundwood-Fine
101 Deink-Fine & Tissue
102 Deink-Newsprint
111 Wastepaper-Tissue
112 Wastepaper-Board
113 Wastepaper-Molded Products
114 Wastepaper-Construction Products
201 Nonintegrated-Fine
202 Nonintegrated-Tissue
204 Nonintegrated-Lightweight
205 Nonintegrated-Filter & Nonwoven
211 Nonintegrated-Paperboard

Other mills in this point source category are included in the following miscellaneous groupings:

Integrated-Miscellaneous, including
    Alkaline-Miscellaneous
    Chemi-Mechanical Pulp and
    Nonwood Pulping;
Secondary Fiber-Miscellaneous; and
Nonintegrated-Miscellaneous

This document presents raw waste loads reported by 644 of the approximately 730 mills in the pulp, paper and paperboard industry, supplemented by the results of in-situ raw waste and effluent sampling and analysis conducted by the E.C. Jordan Co., Inc. and by the U.S. Environmental Protection Agency (EPA) at representative mills throughout the industry.

Available in-plant production process controls and end-of-pipe effluent treatment technologies are identified which can reduce the raw waste loads and effluent pollutant levels discharged by mills in the industry subcategories.

Several levels of improved wastewater management are described which can be implemented by mills to achieve effluent limitations guidelines and standards to be promulgated by EPA in accordance with Best Available Technology Economically Achievable. Levels 1 and 2 consist of in-plant production process controls which reduce raw waste flow, BOD_5 and TSS loadings. Levels 3 and 4 consist of Level 1 and 2 controls plus designated effluent treatment technologies described for direct discharge mills, indirect discharge mills and new source mills in each subcategory.

This document also reports the results of a literature research, sampling and analysis program, and control technology assessments relating to toxic pollutants generated and discharged by the pulp, paper and paperboard industry.

Supportive data and rationale for development of the effluent limitations and standards of performance are contained in this report.

ACKNOWLEDGEMENTS

This program has been conducted under the direction of Donald R. Cote, P.E., Principal-in-Charge, and Willard C. Warren, P.E., Project Manager. The Edward C. Jordan Co., Inc., wishes to thank the project staff members for their many contributions throughout the project and especially during the report preparation. Special recognition is given to John C. Tarbell, P.E. and Charles D. Cox, P.E., for their special efforts contributing to the successful completion of the project. The efforts of Mr. John G. Casana, P.E. and William Welch are also appreciated. Special recognition is also given to Lloyd Fogg, Constance Michaud, and Patricia Beaulieu for their efforts in the preparation of this document.

The cooperation and efforts of Gulf South Research Institute personnel are appreciated. Recognition is given to Dr. Roger Novak, Ph.D., and Kathy Olavesen, Ph.D. for their special efforts and timely performance of analysis.

The contributions of Robert Schaffer and John Riley of the U.S. Environmental Protection Agency, Effluent Guidelines Division, is acknowledged. A special thanks is given to Mr. Robert W. Dellinger, Technical Project Officer, for his direction and input throughout the project, including during the report preparation. Recognition is also given to the efforts of Mr. Craig P. Vogt, former Technical Project Officer.

Appreciation is also extended to companies who granted access to their mills and treatment works from field surveys and for the assistance lent by mill personnel to field crews.

The input received from the representatives of the many research facilities is recognized and appreciated. In addition, appreciation is expressed to the many equipment manufacturers and suppliers which expeditously responded to requests for information relating to their products.

The cooperation and assistance provided by Russell O. Blasser, and William Gillespie of the National Council for Air and Stream Improvement (NCASI) are appreciated. Thanks are also extended to the American Paper Institute and their API-BAT task group.

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LEGEND OF ABBREVIATIONS

A.	Acid
APHA	American Public Health Association
API	American Paper Institute
ASB	Aerated Stabilization Basin
Bd	Board or Paperboard
BATEA	Best Available Technology Economically Achievable
BCPTCA	Best Conventional Pollutant Technology Currently Available
BCT	Paperboard, Coarse, Tissue
Bl.Kr.	Bleached Kraft
BOD_5	Biochemical Oxygen Demand (five-day)
BP	Blow Pit
BPCTCA	Best Practicable Control Technology Currently Available
BS	Bisulfite
BTU	British Thermal Units
C	Chlorination Stage (bleach)
°C	degrees Centigrade
Ca	Calcium
Caust. or Caustic	Causticizing
CMN	Coarse, Molded, Newsprint
CMP	Chemi-mechanical Pulp
COD	Chemical Oxygen Demand
Cont.	Contained

Corrug.	Corrugating
Ctd.	Coated
D	Chlorine Dioxide Stage (bleach)
DAF	Dissolved Air Flotation
Diss.	Dissolving
DO	Dissolved Oxygen
DR	Drum Wash
E	Extraction Stage (caustic bleach)
E. Coli.	Escherica Coliform
Effl. or Eff.	Effluent
ENR	Engineering News Record
Excl.	Excluding
F	Fine
°F	degrees Fahrenheit
FW	Fresh Water
gal	gallons
gpd/sq. ft.	gallons per day per square foot
gpm	gallons per minute
GW	Groundwood
GW. Spec.	Groundwood Specialty
hp	horsepower
HW	Hardwood
H	Hypochlorite (bleach)
Ind.	Industrial
Inf.	Influent

kg	kilogram, 1000 grams
kg/kkg	kilograms per 1000 kilograms
kg/sq cm	kilograms per square centimetre
kgal	1000 gallons
kgal/ton or kgal/t	1000 gallons per ton
kkg	1000 kilograms, metric ton
kl/kkg	kilolitres per thousand kilograms
kw	kilowatt
kwh	kilowatt hour
lb	pound
lb/ac/day	pound per acre per day
lb/ton or lb/t	pounds per ton
mach.	machine
misc.	miscellaneous
mgd	million gallons per day
mg/l	milligrams per litre
MgO	magnesium oxide
min	minute
mkt	market
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MST	Median Survival Time
N.A.	Not Available or Not Applicable
Na	Sodium

NCASI	National Council for Air and Stream Improvement
NH3	Ammonia
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
NSSC	Neutral Sulfite Semi-Chemical
PCB	Polychlorinated biphenyl
Pt-Co	Platinum Cobalt Units
ppm	parts per million
prod.	production
PS	Post Storage
psi	pounds per square inch
psig	pounds per square inch gage
purch.	purchased
RBC	Rotating Biological Contactor
S	Sulfite
San.	Sanitary
sat.	saturated
SB	Settling Basin
SSL	Spent Sulfite Liquor
Std. Meth.	Standard Methods
SW	Softwood
T	Tissue
TAPPI	Technical Association of the Pulp and Paper Industry
Temp	Temperature

TMP	Thermo-mechanical Pulp
TOC	Total Organic Carbon
TOD	Total Oxygen Demand
ton	1000 pounds (short ton)
td	tons per day
TS	Total Solids
TSS	Total Suspended Solids
TVS	Total Volatile Solids
UBKr	Unbleached Kraft
Unctd.	Uncoated
Vibra.	Vibrating
v/v	percent by volume
WF	Wood Flour
WP	Wastepaper
WW	Whitewater
ug/l	Micrograms per litre
Z/A	Zurn/Attisholz

PROCESS DESIGNATIONS

- FLOW DIRECTION
- VALVE
- CONTROL VALVE
- CHECK VALVE
- FLOOR DRAIN
- PUMP
- BLOWER
- SHOWERS
- DISTRIBUTION NOZZLE
- AGITATOR

INSTRUMENTATION

- INSTRUMENTATION LINES
- PROBE
- CONTROLLER

C	CONDUCTIVITY CONTROL
CC	CONSISTENCY CONTROL
CA	CONDUCTIVITY CONTROL & ALARM
FC	FLOW CONTROLLER
HLA	HIGH LEVEL ALARM
LA	LEVEL ALARM
LC	LEVEL CONTROL
LCA	LEVEL CONTROL WITH ALARM
LIC	LEVEL INDICATOR AND CONTROL
PHC	pH CONTROL
RC	REMOTE CONTROL
TC	TEMPERATURE CONTROL
TRC	TEMPERATURE RECORDER & CONTRO

FIGURE XIV -
LEGEND OF SYMBOLS ON DIAGRAMS

SECTION I

RECOMMENDATIONS AND CONCLUSIONS

The United States Environmental Protection Agency (EPA) will propose recommended effluent limitations, guidelines and standards for Best Available Technology Economically Achievable (BATEA), Best Conventional Pollutant Control Technology (BCT), New Source Performance Standards (NSPS), and pretreatment standards for new and existing sources of the Pulp, Paper and Paperboard Point Source Category.

The EPA will also propose general conclusions regarding industry subcategorization, impacting pollutant parameters, alternative treatment technologies, and treatment costs. The proposed effluent limitations guidelines and standards, and the general conclusions, will be published following review and evaluation of the technical information contained in this document, the comments from reviewers of this document, the economic impact on the industry if required to install additional pollution control technology, and other information as appropriate.

SECTION II

INTRODUCTION

PURPOSE AND AUTHORITY

The U.S. Environmental Protection Agency (EPA) has undertaken extensive investigative efforts to provide a realistic basis for establishing effluent limitations and standards for essentially all industrial point source categories. To date, these effluent limitations and standards have included best practicable control technology currently available (BPCTCA), best available technology economically achievable (BATEA), new source performance standards (NSPS), and pretreatment standards for new (PSNS) and for existing sources (PSES).

Section 301 of PL 92-500, the Federal Water Pollution Control Act Amendments of 1972, later amended by PL 95-217, the Clean Water Act of 1977, requires that the EPA review and, if necessary, revise effluent limitations and standards within five years of promulgation. In addition, as a result of a Settlement Agreement, dated June 7, 1976, amended March 19, 1979, between the EPA and several environmental groups represented by the Natural Resources Defense Council (NRDC), the EPA is required to develop regulations taking into account certain toxic pollutants which may be discharged from 21 industrial point source categories.(1) To meet these responsibilities, the EPA's Effluent Guidelines Division has been given the task of developing the technical data bases necessary to review, and possibly revise and/or expand the following:

1. effluent limitations based on the best available technology economically achievable (BATEA) to be met by industrial dischargers by July 1, 1984;

2. effluent limitations based upon best conventional pollutant control technology (BCPCT) to be met by July 1, 1984;

3. new source performance standards (NSPS) based on the best available demonstrated control technology (BADT) to be met by new source industrial discharges;

4. pretreatment standards for existing sources (PSES) discharging to publicly owned treatment works (POTW's); and

5. pretreatment standards for new sources (PSNS) discharging to publicly owned treatment works (POTW's).

In July 1977 the Edward C. Jordan Co., Inc. (E.C. Jordan Co.), of Portland, Maine, was retained by the EPA under Contract No. 68-01-4624 to conduct the technical studies for the pulp, paper and paperboard point source category required as a result of Settlement Agreement and the Clean Water Act. Meta Systems Inc. of Cambridge, Massachusetts, was retained by EPA to undertake the economic project investigations. The scope of the study includes those mills producing pulp, paper, paperboard, and builders' paper.

STATUS OF THE EFFLUENT LIMITATIONS GUIDELINES

The effluent limitations guidelines and standards program for the pulp, paper and paperboard point source category has been active since 1972. In proposing and then promulgating effluent limitations and standards for the pulp, paper and paperboard point source category, the EPA divided the industry into two segments. These segments have been referred to as Phases I and II. In addition to these segments, the industrial point source category now includes builders' paper operations, which had earlier been addressed by EPA as a separate category.

The timing and status of the effluent limitation guidelines resulting from PL 92-500 vary for the industry. Technical studies for the Phase I segment were completed in late 1973, with an EPA Development Document published in May 1974.(2) Proposed BPCTCA, BATEA and NSPS effluent limitations were introduced on January 15, 1974.(3) After a review period, the proposed regulations were adjusted and promulgated for the Phase I mills on May 29, 1974.(4)

The technical studies for the Phase II segment began in late 1973. In July 1974, a draft contractor's report was submitted to the EPA.(5) Additional technical studies were undertaken, and in August 1975 a "Development Document for Advanced Notice of Proposed or Promulgated Effluent Limitations Guidelines and Standards" was published.(6) On February 19, 1976, the EPA published interim-final effluent limitation guidelines and standards for the Phase II segment.(7) On January 6, 1977, BPCTCA effluent limitations were promulgated for the Phase II segment.(8) Subsequently, effluent standards for the dissolving sulfite-subcategory acetate grade pulp were remanded by the Court of Appeals.(9)

On January 14, 1974, effluent limitation guidelines and standards were proposed for the builders' paper and roofing felt mills.(10) These regulations were subsequently promulgated on May 9, 1974.(11)

SCOPE OF PROJECT INVESTIGATIONS

The goal of the effluent guidelines program is to develop a basis for the EPA to regulate three specific categories of pollutants. In carrying out the intent of the Clean Water Act, the EPA has a varying compliance schedule for each category of pollutants. The categories of pollutants outlined in the Act are:

1. conventional pollutants;

2. toxic pollutants; and

3. nonconventional pollutants.

Included in the conventional pollutant category are 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), pH, and fecal coliform. In general, effluent limitations have been developed based on best practicable control technology currently available (BPCTCA). BOD_5, TSS, and pH are regulated for all subcategories. Extensive investigations were completed between 1972 and 1976 on the discharge of these conventional pollutants from the pulp, paper, and paperboard industry.

The next category of pollutants consists of 65 "priority" pollutants or classes of pollutants listed in the settlement agreement between EPA and the Natural Resources Defense Council (NRDC).(1) Prior to undertaking these investigations, limited data was available on the presence of these pollutants in the pulp, paper, and paperboard industry wastewater discharges. As a result, the project investigations were structured to develop the required data base.

Nonconventional pollutants are those not named in one of the previous categories of pollutants. Discharge of these pollutants in this category may be industry-specific and upon a determination by EPA, may be regulated. In addition to industry-specific compounds identified, ammonia and chemical oxygen demand (COD) are included as nonconventional pollutants. COD has been proposed as a conventional pollutant, but it has not been promulgated. Consequently, it will be discussed subsequently as a nonconventional pollutant.

The purpose of project investigations undertaken for this report was to assemble the necessary data that would allow the EPA to promulgate effluent limitations guidelines and standards for the pulp, paper, and paperboard industry in the three categories of pollutants. A work program was prepared and presented to the EPA in September 1977, which included the following major project tasks:

1. existing data evaluation;

2. data request program;

3. screening program;

4. industry profile and review of subcategorization;

5. verification program;

6. data analysis;

7. analysis of treatment alternatives; and

8. analysis of cost and energy data.

The approach to each of these major project tasks is discussed below.

Existing Data Evaluation

To assess existing data on pollutants and their control/reduction in the pulp and paper industry, several data sources were investigated, including:

- the EPA's administrative record;
- information from state regulatory agencies, the EPA regions, and research facilities; and
- the literature.

Administrative Record. The administrative record for the previous Phase I and II segment effluent guidelines studies and for builders' papers was reviewed for:

- the use of chemical additives;
- the use or suspected presence of the 129 toxic compounds;
- the use or suspected presence of other (nonconventional) pollutants;
- available production process controls; and
- available effluent treatment techniques.

Regulatory Agencies and Research Facilities. During the initial months of the project, it was determined that the state regulatory agencies and the EPA regional offices had very few past or ongoing projects which would relate to the toxic pollutants and the pulp, paper, and paperboard industry. The state of Wisconsin and EPA did, however, recently complete a study which deals with toxic pollutants found in the discharges from pulp, paper and paperboard mills.(12) Results show that pulp, paper, and paperboard mill effluents contained numerous organic compounds which are not on the EPA's list of toxic pollutants.

In recent months many of the EPA regional offices have been conducting sampling programs to supplement those being conducted by the E.C. Jordan Co. Future project reporting will include summaries of all available data concerning the supplemental EPA sampling efforts.

In addition, representatives of several research and other facilities have been contacted for information on ongoing or unpublished work. Facilities contacted included:

University of Washington

College of Forest Resources
Seattle, Washington

Washington Department of
Fisheries Laboratory
Quilcene, Washington

B.C. Research, Inc.
Vancouver, B.C.

Institute of Paper Chemistry
Appleton, WS

Forest Products Laboratory
Madison, WS

Simpson Paper Company
Anderson, California

University of California Forest Products Laboratory
Richmond, California

State University of New York
College of Environmental Science and Forestry
Syracuse, New York

University of Toronto
Toronto, Canada

Pulp & Paper Research Institute of Canada
Point Claire, Quebec

HSA Reactors Ltd.
Toronto, Canada

Lundberg Ahlen, Inc.
Richmond (Vancouver), Canada

<u>The Literature</u>. In order to develop background information on the toxic pollutants and their control in the pulp, paper, and paperboard industry, the E.C. Jordan Co. completed an assessment of available data through a review of literature. This review focused on identifying which of the 129 toxic and which other (nonconventional) pollutants, if any, may be present in the wastewaters discharged from pulp, paper and paperboard mills. This included a review of materials, chemicals, and processes which might contribute to the discharge of these pollutants. Additional data was sought on the technology to remove or control the toxic pollutants under investigation.

Several automated document searches were undertaken to identify relevant literature. Sources searched included:

1. The Department of Commerce/National Oceanic and Atmospheric Administration's Environmental Data Service (Environmental Data Index - ENDEX and the Oceanic Atmospheric Scientific Information System - OASIS);

2. University microfilm's xerographic dissertation abstract service (DATRIX II);

3. Environment Canada's Water Resources Document Reference Center through Canada's Inland Waters Directorate (WATDOC); and

4. The Institute of Paper Chemistry's Abstract Service (PAPERCHEM and Chemical Abstracts).

Through these services, over one million articles/papers and 3,500 environmental data files were searched. Those which appeared relevant were obtained and reviewed.

Several other summary documents were also reviewed, including:

1. work conducted by the Pulp and Paper Research Institute of Canada;

2. a report entitled, "Multi-Media Pollution Assessment in Pulp, Paper, and Other Wood Products Industry," prepared for the U.S. EPA by Battelle-Columbus Laboratories, December 1976; and

3. the U.S. EPA's Office of Research and Development Publication Summary (December 1976, Cincinnati, Ohio).

4. Environment Canada's Publication Summary of work conducted under the Canadian Pollution Abatement Research Program, March 1977 and March 1978.

5. "A position paper documenting the toxicity of pulp and paper mill dischargers and recommending regulatory guidelines and measurement procedures" prepared for the Canadian Pulp & Paper Association, by B.C. Research, Vancouver, B.C., Canada, December 1974.

Through these reviews several compounds contained on the toxic pollutant list, as well as certain nonconventional pollutants known to be toxic, were noted as being present in the discharge from pulp, paper and paperboard mills.(13) Table II-1 presents the toxic pollutants identified through these efforts.

TABLE II-1

TOXIC POLLUTANTS
IDENTIFIED IN PULP, PAPER & PAPERBOARD MILL EFFLUENTS (13)

Chlorinated Phenolics	Lead
Chloroform	Lindane (Y-BHC)
Chromium	Mercury
Copper	Pentachlorophenol
DDD	Phenol (Methyl Ether)
DDE	Polychlorinated Biphenyls (PCB)
DDT	Zinc
Dioctyl Phthalate	
Iron	

Data Request Program

To develop an up-to-date industry profile, data from previous effluent guidelines studies was supplemented by a new data request program. The program was developed to collect information for each manufacturing facility, including raw materials, processes, products, production process controls, effluent treatment technologies and the toxic and nonconventional pollutants discharged.

Data Request Development. The process leading to the development of the final data request included considerable input from the industry and EPA. It was initially envisioned that a separate survey form would be developed for each of eight basic types of manufacturing facilities: kraft and soda, sulfite, groundwood, deink, NSSC, and CMP/TMP, builders paper mills, and nonintegrated mills. After numerous discussions with industry representatives and the EPA, it was decided that only two survey forms would be developed for the basic types of manufacturing facilities:(14)

(1) Multiple Pulping/Integrated Mills; including

Kraft and Soda Mills
Sulfite Mills
Groundwood Mills
Deink Mills
NSSC and CMP/TMP Mills
Paperboard from Wastepaper Plants
Builders Paper Mills

(2) Nonintegrated Mills, including

Fine
Coarse
Tissue
Other Mills

The data request development was coordinated with the API-BAT Task Group, an industry committee formed to interact with EPA during the ongoing BATEA review project. This group brought together numerous individuals representing individual companies and technical associations. The committee participated in the review and the development of the survey form and made suggestions concerning its content. Meetings with the API-BAT task group were held on July 12, August 2, and August 18, 1977 to review the draft data request survey forms. Revisions were made to the data requests in accordance with discussions at the meetings.

The final data requests were in two parts. Part I requested information to be used in selection of mills to be sampled in the verification program. Part II contained responses to be used for profiling the industry and for subcategorization.

During the industry meetings, the EPA requested input from the industry group on the required population of mills that should receive a data request. Mill representatives from both large and small mills recommended 100 percent coverage of the industry. The data requests were forwarded by EPA under the authority of Section 308 of PL 92-500 during the last week in September 1977. The response times for Parts I and II were 45 and 90 days, respectively. The response were due in mid-November 1977 and early January 1978.

Due to the complex nature of the data request, representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI), requested that representatives of the EPA and the E.C. Jordan Co. attend an instructional meeting on October 6, 1977, in Chicago, Illinois, to answer questions from mill representatives on completing the data requests. As a result of this meeting, an errata sheet was assembled and distributed to mills which had received the data request.(15)

Throughout the response time, numerous questions were asked of E.C. Jordan Co. personnel on the data request. The largest number of questions related to: production information, raw material utilization, process chemicals, and process description.

Representatives of the surveyed mills were allowed to request that information be held confidential. The program also included a release statement giving the NCASI access to a mill's response and to additional mill data developed in the program. As a result, the EPA and E.C. Jordan Co. could communicate with the NCASI on data including confidential data, except for those mills that elected not to release the information to the NCASI.

Data Processing System. Since there were 700 anticipated responses to the data request program, it was imperative that a definite methodology be developed for processing the responses. A multi-phase procedure was developed for receiving and processing responses to the data requests. The first step in the processing system was to develop a mill code to ensure mill anonymity in reports and to facilitate computer analysis of the data request and sampling data. Principal steps included keytape of data, data verification, and data processing.

As responses to the data requests were received, they were first dated and logged into the data processing system.

Since numerous nonstandard and lengthy responses were anticipated, the survey forms were manually reviewed before the data was keytaped. This review was primarily for compatibility with the data input format, and for reasonableness of responses.

In the review for reasonableness, numeric responses totally out of line with expected values were either reconciled with other responses in the mill's data request, or the respondent was contacted for clarification and correction. The same was true for responses which indicated a misunderstanding or misinterpretation of the question.

Responses were stored as they appeared on the original survey form or through the use of codes. If a question requiring a numeric response (e.g., year, quantity, etc.) was answered by a number plus text explanation, or simply text, then a code was inserted in the data base which indicated the presence of the additional information. A similar code was used to indicate an answer which had been calculated by the reviewing engineer; such an answer normally consisted of conversions to standard units, often confirmed by communication with the respondent. Codes for "unknown" or "not available" information were also utilized where appropriate. All codes and notes indicating additional information can be retrieved so that all responses are accounted for during the data analysis phase.

In general, it was necessary to contact 30 to 40 percent of the responding mills for verification of responses. In some cases obviously erroneous data was submitted relative to some mills. The production and wood utilization data for all responding mills was reviewed to ensure consistent results and reliable data interpretation.

Data Verification and Edit Techniques. Information contained in the data files was verified by comparing the printed output file copy with the original data request responses. The purpose was to ensure accuracy in the data. Data files were updated according to the verified printouts.

Response to Data Request. Responses to both the integrated and nonintegrated data request forms was good. The total number of respondents and the percentage of the total that this represented are shown in Table II-2.

TABLE II-2

RESPONSE TO DATA REQUEST

Number of surveys sent:	730
Number of 308 surveys returned:	644
Percentage response:	(88%)
Summary of Non-Response	
No reply:	45
Shut down:	21
Exempt:	20
Total	86
Overall Percentage Response:	94%
Method of Discharge - Responding Mills	
Direct Dischargers:	359
Indirect Dischargers:	230
Self Contained:	55

The EPA is currently developing a strategy to survey those mills not responding to the data request.

Screening Program

As a result of the settlement agreement the EPA was to determine the presence or absence of 65 "priority" pollutants or classes of pollutants in industrial effluent discharges. Prior to commencing the technical studies required, the EPA expanded the list of "priority pollutants" to include 129 toxic pollutants.(16)

The screening program was established to determine the presence or absence of the 129 toxic and 14 nonconventional pollutants listed in Table II-3 in pulp, paper, and paperboard wastewaters. This information would be used to develop

TABLE II-3

TOXIC AND NONCONVENTIONAL POLLUTANTS UNDER INVESTIGATION IN THE SCREENING PROGRAM

1. *acenaphthene
2. *acrolein
3. *acrylonitrile
4. *benzene
5. *benzidine
6. *carbon tetrachloride (tetrachloromethane)

CHLORINATED BENZENES (other than DICHLOROBENZENES)

7. chlorobenezene
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene

CHLORINATED ETHANES

10. 1,2-dichloroethane
11. 1,1,1-trichloroethane
12. hexachloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane

CHLOROAKLYL ETHERS

17. bis(chloromethyl) ether
18. bis(2-chloroethyl) ether
19. 2-chloroethyl vinyl ether (mixed)

CHLORINATED NAPTHALENE

20. 2-chloronaphthalene

CHLORINATED PHENOLS (Other than those listed elsewhere; includes chlorinated cresols

21. 2,4,6-trichlorophenol
22. parachlorometa cresol
23. *chloroform (trichloremethane)
24. *2-chlorophenol

DICHLOROBENZENES

25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene

DICHLOROBENZIDINE

28. 3,3'-dichlorobenzidine

DICHLOROETHYLENES

29. 1,1-dichloroethylene
30. 1,2-trans-dichloroethylene
31. *2,4-dichlorophenol

DICHLOROPROPANE AND DICHLOROPROPENE

32. 1,2-dichloropropane
33. 1,3-dichloropropylene (1,3-dichloropropene)
34. *2,4-dimenthylphenol

DINITROTOLUENE

35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene
37. *1,2-diphenylhydrazine
38. *ethylbenzene
39. *fluoranthene

*Specific compounds and chemical classes as listed in the consent degree.

TABLE II-3 (Continued)

*HALOETHERS (other than those listed elsewhere)

40. 4-chlorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. bis(2-chloroisopropyl) ether
43. bis(2-chloroethoxy) methane

*HALOMETHANES (other than those listed elsewhere)

44. methylene chloride (dischloromethane
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
49. trichlorofluoromethane
50. dichlorodifluoromethane
51. chlorodibromomethane
52. *hexachlorobutadiene
53. *hexachlorocyclopentadiene
54. *isophorone
55. *naphthalene
56. *nitrobenzene

*NITROPHENOLS

57. 2-nitrophenol
58. 4-nitrophenol
59. *2,4-dinitrophenol
60. 4,6-dinitro-o-cresol

*NITROSAMINES

61. N-nitrosodimethylamine
62. N-nitrosodiphenylamine
63. N-nitrosodi-n-propylamine
64. *pentachlorophenol
65. *phenol

*PHTHALATE ESTERS

66. bis(2-ethylhexyl) phthalate
67. butyl benzyl phthalate
68. di-n-butyl phthalate
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate

*POLYNUCLEAR AROMATIC HYDROCARBONS

72. benzo (a)anthracene (1,2-benzanthracene)
73. benzo (A)pyrene (3,4-benzopyrene)
74. 3,4-benzo fluoranthene
75. benzo (k) fluoranthene (11,12-benzo fluoranthene)
76. chrysene
77. acenaphthlene
78. anthracene
79. benzo(ghi)perylene (1,12-benzoperylene)
80. fluorene
81. phenathrene
82. dibenzo (a,h) anthracene (1,2,5,6-dibenzanthracene)
83. indeno (1,2,3-cd) pyrene (2,3-O-phenylenepyrene)
84. pyrene
85. *tetrachloroethylene
86. *toluene
87. *trichloroethylene
88. *vinyl chloride (chloroethylene)

PESTICIDES AND METABOLITES

89. *aldrin
90. *dieldrin
91. *chlordane (technical mixture & metabolites)

*Specific compounds and chemical classes as listed in the consent degree.

TABLE II-3 (Continued)

*DDT AND METABOLITES

92. 4,4'-DDT
93. 4,4'-DDE (p,p'-DDX)
94. 4,4'-DDD (p,p'-TDE)

*ENDOSULFAN AND METABOLITES

95. a-endosulfan-Alpha
96. b-endosulfan-Beta
97. endosulfan sulfate

*ENDRIN AND METABOLITES

98. endrin
99. endrin aldehyde

*HEPTACHLOR AND METABOLITES

100. heptachlor
101. heptachlor epoxide

*HEXACHLOROCYCLOHEXANE (all isomers)

102. a-BHC-Alpha
103. b-BHC-Beta
104. r-BHC (lindane)-Gamma
105. g-BHC-Delta

*POLYCHLORINATED BIPHENYLS (PCB's)

106. PCB-1242 (Arochlor 1242)
107. PCB-1254 (Arochlor 1254)
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
110. PCB-1248 (Arochlor 1248)
111. PCB-1260 (Arochlor 1260)
112. PCB-1016 (Arochlor 1016)

113. *Toxaphene
114. *Antimony (Total)
115. *Arsenic (Total)
116. *Asbestos (Fibrous)
117. *Beryllium (Total)
118. *Cadmium (Total)
119. *Chromium (Total)
120. *Copper (Total)
121. *Cyanide (Total)
122. *Lead (Total)
123. *Mercury (Total)
124. *Nickel (Total)
125. *Selenium (Total)
126. *Silver (Total)
127. *Thallium (Total)
128. *Zinc (Total)
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

ADDITIONAL COMPOUNDS

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130. Abietic Acid
131. Dehydroabietic Acid
132. Isopimaric Acid
133. Primaric Acid
134. Oleic Acid
135. Linoleic Acid
136. Linolenic Acid
137. 9,10-Epoxystearic Acid
138. 9,10-Dichlorostearic Acid
139. Monochlorodehydroabietic Acid
140. Dichlorodehydroabietic Acid
141. 3,4,5-Trichloroguaiacol
142. Tetrachloroguaiacol
143. Xylenes

*Specific compounds and chemical classes as listed in the consent degree.

a verification sampling program. To limit the amount of sampling required during the screening program, specific criteria were developed for selecting representative pulp, paper and paperboard mills.

Mill Selection for Sampling. The initial step in selecting mills for sampling during the screening program was to obtain an adequate cross-section of the pulp, paper and paperboard industry. Discussions between the E.C. Jordan Co. and EPA representatives led to the selection of 15 subcategory groups within the pulp, paper, and paperboard industry for inclusion in the screening program. These 15 groups are listed in Table II-4.

TABLE II-4

SUBCATEGORY GROUPS SELECTED FOR SCREENING PROGRAM

Bleached Kraft:	Fine Papers
Bleached Kraft:	BCT/Market Pulp/Dissolving
Unbleached Kraft	
Unbleached Kraft/NSSC	
NSSC	
Sulfite	
Groundwood:	Fine Papers
Deink	
Nonintegrated:	Fine Papers
Nonintegrated:	Tissue Papers
Nonintegrated:	Coarse Papers
Nonintegrated:	Specialty Papers (I)
Nonintegrated:	Specialty Papers (II)
Paperboard from Wastepaper	
Builders' Paper	

It was concluded that one mill in each of these groupings would adequately represent the grouping if the following criteria were met:

1. a biological treatment system is employed at the mill and it is direct discharging;

2. the flow and BOD_5 raw wastewater characteristics of the mill discharge approximate BPCTCA raw wastewater levels used in development of regulations for the specific mill grouping; and

3. the manufacturing process is representative of the respective mill grouping.

Based upon these criteria, mills were selected for 11 of the 15 subcategory groups. Because of insufficient data, representative mills meeting the selection criteria could not be found for the following subcategory groups:

Nonintegrated .... Coarse Papers;
Nonintegrated .... Specialty Papers (I);
Nonintegrated .... Specialty Papers (II); and
Builders' Paper.

For these subcategory groups, it was noted that additional data would be forthcoming as a result of the data request program included in the current study program. Therefore, screening program visits to facilities included in these subcategory groups were delayed until the early phase of the verification program.

In addition to the 11 screening program sampling surveys conducted by the E.C. Jordan Co., EPA regional sampling and analysis teams surveyed an additional 47 mills to provide supplemental information. The additional mills were selected on the basis of the criteria detailed earlier.

A total of 32 of the 47 EPA regional surveys were performed as part of the verification sampling program. However, the analytical procedures used by the contracting analytical laboratories were those used in the screening program. Therefore, the results are comparable to those developed in the E.C. Jordan Company's screening program.

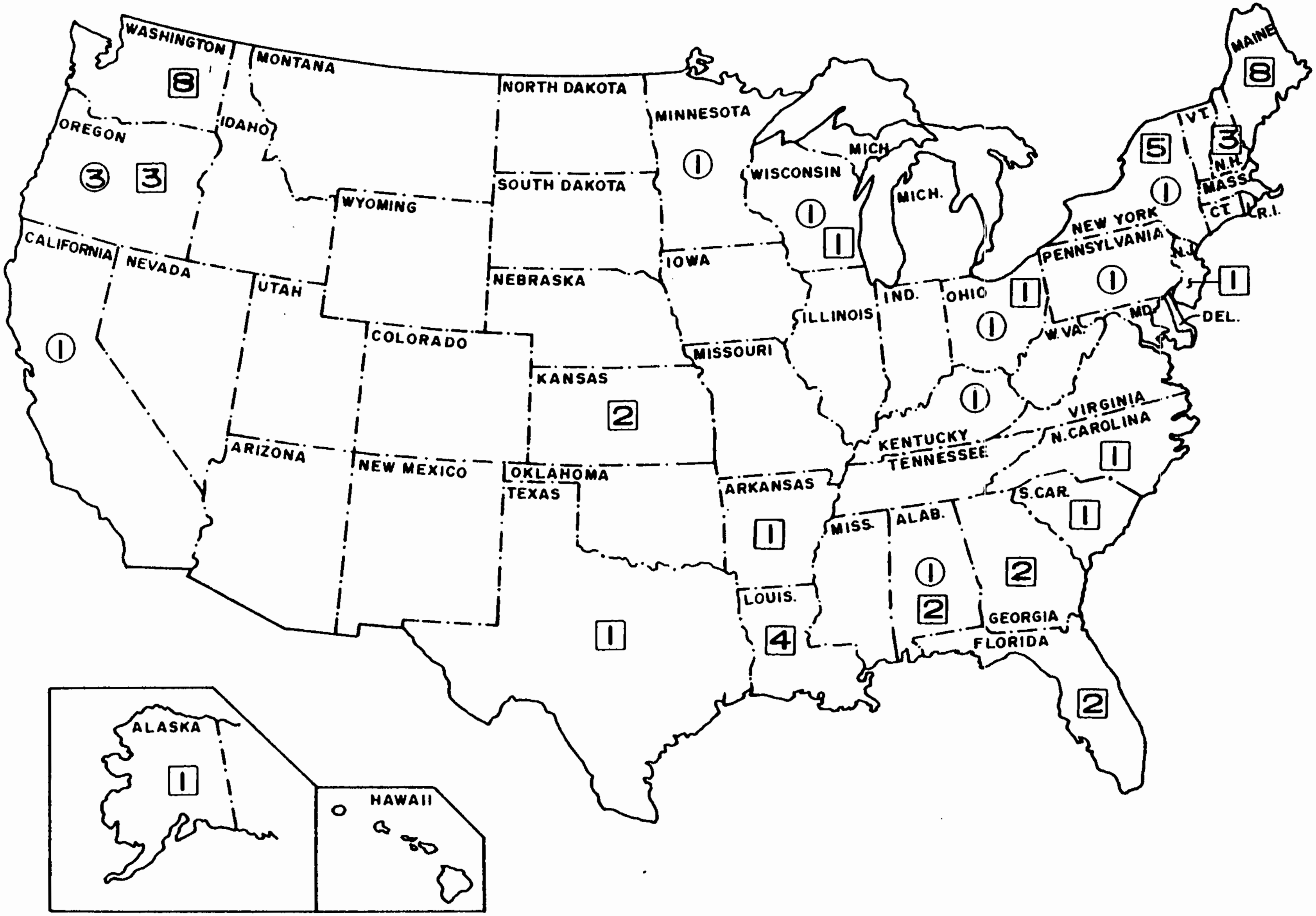
Figure II-1 shows the location of the 58 mills sampled as part of the screening program.

Sampling Program. Three sample locations for each mill were chosen for the sampling program: 1) the raw process water prior to any treatment; 2) the raw wastewater discharge to the wastewater treatment system; and 3) the final effluent from the wastewater treatment system(s).

The raw process water was selected to obtain background concentration levels for the toxic pollutants present in the water supply prior to use at the mill. The raw wastewater was selected because it would provide data on the toxic pollutants resulting from the industrial process and being discharged to the wastewater treatment system. The final effluent was sampled to determine the presence of and quantify the toxic pollutants remaining after wastewater treatment.

Prior to the sampling program, E.C. Jordan Co. prepared a "Screening Program Work Booklet" detailing the specific procedures to be followed during the program.(17) The specific procedures were derived from, and are consistent with, the EPA's March 1977 booklet entitled "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants".(18)

The screening program survey at each of the 11 mills included the taking of both composite and grab samples during the 3-day survey. Composite sampling was conducted for a period of 72 consecutive hours at the raw wastewater and final effluent sample locations. Grab samples were collected once daily at these two locations, as well as once on the second day of the sampling survey at the raw process water location. Table II-5 shows the work items covered during a typical screening sampling program survey.



LEGEND

(1) CONTRACTOR SURVEYS

[1] AGENCY SURVEYS

FIGURE II-1
LOCATION OF SCREENING
MILL SURVEYS

TABLE II-5

TYPICAL SCREENING PROGRAM SURVEY

Day 1 of the Survey	Day 2 of the Survey	Day 3 of the Survey	Day 4 of the Survey
1. Meet with mill personnel and discuss the program	1. Check automatic samplers	1. Check automatic samplers	1. Distribute 72 hour composite between the required composite samples
2. Select sample locations	2. Collect all grab samples required	2. Collect all grab samples required	2. Break down automatic samplers
3. Set up automatic samplers	3. Take pH and temperature readings at each sample location twice during 24 hours	3. Take pH and temperature readings at each sample location twice during 24 hours	3. Final meeting with mill personnel to wrap up the survey
4. Collect all grab samples required	4. Check automatic samplers periodically and keep composite sample container iced	4. Check automatic samplers periodically and keep composite sample container iced	4. Pack the samples and equipment for shipment
5. Take pH and temperature readings at each sample location twice during 24 hours			5. Ship samples to the appropriate analytical laboratory
6. Check automatic samplers periodically and keep composite sample container iced			

The composite sample was made up of approximately a 75-millilitre (ml) sample aliquot collected every 30 minutes using an ISCO model 1580 -superspeed or 1680 automatic sampler. The Teflon tubing used to collect samples was replaced after use at each mill. The tubing was prepared in accordance with the criteria established by the EPA.(18)

The particular categories of compounds sampled, as well as the type of container used to collect the sample during the screening program, were as follows:

Composite Samples	Container Size and Material
Extractable Organics	1 gallon glass
Metals	500-ml glass
Asbestos	1-litre, amber plastic
Grab Samples	
Volatile Organics	125-ml glass
Phenol	1-litre, glass
Cyanide	1-litre, amber plastic
Mercury	500-ml, plastic

To minimize biochemical degradation of the sample, the composite sampler jar was packed in ice during the 72-hr sampling period. Grab samples were collected and immediately packed in ice. All composite samples were also packed in ice immediately after the appropriate containers were filled at the end of the 72-hr period at each location.

Split Sampling Program. At each mill sampled by the E.C. Jordan Co. the screening survey team also split samples, both grab and composite, for analysis by representatives of the National Council of the Paper Industry for Air and Stream Improvement (NCASI). The bottles for the NCASI samples were prepared and delivered to each mill by NCASI personnel in Gainesville, Florida. The mill personnel assumed responsibility for the bottles prior to and immediately after sample collection. At most of the mills sampled, a member of the mill staff was present during the sample collection process.

Sample Analysis Procedures. The screening program samples were analyzed in accordance with EPA procedures.(18) The organic compounds were analyzed by gas chromatography-mass spectrometry (GC-MS). Metals were analyzed by the following method(s):

1. beryllium, cadmium, chromium, copper, nickel, lead, silver, arsenic, antimony, selenium, and thallium were first analyzed by flameless atomic adsorption (AA). If the metal was above the dynamic range of the flameless AA the metal was then analyzed by flame AA.

2. zinc was analyzed by flame AA.

3. mercury was analyzed by cold vapor flameless AA.

Industry Profile and Review of Subcategorization

During the screening program, available data and newly obtained information from the data request program were reviewed to develop a revised profile of the pulp, paper and paperboard industry. The review recognized such factors as plant size, age, location, raw materials, production process controls, products and effluent treatment systems. Based on these factors, the industry subcategorization has been reviewed and adjusted to reflect current practices.

By grouping similar mills together into subcategories, uniform national effluent limitations and standards can be developed (as required by PL95-217) which are applicable to groups of mills that fit discreet production and process patterns. If properly classified, a grouping (or subcategory) of similar mills will use similar production processes, show similar raw waste characteristics, experience similar effects resulting from specific process modifications, and share similar costs for those modifications in proportion to each mill's individual production rate.

Earlier efforts in subcategorizing the pulp, paper and paperboard industry resulted in establishing current Phase I and Phase II subcategories, as shown in Table II-6.

As part of this updated industry-wide survey, the existing subcategorizaton was reviewed based on more comprehensive data obtained during the screening program, the data request program and related efforts. As a result, a new subcategorization scheme has been developed as shown in Table II-6. This revised subcategorization better reflects the industry as it now operates with respect to raw materials, processing sequences and product mix.

A more detailed explanation of the rationale and process of subcategorization is presented in Section IV of this document, along with profile information for each of the revised subcategories.

The revised subcategorization was used in designing and conducting the verification program, as discussed below.

Verification Program

The verification program was established to verify the presence of the compounds found during the screening program, and to obtain information on the quantity of toxic and nonconventional pollutants present in pulp, paper and paperboard effluents. The selection of the compounds to be analyzed during the verification program was based on the screening program results at the mills sampled by the E.C. Jordan Co.

TABLE II-6

CURRENT AND REVISED INDUSTRY SUBCATEGORIZATION

Current Subcategories	Revised Subcategories
Phase I	
Unbleached Kraft	011 Alkaline-Dissolving
NSSC - Ammonia	012 Alkaline-Market
NSSC - Sodium	013 Alkaline-BCT
Unbleached Kraft-NSSC	014 Alkaline-Fine
Paperboard from Wastepaper	015 Alkaline-Unbleached
	016 Semi-Chemical
Phase II	017 Alkaline Unbleached and Semi-Chemical
	019 Alkaline-Newsprint
Dissolving Kraft	021 Sulfite-Dissolving
Market Kraft	022 Sulfite-Papergrade
BCT-Kraft	032 Thermo-Mechanical Pulp
Fine Kraft	033 Groundwood-CMN
Papergrade Sulfite	034 Groundwood-Fine
- Blow Pit Wash (plus allowances)	101 Deink-Fine and Tissue
Papergrade Sulfite-Drum Wash	102 Deink-Newsprint
- Drum Wash (plus allowances)	111 Wastepaper-Tissue
Dissolving Sulfite (allowances by	112 Wastepaper-Board
grade)	113 Wastepaper-Molded Products
Groundwood Chemi-Mechanical	114 Wastepaper-Construction Products
Groundwood Thermo-Mechanical	
Groundwood-CMN	201 Nonintegrated-Fine
Groundwood-Fine	202 Nonintegrated-Tissue
Soda	204 Nonintegrated-Lightweight
Deink	205 Nonintegrated-Filter and Nonwoven
Nonintegrated-Fine	211 Nonintegrated-Paperboard
Nonintegrated-Tissue	
- from Waste Paper	Mill Groupings:
	*Integrated Miscellaneous including
Builders Paper and Roofing Felt	o Alkaline-Miscellaneous
	o Groundwood Chemi-Mechanical
	o Nonwood Pulping
	*Secondary Fiber-Miscellaneous
	*Nonintegrated-Miscellaneous

*Groupings of miscellaneous mills - not subcategories.

Selection of Significant Parameters. Many of the toxic pollutants were not detected in pulp, paper and paperboard wastewaters during the screening program. Pollutants selected for the verification program included those detected during the screening program, plus specific compounds thought to be present in pulp, paper, and paperboard wastewaters based on literature reviews and industry data responses. The compounds included in the verification program are listed on Table II-7.

Selection of Mills for Verification Program. Part I of the EPA Survey Form, (14) returned by representatives of 644 mills, was used in selecting mills for verification program surveys. One of the first items that had to be addressed in selecting verification mills involved industry subcategorization. A preliminary revised subcategorization scheme was developed based on initial evaluations of the information submitted in Part I of the EPA Survey Form. Candidate mills for the verification program were listed for each of the revised subcategories. The criteria used to determine a mills candidacy for verification sampling were as follows:

1. the mill was direct discharging;

2. a secondary treatment system was employed at the mill;

3. the final effluent flow and BOD_5 from the wastewater treatment system were less than twice the average day BPCTCA limitations for the subcategory.

Those mills which met the above criteria were considered as primary candidates for the verification program. Some of the subcategories analyzed had primarily mills with only primary treatment systems, or discharge was to a private or publicly owned treatment works (POTW). For such subcategories the selection criteria were altered to include mills with these methods of handling their wastewater.

After determining which mills were primary candidates for the verification program, more specific process and wastewater selection criteria were evaluated, including:

1. raw wastewater and final effluent flow and BOD_5 and the percentage above or below the average day BPCTCA limitations;

2. the average daily production rates (raw materials, pulp manufactured, and paper);

3. the Kappa or permanganate number (if applicable to the subcategory that was analyzed);

4. the type of debarking used, i.e., wet or dry (if applicable to the subcategory analyzed);

5. the brown stock washer efficiency in terms of pounds of soda loss (if applicable to the subcategory analyzed);

TABLE II-7

VERIFICATION PROGRAM COMPOUNDS ANALYZED

4. *benzene
6. *carbon tetrachloride (tetrachloromethane)

*CHLORINATED BENZENES (other than dichlorobenzenes

7. chlorobenzene

*CHLORINATED ETHANES

10. 1,2-dichloroethane
11. 1,1,1-trichloroethane
13. 1,1-dichloroethane
15. 1,1,2,2-tetrachloroethane

*CHLORINATED PHENOLS (other than those listed elsewhere; includes chlorinated cresols)

21. 2,4,6-trichlorophenol
22. parachlorometa cresol
23. *chloroform (trichloromethane)
24. *2-chlorophenol

*DICHLOROETHYLENES

31. *2,4-dichlorophenol

*DINITROTOLUENE

38. *ethylbenzene

*HALOMETHANES (other than those listed elsewhere)

44. methylene chloride (dichloromethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
49. trichlorofluoromethane
51. chlorodibromomethane
54. *isophorone
55. *naphthalene

*NITROPHENOLS

59. *2,4-dinitrophenol

*NITROSAMINES

64. *pentachlorophenol
65. *phenol

*PHTHALATE ESTERS

66. bis(2-ethylhexyl)phthalate
67. butyl benzyl phthalate
68. di-n-butyl phthalate
69. di-n-octyl phthalate
70. diethyl phthalate

*POLYNUCLEAR AROMATIC HYDROCARBONS

76. chrysene
78. anthracene
80. fluorene
84. pyrene

*Specific compounds and chemical classes as listed in the consent degree.

TABLE II-7 (Continued)

85. *tetrachloroethylene
86. *toluene
87. *trichloroethylene

*POLYCHLORINATED BIPHENYLS (PCB's)

106. PCB-1242 (Arochlor 1242) as required
107. PCB-1254 (Arochlor 1254) as required
108. PCB-1221 (Arochlor 1221) as required
109. PCB-1232 (Arochlor 1232) as required
110. PCB-1248 (Arochlor 1248) as required
111. PCB-1260 (Arochlor 1260) as required
112. PCB-1016 (Arochlor 1016) as required
119. *Chromium (Total)
120. *Copper (Total)
121. *Cyanide (Total) as required
122. *Lead (Total)
123. *Mercury (Total)
124. *Nickel (Total)
126. *Silver (Total)
128. *Zinc (Total)

ADDITIONAL COMPOUNDS

Abietic Acid
Dehydroabietic Acid
Isopimaric Acid
Pimaric Acid
Oleic Acid
Linoleic Acid
Linolenic Acid
9,10-Epoxystearic Acid
9,10-Dichlorostearic Acid
Monochlorodehydroabietic Acid
Dichlorodehydroabietic Acid
3,4,5-Trichloroguaiacol
Tetrachloroguaiacol
Xylenes
COD
Ammonia

*Specific compounds and chemical classes as listed in the consent degree.

6. bleach plant data (if applicable to the subcategory analyzed) including:

   a. bleaching sequence;

   b. tonnage;

   c. shrinkage;

   d. brightness;

   e. fresh water usage; and

   f. type of washing;

7. the type of evaporator condenser used (if applicable to the subcategory analyzed);

8. the number of papermachines used (if applicable to the mill analyzed);

9. the number of papermachines for which savealls were utilized for fiber recovery (if applicable to the mill analyzed); and

10. the effluent treatment system used at the mill.

Based on the above data, the E.C. Jordan Co. selected mills which best represented each subcategory. The selected mills and data employed to make the selection were reviewed by EPA personnel. Based on this review, 59 mills were selected for the verification program being conducted by E.C. Jordan Co. The number of mills selected was based on the total required to represent each of the revised subcategories.

An additional 32 mills were subsequently selected and surveyed by the EPA's regional survey teams to provide additional coverage in specific subcategories. However, the analytical procedures used were screening protocol methods; therefore, the analytical results are comparable to that obtained in the E.C. Jordan Co. screening program.

Two of the 59 facilities selected for sampling by the E.C. Jordan Co. were not visited during the verification program. At one of the mills union employees were on strike; at the other mill, the aeration system was being dredged causing much higher levels of solids then normally experienced. No adequate replacement mills were available. It was decided to review all data prior to making a determination of whether additional sampling or substitutions would be necessary.

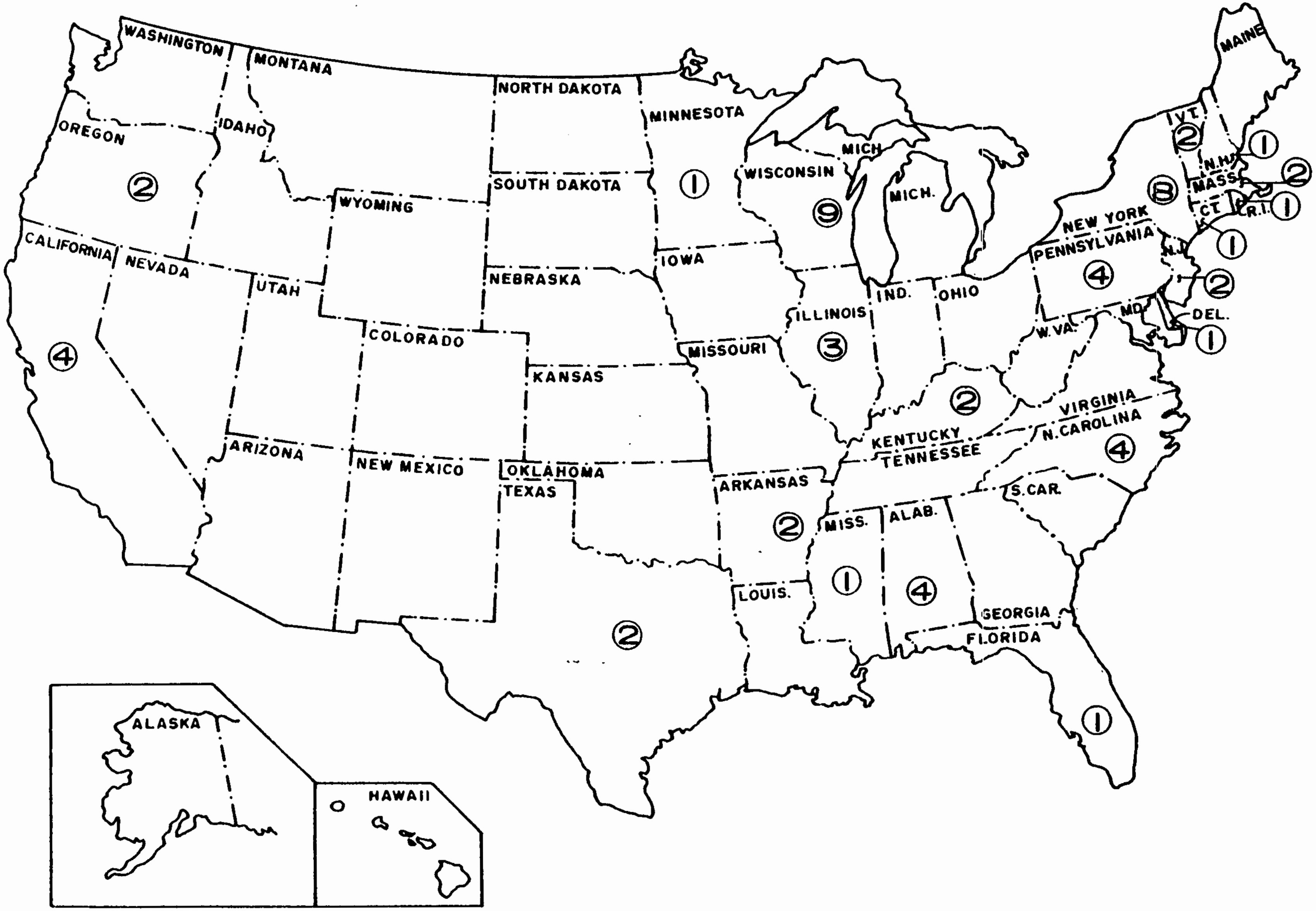
Table II-8 lists the preliminary subcategories included in the verification sampling program, and shows the total number of mills surveyed in each subcategory. The geographical distribution of the verification program surveys is shown on Figure II-2.

TABLE II-8

VERIFICATION PROGRAM SUMMARY OF MILLS SAMPLED

Subcategory	Number of Mills Surveyed E.C. Jordan	Number of Mills Surveyed Agency Regional S&A's	Total Mills Surveyed
011 Alkaline-Dissolving	0	1	1
012 Alkaline-Market	2	2	4
013 Alkaline-BCT	3	2	5
014 Alkaline-Fine	3	2	5
015 Alkaline-Unbleached	3	4	7
016 Semi-Chemical	2	1	3
017 Alkaline-Unbleached and Semi-Chemical	2	1	3
019 Alkaline-Newsprint	0	1	1
021 Sulfite-Dissolving	0	3	3
022 Sulfite-Papergrade	4	1	5
032 Thermo-Mechanical Pulp	0	2	2
033 Groundwood-CMN	1	1	2
034 Groundwood-Fine	2	0	2
101 Deink-Fine and Tissue	3	0	3
102 Deink-Newsprint	1	0	1
111 Wastepaper-Tissue	3	0	3
112 Wastepaper-Board	6	4	10
113 Wastepaper-Molded Products	2	0	2
114 Wastepaper-Construction Products	4	2	6
201 Nonintegrated-Fine	3	0	3
202 Nonintegrated-Tissue	2	0	2
204 Nonintegrated-Lightweight	1	0	1
205 Nonintegrated-Filter and Nonwoven	2	0	2
211 Nonintegrated-Paperboard	2	0	2
*Integrated-Miscellaneous	3	3	6
*Secondary Fiber-Miscellaneous	0	1	1
*Nonintegrated-Miscellaneous	3	1	4
Total	57	32	89

*Groupings of miscellaneous mills - not subcategories.



LEGEND

① CONTRACTOR SURVEYS

FIGURE II-2
LOCATION OF VERIFICATION PROGRAM
MILL SURVEYS

Sampling Program. The purpose of the verification program surveys was to verify the presence of and quantify those toxic and nonconventional pollutants detected during the screening program. The verification program surveys were to provide a more thorough examination of the possible process sources of toxic and nonconventional pollutants discharged; the quantity discharged to the biological treatment system; the levels in the final mill effluent; and the relative efficiency of the treatment system for removing specific compounds. Several different sampling procedures were examined for accomplishing these goals. Table II-9 presents the general format for sampling in particular subcategories which were chosen to meet the verification program goals. This table presents the sample points and the sample duration proposed for each.

Representatives of the selected mills were contacted by telephone, and a confirmation letter was sent verifying the scheduled survey. This confirmation letter submitted two separate forms which detailed the data requests for the survey period and for identification of management practices as they relate to Section 304(e) of the Clean Water Act of 1977.(19)

A "Verification Program Work Booklet", similar to the "Screening Program Work Booklet", was developed prior to initiation of the sampling surveys.(20) The work booklet detailed the specific procedures to be followed during the survey period.

The survey included collecting composite and grab samples during the 3-day survey. Composite sampling was normally performed for three separate 24-hr periods at each sample location. However, certain internal sewers were monitored, usually for one 24-hr period. Compositing usually started between 8:00 and 11:00 a.m. on the first day of the survey and ended 24 hours later. Table II-10 shows the work items performed during each day of a typical verification survey.

Composite sampling was performed using a model 1580 ISCO superspeed automatic sampler, except for the raw water sample which was done manually.

After completing one 24-hr period, the composite sample was divided as follows:

1. metals and color;

2. extractable organics;

3. COD;

4. PCB's and pesticides (where appropriate); and

5. ammonia (where appropriate).

After dividing the sample, the composite sample container was thoroughly rinsed with blank water, and the sampling was resumed for the next 24-hr period. Internal sewers were not sampled for COD.

TABLE II-9

VERIFICATION PROGRAM SAMPLING POINTS

Subcategory	Type of Samples	Duration of Sampling (days)
Bleached Kraft/Sulfite Mills		
1. Raw Water	Grab Samples (3 per day)	3
2. Pulp Mill/Screening	24-hr composite	1
3. Bleach Plant	24-hr composites	3
4. Secondary Treatment Influent	24-hr composites	3
5. Final Effluent	24-hr composites	3
Groundwood Mills		
1. Raw Water	Grab samples (3 per day)	3
2. Pulp Mill/Screening	24-hr composite	1
3. Secondary Treatment Influent	24-hr composites	3
4. Final Effluent	24-hr composites	3
Unbleached Kraft/Semi-Chemical Mills		
1. Raw Water	Grab Samples (3 per day)	3
2. Pulp Mill/Screening	24-hr composite	1
3. Secondary Treatment Influent	24-hr composites	3
4. Final Effluent	24-hr composites	3
Secondary Fiber Mills		
1. Raw Water	Grab samples (3 per day)	3
2. Stock Preparation	24-hr composites	3
3. Secondary Treatment Influent	24-hr composites	3
4. Final Effluent	24-hr composites	3
Builders Paper Mills		
1. Raw Water	Grab samples (3 per day)	3
2. Saturating	24-hr composites	3
3. Secondary Treatment Influent	24-hr composites	3
4. Final Effluent	24-hr composites	3
Paperboard From Wastepaper Mills & Nonintegrated Mills		
1. Raw Water	Grab Samples (3 per day)	3
2. Secondary Treatment Influent	24-hr composites	3
3. Final Effluent	24-hr composites	3

TABLE II-10

TYPICAL VERIFICATION SAMPLING PROGRAM SURVEY

Day 1 of the Survey	Day 2 of the Survey	Day 3 of the Survey	Day 4 of the Survey
1. Meet with mill personnel and discuss the program	1. Distribute 24 hour composite between the required composite samples	1. Distribute 24 hour composite between the required composite samples	1. Distribute 24 hour composite between the required composite samples
2. Select sample locations	2. Rinse sample composite container and start automatic sampler for the next 24 hr period	2. Rinse sample composite container and start automatic sampler for the next 24 hr period	2. Break down automatic sampler at each location and pack equipment
3. Discuss mill's management practices and tour mill to observe the items covered	3. Collect all grab samples required	3. Collect all grab samples required	3. Final meeting with mill personnel to wrap up the survey
4. Set up the automatic samplers	4. Take pH and temperature readings at each sample location twice during 24 hours	4. Take pH and temperature readings at each sample location twice during 24 hours	4. Pack samples in ice and ship to the appropriate laboratory
5. Collect all grab samples required	5. Check automatic samplers periodically and keep composite sample container iced	5. Check automatic samplers periodically and keep composite sample container iced	
6. Take pH and temperature readings at each sample point twice during 24 hours			
7. Check automatic samplers periodically and keep composite sample container iced			

Grab samples were taken once per day at each of the sample locations including the raw process water. The grab samples included the following samples:

1. volatile organics;

2. mercury; and

3. cyanide (where necessary).

An attempt was made to obtain grab samples directly from the sample location; however, the sample location often required that personnel use the ISCO sampler to safely collect the grab sample (i.e., limited access).

The raw water composite sample consisted of three 1-litre grabs per day over the 3-day survey period. At the completion of the survey the 1-litre containers were emptied into a 3-gallon composite container and mixed thoroughly, prior to dividing the sample among the required sample containers.

Temperature and pH readings were taken at least three times per day at each of the sample locations.

Split Sampling Program. As with the screening program, representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) obtained split samples. The NCASI shipped the necessary sample containers to the mills. The E.C. Jordan Co.'s sampling team collected the samples for NCASI and returned them to the mill personnel for shipment to the appropriate NCASI laboratory for analysis. The NCASI split sampling effort did not include collection of all of the samples collected by the E.C. Jordan Co. sampling team at each mill. Generally the NCASI samples were collected as follows:(21)

Parameter	Raw Water	Influent to Treatment	Final Effluent
Extractable Organics	Day 3 of Survey	Day 1 of Survey	Day 2 of Survey
Resin Acids	-	-	Day 1 of Survey
Metals	Day 3 of Survey	Day 2 of Survey	Day 3 of Survey
Mercury	"	-	"
Volatile Organics	"	Day 2 of Survey	"
Cyanide	Day 2 of Survey	-	Day 2 of Survey

Analytical Methods for Verification Program Analysis. Samples collected for the verification program were analyzed by the E.C. Jordan Co. and Gulf South Research Institute (GSRI) in New Orleans, Louisiana. Analysis undertaken by E.C. Jordan Co. included metals, mercury, cyanide, ammonia, color and COD. GSRI analyzed the samples from each verification mill for 15 volatile (VOA), and 33 extractable organic pollutants. Included in the extractable organics were 13 resin and fatty acids and bleach plant derivatives, nonconventional pollutants specific to the pulp, paper, and paperboard industry. In addition, samples from mills utilizing wastepaper as a source of raw material were analyzed by GSRI for PCB's.

Analysis By E.C. Jordan Co. Copper, chromium, lead, nickel, zinc and mercury were analyzed by the same procedures described earlier in the screening program analysis methods.

Cyanide was analyzed in accordance with the total cyanide method described in the 14th edition of Standard Methods.(22) Ammonia was analyzed by distillation and Nesslerization as described in the same edition of Standard Methods.(22) Color was analyzed in accordance with the procedures set forth in the National Council of the Paper Industry for Air and Stream Improvement (NCASI) Technical Bulletin Number 253.(23) Chemical oxygen demand (COD) was analyzed in accordance with the procedures presented in the 14th edition of Standard Methods.(22)

Analysis By GSRI. The analytical procedures conducted by GSRI in the analysis of the toxic organic pollutants were a modification of the procedures detailed in EPA's screening program document.(18) Gas chromatography mass spectrometry (GC/MS), interfaced with a computer system was the primary analytical instrument for volatile and extractable organic analysis.

The computer system interfaced with the mass spectrometer allowed acquisition of continuous mass scans throughout the chromatogram. Standards were obtained for each pollutant to be assayed in the samples and the mass spectrum for each of these standards was determined daily throughout the analysis program. The computer software was capable of searching a GC/MS run for specific ions and plotting the intensity of the ions with respect to time. The standard spectra provided the retention time and characteristic ions for each compound of interest. The characteristic ions for a pollutant maximize in the same mass spectrum when the compound is eluted from a GC column, and comparing the chromatographic and mass spectral data recorded for each sample with chromatographic and mass spectral data of toxic pollutant standards, it was possible to identify and quantify the organic pollutants present. In general, to confirm the presence of a compound it was necessary that the retention time agree with standard data within ± 1 minute, and that the relative intensities of the characteristic ions agree with standard data within ± 20 percent.

Volatile Organic Analysis

Duplicate 125-ml samples were collected at each sampling point for volatile organic analysis (VOA). Volatile samples were checked for chlorine content in the field and preserved with sodium thiosulfate as necessary. Volatile organic analysis utilized the purge and trap method, which is a modified gas sparging-resin adsorption technique, followed by thermal desorption and analysis by packed column GC/MS, as outlined above.

Extractable Organic Analysis

The E.C. Jordan Co. provided duplicate 1-litre samples of wastewaters for analysis of extractable organic compounds. Extractable organic samples were preserved in the field with sodium hydroxide to a pH of approximately 10 or higher. For extractable organic analysis, the sample was acidified to a pH of 2 or below, extracted with methylene chloride, concentrated, and chromatographed on a GC/MS system equipped with a support coated open tubular (SCOT) capillary column.

Extracts prepared for PCB analysis were analyzed by electron capture detection/gas chromatography (EC/GC). Extracts in which PCB's were detected were confirmed by GC/MS.

Quality Control/Quality Assurance

The verification program included the implementation of a quality control/quality assurance (QC/QA) program consisting of internal standards, field blanks, method blanks, and replicate analysis. Deuterated internal standards were selected to provide QC/QA data on primary groups of pollutants under evaluations in the verification program. The deuterated compounds selected are shown in Table II-11. These compounds were selected because of their similarity to the compounds under investigation. By adding deuterated internal standards to each sample analyzed by GC/MS, it was possible to assess system performance on a per-sample basis. Upon completion of each GC/MS analysis, the characteristic ions of the internal standards were profiled with extracted ion currents. The area of the 100 percent ion for each standard was integrated and a judgment was made on the validity of the analysis.

Recovery of the internal standards in the volatile organic analysis assured that the apparatus was leakproof and that the analysis was valid. For extractable organic analyses, percent recoveries of the internal standards indicated the complexity of the sample matrix and the validity of the analysis. In each case, low recovery of internal standards signalled possible instrument malfunction or operator error; if low recovery occurred, the analysis was repeated.

To demonstrate satisfactory operation of the GC/MS system, the mass spectrometers were tuned each day with perfluorotributylamine (PFTBA) to optimize operating parameters according to the manufacturer's specifications. Calibration logs were maintained to document instrument performance. The entire GC/MS system was further evaluated with the analysis of a composite standard which contained all pollutants of interest and the various deuterated internal standards. This standard was analyzed with each sample set or with each change in instrument calibration/tune. This daily analysis of the composite standard supplied data which 1) verified the integrity of the chromatographic systems, 2) produced acceptable low-resolution mass spectra of the compounds assayed, and 3) verified machine sensitivity.

The field and method blanks were included in the analytical program to indicate possible sample contamination and confirm analytical methodologies. Field blanks were spiked with deuterated internal standards. Method blanks were spiked with the deuterated internal standards and standards for compounds under evaluation, as discussed previously. The

TABLE II-11

SUMMARY OF INTERNAL STANDARDS

Volatile*	
	Methylene chloride-d2
	1,2-dichloroethane-d4
	1,1,1-trichloroethane-d3
	benzene-d3
	toluene-d3
	p-xylene-d10
Extractable	
	phenol-d5-TMS
	naphthalene-d8
	diamylphthalates-d0
	stearic acid-d35-TMS

*Relative to benzene-d3

mass spectrum for each of these standard compounds was determined daily throughout the analysis program. The blanks provided additional quality assurance, including: 1) data on clean matrix recoveries; and 2) replicate analysis for precision determinations.

Data Analysis

The data analysis task is a multi-fold program bringing together data obtained from each task previously outlined, including:

- existing data evaluation;
- screening data;
- industry profile and subcategorization; and
- verification data.

Industry data gathered through the data request program has been utilized extensively in reviewing subcategorization and profiling the industry. Factors considered in these efforts have been presented previously and are reported on in subsequent sections of the report. These efforts have included profile developments for production process controls and effluent treatment systems.

As outlined previously, several areas of existing data have been evaluated. These efforts have included assessment of the reduction/removal capabilities of the production process controls and effluent treatment technology for conventional toxic, and nonconventional pollutants.

In the verification program sampling data was gathered for toxic and nonconventional pollutants. This data presented in Section V has recently been finalized and may now be evaluated and analyzed to quantify the level of toxic and nonconventional pollutant discharge in the pulp, paper and paperboard industry. Additional evaluations will include determining the effectiveness of various control and treatment systems in removing the toxic and nonconventional pollutants.

During the verification program the Jordan Company requested long-term data at each of the 57 surveyed mills for the conventional pollutants. This data was obtained to analyze the effectiveness of in-place BPCTCA technology, as well as statistically quantify the variability in effluent quality. The data has been evaluated to determine if sufficient data were obtained in the verification program to complete the analysis. Initial reviews of the data have determined that it will be necessary to supplement the current conventional pollutant data base. The EPA is currently developing a strategy to request the supplemental information.

Analysis of Treatment Alternatives

As a result of the literature reviews, numerous available production process controls and effluent treatment systems have been identified. These processes and systems for reduction/removal of the conventional, nonconventional and toxic pollutants include those:

- in place within the pulp, paper, and paperboard industry; and
- at laboratory, pilot plant and/or demonstration levels within an industrial category including pulp, paper, and paperboard.

This data, along with the data developed through the screening and verification program, has been analyzed to determine reduction/removal capabilities of the control and treatment technologies.

The production process controls and effluent treatment technology under evaluation and their area of application are presented in Table II-12.

Based on the technical investigations the EPA will develop effluent limitations guidelines and standards of performance for the pulp, paper and paperboard point source category. In developing the limitations and standards EPA must consider the environmental benefit and economic impact of the proposed regulations. This project task has quantified the reduction/removal capabilities of numerous control and treatment strategies. In order to complete the assessment outlined above, four levels of control have been developed. Based on the application of the specified technologies, predicted effluent qualities are presented in Section VIII. Subsequent evaluations and analysis will be made in the forthcoming months. The suggested available production process controls are discussed in detail in Section VI and effluent treatment technologies are described in Section VII.

Analysis of Cost and Energy Data

Previous project tasks have described production process controls and effluent treatment technologies available for implementation. The technologies have been investigated to develop four levels of control which represent the range of effluent quality under investigation. As part of the program, the E.C. Jordan Co. has addressed the cost, energy, and non-water-quality aspects of the technology.

Because the pulp, paper and paperboard industry is diverse, the "model mill" concept has been used to address the cost for implementation of the identified technology. Several model mill sizes have been developed for each subcategory.

Through the data assessment phase, mill surveys, and EPA data requests, baseline data has been gathered for analysis. Data obtained and evaluated includes: 1) age of mill; 2) production process controls employed; 3) effluent treatment technology employed; 4) cost for the technology employed (if available); 5) site conditions, i.e., ledge, poor soils, etc.; and 6) land avail-

TABLE II-12

PRODUCTION PROCESS CONTROLS AND EFFLUENT TREATMENT TECHNOLOGY

Production Process Controls:

1. Woodyard/Woodroom
a. Close-up or dry woodyard and barking operation
b. Segregate cooling water

2. Pulp Mill
a. Reuse relief and blow condensates
b. Reduce groundwood thickener overflow
c. Spill collection

3. Washers and Screen Room
a. Add 3rd or 4th stage washer or press
b. Recycle more decker filtrate
c. Reduce cleaner rejects and direct to landfill
d. Replace sidehill screens

4. Bleaching
a. Countercurrent or jump stage washing
b. Evap. caustic extract filtrate

5. Evaporation and Recovery Areas
a. Recycle condensate
b. Replace barometric condenser
c. Boil out tank
d. Neutralize spent sulfite liquor
e. Segregate cooling water
f. Spill collection

Other Technologies
a. Oxygen bleaching process
b. Rapson/Reeves process
c. Oxygen pulping process

6. Liquor Preparation Area
a. Green liquor dregs filter
b. Lime mud pond
c. Spill collection
d. Spare tank

7. Papermill
a. Spill Collection
  1. Papermachine and bleached pulp spill collection
  2. Color plant
b. Improve saveall
c. High pressure showers for wire and felt cleaning
d. Whitewater use for vacuum pump seal water
e. Paper machine whitewater showers for wire cleaning
f. Additional whitewater storage for upsets and pulper dilution
g. Recycle press effluent
h. Reuse of vacuum pump water
i. Broke storage
j. Wet lap machine
k. Separate cooling water
l. Cleaner rejects to landfill

8. Steam Plant and Utility Areas
a. Segregate cooling water
b. Lagoon for boiler blowdown & backwash waters

9. Recycle of Effluent
a. Filtrate
b. Sludge

Effluent Treatment Technology

1. primary clarification
2. biological treatment
   a. activated sludge
   b. aerated stabilization basin
3. chemically assisted clarification
4. foam separation
5. carbon adsorption
6. steam stripping
7. reverse osmisis
8. filtration
9. dissolved air flotation
10. ultrafiltration
11. resin separation and ion exchange
12. amine
13. electro-chemical

ability. Such data has been retrieved from the industry profile and used to characterize a model facility.

In developing cost data for the production process controls and effluent treatment, construction materials were estimated in 1978 dollars. Equipment and material suppliers were contacted for cost estimates. Installation, labor, and miscellaneous costs for such items as electrical, instrumentation, and contingencies have been added to determine a total construction cost, depending on the controlling parameters. The cost data that has been developed is discussed in Section IX of this report.

As part of this work task the E.C. Jordan Co. has evaluated baseline energy consumption and also the increase resulting from implementation of the technology levels. Data developed through the EPA data request has been used in establishing this baseline. Energy consumption data is presented in Secton IX of this report.

SECTION III

THE PULP AND PAPER INDUSTRY

INTRODUCTION

With approximately 730 operating mills, the pulp, paper and paperboard industry is one of the largest industries in the United States. The mills vary in size, age, location, raw material usage, products manufactured, production processes, and effluent treatment systems. This highly diversified industry comprises not only the primary production of wood pulp and paper, but also the use of such nonwood pulp materials such as asbestos, jute, hemp, rags, cotton linters, bagasse and esparto. Included are mills which produce only pulp, mills which produce both pulp and paper products, and mills which produce only paper products from pulp manufactured elsewhere. Also included in this industry are mills which use secondary fibers (usually waste paper) to produce paper and paperboard products.

End-products of the industry include stationery, tissue, printing newspaper, boxes, builders' papers, and numerous other grades of industrial and consumer papers. The industry is highly sensitive to changing demands for paper and paperboard products, and is constantly adjusting to changes in market conditions. Mills frequently expand or modify their operations to accommodate different raw materials, or new product demands.

BASIC PRODUCTION PROCESSES

Raw Material Preparation

Mills which produce pulp on-site must first prepare raw materials for the pulping process. During the nineteenth century, wood began to supplant cotton and linen rags, straw, and other less plentiful fiber sources as a raw material for the manufacture of paper products. Today, wood is the most widely used fiber source for the pulp, paper and paperboard industry. Wood accounts for over 98 percent of the virgin fiber sources used in papermaking.

Steps which may be required to prepare wood for pulping include log washing, bark removal and chipping. A mill may use all these steps, or none of them, depending on the form in which the raw materials arrive at the mill.

Pulping

There are several methods for pulping wood. In some, the wood is cooked with chemicals under controlled conditions of temperature, pressure, time and cooking liquor composition.(24) These processes use different chemicals or combinations of them. Other methods reduce the wood to a fibrous state by mechanical means alone, or by the combination of chemical and mechanical action. The primary types of pulping process employed are: 1) mechanical pulping (groundwood); and 2) chemical pulping (alkaline, sulfite or semi-chemical processes).

Mechanical Pulping. Mechanical pulp is commonly known as groundwood. There are two basic processes: 1) stone groundwood, in which pulp is made by tearing fiber from the side of short logs (called billets) with a grindstone; and 2) refiner groundwood, in which pulp is produced by passing wood chips through a disc refiner.

In the chemi-mechanical modification of the process, wood is softened with chemicals to reduce the power required for grinding. In a new process called thermo-mechanical pulping, chips are first softened with heat and then refined under pressure.

The resulting mechanical pulps are obtained at a high yield, generally over 90 percent of the original substrate. The pulp produced is relatively inexpensive and it requires minimal use of forest resources. However, the process does not remove most of the natural wood binder (lignin) and resin acids inherent in the wood; therefore, mechanical pulp deteriorates quite rapidly. The pulp is suitable for use in a wide variety of consumer products including newspapers, tissue, catalogs, one-time publications, and throw-away molded items. An observable yellowing, resulting from natural oxidation of the impure cellulose, is noted early in the life of such papers, and a physical weakening soon occurs. Thus, the use of extensive quantities of groundwood in higher quality grades of paper requiring permanence is not generally permissible.

Chemical Pulping. Chemical pulping involves controlled conditions and chemicals to yield a variety of pulps with unique properties for conversion into paper products that have high quality standards or require special properties. There are three basic types of chemical pulping: 1) alkaline; 2) sulfite; and 3) semi-chemical.

Alkaline Pulping

The initial alkaline pulping process developed in the nineteenth century was the soda process. This was the alkaline forebearer of the kraft process, which produces a stronger pulp and is currently the dominant pulping process in the world. At the current time, only two soda mills in the United States have not converted to the kraft process.(25)

Early in the twentieth century, the kraft process became the major competitor of the sulfite process for some grades of pulp. Kraft pulp now accounts for over 80 percent of the chemical pulp produced in this country. Sulfite is still preferred for some grades of products, but the role of kraft continues to increase, while sulfite production is declining.

Several major process modifications/achievements have resulted in widespread application of the kraft process. First, because of the increasing cost of chemicals used, chemical recovery became an economic necessity of this process. In the 1930's, successful recovery techniques were applied and have since been vastly improved. Second, the process was found to be adaptable to nearly all wood species. Its application to the pulping of southern pines resulted in a rapid expansion of kraft pulping.(25) Third, new developments in the kraft bleaching techniques (primarily use of chlorine dioxide) spurred another dramatic growth period in the late 1940's and early 1950's. This bleaching agent, for the first time, enabled production of high brightness kraft pulps, with good strength retention in simplified bleach sequences of four or five stages.

Sulfite Pulping

Sulfite pulps are associated with the production of both tissue and fine papers. In combination with other pulps, sulfite pulps have many papermaking capabilities. In addition, dissolving pulps (i.e., the highly purified chemical cellulose used in the manufacture of rayon, cellophane and explosives) were produced solely by the sulfite process for many years.

Sulfite pulping developed using calcium (lime slurries sulfited with sulfur dioxide) as the sulfite liquor base, because of an ample and inexpensive supply of limestone (calcium carbonate). The use of calcium as a sulfite base has declined in recent years because: 1) it is difficult and expensive to recover or burn spent liquor from this base; 2) the lack of spent liquor recovery makes it difficult to comply with water quality standards and effluent limitations; and 3) the availability of softwoods, which are most suitable for calcium-base pulping, is diminishing.(26)(27) In addition, attempts to use more than about 10 percent of the spent liquor in various byproducts failed. As a result, most calcium-base sulfite mills have changed to a soluble base (magnesium, ammonia, or sodium), which permit recovery or incineration of the spent liquor.

In recent years, some sulfite mills have been switched to the kraft pulping process.(27)(28) In addition, several sulfite mills have shut down rather than install recovery/incineration technology or convert to other pulping processes. During the EPA Survey Program, only six papergrade mills used a calcium base; three employed magnesium, eight used ammonia, and one used a sodium and calcium mixed base.

Semi-Chemical Pulping

The early applications of the semi-chemical process in the nineteenth century consisted of the cooking of chips with a neutral or slightly alkaline sodium sulfite solution. This is termed neutral sulfite semichemical (NSSC) pulping. In the 1920's, the U.S. Forest Products Laboratory demonstrated the advantages of NSSC pulping. The first NSSC mill began operation in 1925 for production of corrugating board.(25)

The NSSC process gained rapid acceptance because of its ability to utilize the vast quantities of inexpensive hardwoods previously considered unsuitable for producing quality pulp.(29) Also, the quality of stiffness which hardwood NSSC pulps impart to corrugating board, and the large demand for this material have promoted a rapid expansion of the process.(25)

The future of NSSC pulping depends on the development of economic chemical recovery systems and nonpolluting chemical disposal. In the past, the small size of mills, the low organic content and heat value of the spent liquor, and the low cost of cooking chemicals provided little incentive for large capital investment for NSSC chemical recovery plants.(25) Somewhat lower cost fluidized bed recovery systems have been extensively used in these mills. However, with NH_3 base, only SO_2 recovery is practiced, so recovery economics are marginal with sodium base a by-product saltcake is obtained, which cannot be recycled. Sales of this material to alkaline pulp mills have been very limited because of variable composition.

Advances have been made in semi-chemical pulping process technology with respect to liquor recovery systems. There are basically three no-sulfur semi-chemical processes: 1) the Owens-Illinois process; 2) the soda ash process; and 3) the modified soda ash process. The present use of the patented Owens-Illinois soda ash-caustic pulping process permits ready recovery of sodium carbonate. With either a balanced caustic make-up or selective recausticizing, a balanced pulping liquor is assured. Their process uses 15 to 50 percent caustic as Na_2O, with the remainder consisting of soda ash. Spent liquor is burned in a modified kraft-type furnace or fluidized bed. Traditionally, the difficulty has been in reclaiming sodium sulfite from normal liquors made up of both sodium carbonate and sodium sulfite.

In the soda ash process, soda ash is used at 6 to 8 percent, based on the wood. Spent liquor is burned in a fluidized bed, and the soda ash is recovered. Caustic make-up provides a balanced pH liquor for reuse.

The modified soda ash process uses a small amount of caustic along with the soda ash, typically 7 to 8 percent NaOH (as Na_2O).(30) There are valid reasons for mills to convert from the standard NSSC pulping process:

1. A poor market for the saltcake (Na_2SO_4) byproduct derived from fluidized bed recovery of NSSC liquors.

2. High make-up chemical costs, as saltcake cannot be reused in the NSSC process, and sodium sulfite is not produced in most recovery schemes.

3. Sulfur emission problems result from burning the waste liquors.

There has been a significant increase in combined alkaline semi-chemical mills with cross-recovery liquor systems. A balanced operation, using the semi-chemical side for total mill chemical make-up, permits a ratio of about 4:1 kraft:NSSC (or comparable). Use of green liquor as part of the semi-chemical cooking liquor gives a new flexibility to balanced operations, and it permits greater semi-chemical production while maintaining a balanced liquor system.

Use of Secondary Fibers

In recent years, secondary fiber sources such as waste paper of various classifications have gained increasing acceptance as a raw material fiber source. Many uses of such secondary fiber allow its use without processing. Other uses, however, require that the reclaimed waste papers be deinked prior to use. In 1976, more than 22 percent of the fiber furnish in the U.S. was derived from waste paper.

Non-Deink Waste Paper Applications. Some waste paper can be used with little or no preparation, particularly if the waste paper is purchased directly from other mills or converting operations producing a similar product grade. Such material is usually relatively free of dirt and can sometimes be directly slushed or blended with other virgin pulps to provide a suitable furnish for the papermachine. The only cleaning and screening performed in such applications would occur with the combined stock in the papermachine's own stock preparation system.

Mills making low quality paper products, such as industrial tissue, coarse consumer tissue, molded items, builders' papers and many types of paperboard, may rely extensively on waste paper in the raw material furnish. Such operations typically involve a dispersion process using warm recycled papermachine whitewater, followed by coarse screening to remove gross contamination and debris which may have been received with the waste paper. More extensive fine screening and centrifugal cleaners may then be used before the papermaking step.

Higher quality products such as tissue, printing and other quality grades, may use small percentages of waste paper. These products require clean, segregated waste paper and a more extensive preparation system, usually including a deinking system.

Deinking. Deinking of waste paper was in commercial application during the nineteenth century. However, the large-scale operations existing today developed much more recently. Materials which must be removed in order to reclaim a useful pulp include ink, fillers, coatings and other noncellulosic materials. Deinked pulp is used in business, bank and printing papers, tissue and toweling, as a liner for some paperboards, and in molded products and newsprint.

The existing use of detergents and solvents, instead of harsh alkalis, has permitted effective reuse of many previously uneconomical types of waste paper. Similar advances, such as flotation deinking and recovery of waste sludge by centrifuges, may yield more effective deinking processes with inherently lower waste loads as development proceeds.

Presently, however, the secondary fiber field is critically dependent upon balancing available waste paper type (pre-or post-consumer) with the demands of the product produced. Upgrading is difficult and costly, with inherently high discharge of both BOD_5 and TSS to ensure adequate deinked pulp quality.

Bleaching

After pulping, the unbleached pulp is brown or deeply colored because of the presence of lignins and resins and sometimes because the inefficient washing of the spent cooking liquor from the pulp. In order to remove these color bodies from the pulp and produce a light colored or white product, it is necessary to bleach the pulp.

The degree of bleaching pulp for paper manufacture is measured in terms of units of brightness and is determined optically using methods established by the Technical Association of the Pulp and Paper Industry (TAPPI).(31) Partially bleached pulps (semi-bleached) are employed in making newsprint, food containers, computer cards, and similar papers. Fully bleached pulp is used for white paper products. By different degrees of bleaching, pulp of the desired brightness can be manufactured up to a level of 96 on the brightness scale of 100. These techniques are described in detail in a TAPPI monograph.(32)

Bleaching is frequently performed in several stages in which different chemicals are applied. The symbols commonly used to describe a bleaching sequence are shown and defined in Table III-1. The table can be used to interpret bleaching "shorthand", which is used extensively in later sections of this report. For example, a common sequence in kraft bleaching, CEDED, is interpreted as follows:

C = chlorination and washing;
E = alkaline extraction and washing;
D = chlorine dioxide addition and washing;
E = alkaline extraction and washing; and
D = chlorine dioxide addition and washing.

Almost all sulfite pulps are bleached, but usually a shorter sequence such as CEH is sufficient to obtain bright pulps from this lower yield product with an inherently lower residual lignin content. This sequence involves chlorination, alkaline extraction, and hypochlorite application, each followed by washing.

Papermaking

Some mills manufacture paper and/or paperboard, but do not make pulp. These are called nonintegrated paper mills, and the pulp they use is either shipped from another of the company's facilities or is purchased. Pulp mills which do not have attendant papermaking operations are a major source of pulp for these nonintegrated mills. Pulp may also be provided by integrated mills which produce pulp for their own papermaking, plus "market" pulp for sale to nonintegrated operations.

TABLE III-1

BLEACHING SYMBOLS

Symbol	Bleach Chemical or Step Represented by Symbol
A	Acid Treatment or Dechlorination
C	Chlorination
D	Chlorine Dioxide
E	Alkaline Extraction
H	Hypochlorite
HS	Hydrosulfite
O	Oxygen
P	Peroxide
PA	Peracetic Acid
W	Water Soak
( )	Simultaneous Addition of the Respective Agents
/	Successive Addition of the Respective Agents Without Washing in Between

The papermaking process has basic similarities regardless of the type of pulp used or the end-product produced. A layer of fiber is deposited from a dilute water suspension of pulp on a fine screen, called the "wire", which permits the water to drain through and retains the fiber layer.(25) This layer is then removed from the wire, pressed, and dried. Two basic types of papermachines and variations thereof are commonly employed. One is the cylinder machine in which the wire is on cylinders which rotate in the dilute furnish. The other is the fourdrinier in which the dilute furnish is deposited upon an endless wire belt. Generally, the fourdrinier is associated with the manufacture of paper, and the cylinder with heavier paperboard grades.

PRODUCTION PROFILE

Pulp

Many types of pulp are manufactured. Some are naturally more suitable for certain paper grades than others. Suitability is influenced by fiber length, strength and other factors which can be controlled by the type(s) of wood employed, the selection of a pulping process, cooking chemicals, cooking time and other variables. With improved techniques and the ability to mix pulps to achieve desired properties, few paper grades are a product of one pulp only.

The total daily pulp production listed in Table III-2 has been tabulated by pulp type. These figures represent the best estimates which can be made utilizing published information and data gathered during the course of the project.

TABLE III-2

ESTIMATED PULP PRODUCTION - 1977 (33, 34)

Pulp Type	Production (short tons x 1,000)
Dissolving and Special Alpha	1,465
Sulfite-Bleached	1,653
-Unbleached	389
Alkaline-Bleached	14,929
-Semi-Bleached	1,523
-Unbleached	18,411[a]
Groundwood	4,481
Semi-Chemical	3,876[a]
Other Mechanical	2,941[a]
Screenings	110
TOTAL	49,777
Market Pulp	4,881
Waste Paper Used	14,015

[a] Includes insulation and hard-pressed wood fiberboard not evaluated within the scope of this report.

Paper and Paperboard Products

The pulp, paper and paperboard industry manufactures a diversity of products. The various grades or types of products are delineated according to end use and/or furnish. The basic differences in the various papers include durability, basis weight, thickness, flexibility, brightness, opacity, smoothness, printability, strength and color. These characteristics are a function of raw material selection, pulping methods and papermaking techniques.

In addition to variations in stock preparation and sheet control on the papermachine, the papermaking operation may enhance the basic qualities of paper, or achieve other properties (e.g., wet strength, greaseproofness, printing excellence) through the use of additives. These additives include a variety of substances such as starch, clay, and resins used as fillers, sizing, and coatings.

Table III-3 presents a general list of the various products produced by the industry. The grades listed are, for the most part, self-explanatory. Definitions according to industry usage may be found in the publication, Paper & Pulp Mill Catalog and Engineering Handbook 1978, by Paper Industry Management

TABLE III-3

PAPER AND PAPERBOARD PRODUCTS OF INDUSTRY (34)

A. PAPER

I. PRINTING, WRITING AND RELATED
- a. Newsprint
- b. Groundwood paper, uncoated
  - 1. Publication and printing
  - 2. Miscellaneous groundwood
- c. Coated printing and converting
  - 1. Coated, one side
  - 2. Coated, two sides
- d. Book paper, uncoated
  - 1. Publication and printing
  - 2. Body stock for coating
  - 3. Other converting and miscellaneous book
- e. Bleached bristols, excluding cotton fiber, index, and bogus
  - 1. Tab, index tag and file folder
  - 2. Other uncoated bristols
  - 3. Coated bristols
- f. Writing and related papers not elsewhere classified
  - 1. Writing, cotton fiber
  - 2. Writing, chemical woodpulp
  - 3. Cover and text
  - 4. Thin paper

II. PACKAGING AND INDUSTRIAL CONV.
- a. Unbleached kraft packaging and industrial converting
  - 1. Wrapping
  - 2. Shipping sack
  - 3. Bag and sack, other than shipping sack
  - 4. Other converting
    - . Glassine, greaseproof and vegetable parchment
- c. Special industrial paper

III. TISSUE AND OTHER MACHINE CREPED
- a. Sanitary paper
  - 1. Toilet tissue
  - 2. Facial tissue
  - 3. Napkin
  - 4. Toweling, excluding wiper stock
  - 5. Other sanitary stock
- b. Tissue, excluding sanitary and thin

B. PAPERBOARD

I. SOLID WOODPULP FURNISH
- a. Unbleached kraft packaging and industrial converting
  - 1. Unbleached linerboard
  - 2. Corrugating medium
  - 3. Folding carton type
  - 4. Tube, can and drum
  - 5. Other unbleached packaging and industrial converting kraft
- b. Bleached packaging and industrial conv. (85% or more bleached fiber)
  - 1. Folding carton type
  - 2. Milk carton
  - 3. Heavyweight cup stock
  - 4. Plate, dish and tray
  - 5. Linerboard
  - 6. Tube, can and drum
  - 7. Other, including solid groundwood pulp board
- c. Semi-chemical paperboard

II. COMBINATION FURNISH
- a. Combination-shipping containerboard
  - 1. Linerboard
  - 2. Corrugating medium
  - 3. Container chip and filler
    - . Combination-bending
    - . Combination-nonbending
    - . Gypsum linerboard
    - . Special packaging and industrial conv.

III. CONSTRUCTION PRODUCTS
- a. Wet machine board
- b. Construction paper and board
  - . Construction paper

Association (PIMA). For purposes of this study, the many separate grades have been grouped under the following major classifications: newsprint, tissue, fine papers, coarse papers-packaging and industrial converting, paperboard, and construction products. Table III-4 presents 1977 production statistics for each major group.

TABLE III-4

PRODUCTION STATISTICS
PAPER AND PAPERBOARD PRODUCTS OF INDUSTRY (33)

Product	Short Tons x 10^3
Paper	
Newsprint	3,515
Tissue	4,097
Fine	13,929
Coarse - Packaging and Industrial Converting	5,740
Paperboard	27,881
Construction Products	5,567

Newsprint includes paper made largely from groundwood pulp, used chiefly in the printing of newspapers.

Tissue is set apart from other paper grades, and includes many different types of tissue and thin papers. These range from typical sanitary tissue products to industrial tissue which includes packing, wadding, and wrapping papers. Also many special purpose grades with unique process and product requirements such as glassine, greaseproof, electrical, and cigarette papers are produced.

Fine papers include printing, reproductive and writing papers.

Coarse papers-packaging and industrial converting include kraft packaging papers used for grocery and shopping bags, sacks and special industrial papers.

Paperboard includes a wide range of types and weights of products made on both cylinder and fourdrinier machines for packaging and special purposes, from lignin pulps, waste paper, or combination furnishes. Board products include such items as shoe board, automotive board, and luggage board.

Construction products include various paper and board products. Paper products include sheathing paper, roofing felts, and asbestos filled papers.

WATER USE AND POLLUTION CONTROL PROFILE

Significant progress has been made in reducing water use in the pulp, paper, and paperboard industry, as shown by the water use comparison in Table III-5.

TABLE III-5

TYPICAL WATER USE IN PULP, PAPER AND PAPERBOARD INDUSTRY

	1952(36) (kgal/t)	1968(35) (kgal/t)	BPT(37) (kgal/t)	1976* (kgal/t)
Alkaline	58.2	45.0	30.9	28.3
Sulfite	97.6	55.0	(44.5-53)	35.7
Groundwood	40.5	—	21.9	19.2
Deink	35.8	—	24.4	15.3
Semi-Chemical	21.0	—	(8.3-14.0)	17.8
Nonintegrated-Fine	44.9	18.0	15.2	16.1
Nonintegrated-Construction	8.7	—	—	3.2

*Average from response to data request program.

In 12 subcategories, average water use is now below earlier published BPT guidelines. In only three is it greater. The industry, of economic necessity, has learned to live with significantly less water use. This decrease usually accompanies internal modifications, which yield savings in fiber, chemicals, and heat. Over 20 years ago many integrated kraft fine paper mills used up to 89.7 kilolitres (kl) per thousand kilograms (kkg) of product, or about 93 thousand gallons (kgal) per ton (t); average water use was about 243 kl/kkg (58 kgal/t).(36) Today's average for that type of mill is about 125.7 kl/kkg (30 kgal/t).(36)

Figure III-1 schematically shows points of effluent discharge from a typical pulp and paper mill. The figure illustrates major unit operations for an integrated pulp and paper mill using a fully cooked, bleached wood pulp for making high quality printing, writing, business, or converting papers. However, it must be remembered that there are a wide variety of raw materials, processes, and products in this industry, and often multiple combinations of these at specific manufacturing sites.

High water use is clearly synonymous with the industry. Starting with the wood pulped, typically 50 percent of its weight is water. Large quantities of water can be required to wash dirt and debris from the logs and for chip preparation. In older mills, water is also used to convey logs through the woodyard. Water is used for cooling drive gears on conveyors, barking drums, and chippers. In total, up to 41.9 kl/kkg (10 kgal/t) with an average of 14.2 kl/kkg (3.4 kgal/t) of water is used in processing wood from tree length logs to clean chips suitable for cooking into chemical pulps, or for mechanical processing into groundwood type pulps.(35)

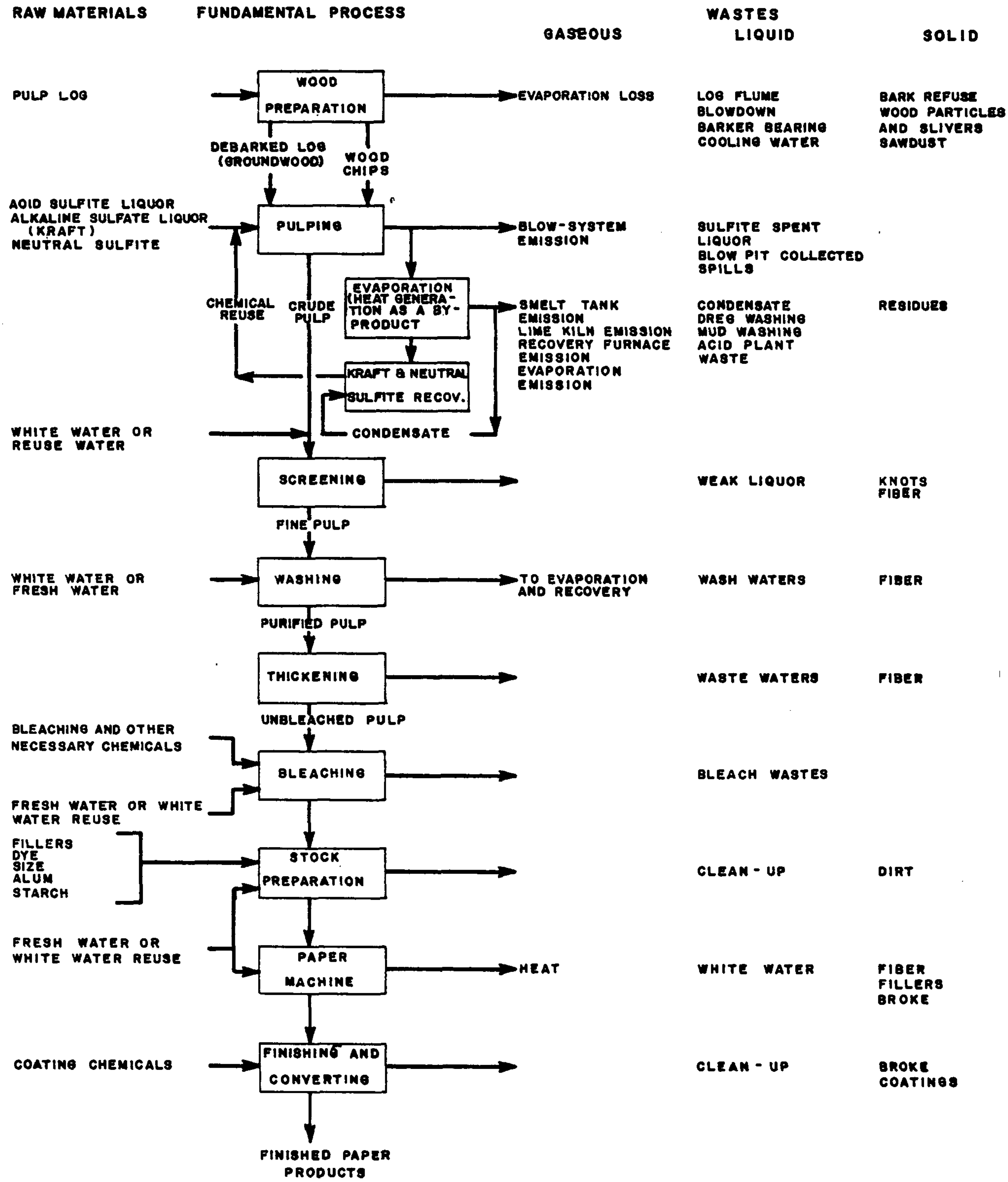


FIGURE III - 1
GENERAL FLOW SHEET
PULPING AND PAPERMAKING PROCESS

Effluent losses from woodyard operations include:

1. the log transport flume overflow;

2. log washing and debarking effluent; and

3. equipment cooling, lubrication and condensate streams.

Additionally, small losses occur as evaporation, particularly from log storage ponds and flumes.

Present operations include extensive recycle of water in the woodyard, and use of wastewater from other mill areas to convey and wash the wood. Wastewater used in this way can be treated in sedimentation ponds and/or strainers to remove waste bark, dirt and other debris. This allows continuous reuse of woodyard water for floating, washing and hydraulic barking operations. Removed woodyard solids are then discharged dry to landfill, and a very small load of BOD_5 and TSS remains, which may be discharged with the mill effluent.

Pulping Processes

As outlined previously, the two most common types of pulping processes are mechanical and chemical.

Chemical pulping uses controlled alkaline and acidic conditions to yield a variety of pulps with unique properties for conversion into paper products that have high quality standards and/or special properties.

There is little direct loss in the pulping process except for release of steam and vapors, which can be subsequently condensed and reused. Generally, except for accidental spills, leaks, or washups, losses of effluent from this area of the mill are minor in volume.

After cooking, the brown stock is washed and screened. Pulping liquors are clarified and the chemicals recovered for reuse. The likelihood of liquid loss in these operations is great. Extensive use is made of efficient countercurrent washing systems, as well as the use of excess weak effluents from other operations, such as papermaking. With such recycling, however, an upset in one area can create further process imbalances, often leading to generation of low-strength, but potentially high-volume loads of various cooking and recycled liquor streams. These loads can exceed the available storage capacity for the capabilities of in-line processing units such as black liquor evaporators. To avoid high-volume loads resulting from upsets, excess weak spent liquor, wash waters, alkaline streams from lime mud washing, and from other reclaim systems commonly have to be sewered. Storage system controls and surge control systems can reduce the effects of upsets while minimizing economic loss to the mill in terms of heat, cooking chemicals, and pulp quality.

Very few of today's chemical pulp mills operate without chemical and waste liquor recovery systems. Those which do not practice recovery are small mills or those with a low loss resulting from cooking wood or other fibers to a high yield. However, a few full cook sulfite mills still operate without recovery systems.

Any imbalanced flow in the pulp screening and washing operations may create excess weak black liquor. Losses can be minimized by providing sufficient storage capabilities in excess evaporator capacity. Even so, pulp loss may occur during startup, shutdowns, washups, and breakdowns. Unless pulp spill collection and reclaim systems are provided, such losses may overload waste treatment systems, while representing the economic loss of fiber and cooking chemicals to the manufacturer.

Th bleachery area is often a major contributor to the total effluent flow. However, with the exception of the first two bleaching stages, losses from succeeding bleachery stages are very low in terms of either dissolved solids or BOD 5. The latter-stage bleachery filtrates can therefore be recycled forward to earlier-stage bleach steps. However, even in large modern alkaline pulp bleaching systems, very few mill bleacheries practice complete countercurrent recycling of filtrate from the chlorine dioxide and preceding stages. To the extent that recycling is practiced, water use is reduced.

In integrated mill complexes, effluent flows from bleaching have been drastically reduced in recent years because of improved countercurrent use of filtrates. Typical effluent flows range from 16.7 kl/kkg (4 kgal/t) for a simple groundwood system to as much as 133.4 kl/kkg (32 kgal/t) for a fully bleached kraft pulp mill. Sulfite bleaching, although generally of three or fewer stages, contributes 260.8 kl/kkg (15 kgal/t), and deinking systems 22.9 kl/kkg (5.5 kgal/t). (See Table III-6.)

Stock Preparation

In the stock preparation area, the pulps are blended with materials such as alum and rosin for sizing the paper sheets. Fillers such as clay can be added to give improved brightness, smoothness and opacity; dyes are added for color and shade control. Process losses in the stock preparation area are usually minimal; they normally occur with washups, order changes, shutdowns, and other upsets to the normal production process. The use of spill prevention and control systems can reduce the loss of stock on such changeovers. Reclaimed stock can subsequently be processed as broke with other furnishes.

Papermaking

After stock preparation, the final blended furnish is conveyed to the papermachine headbox. The blended stock is carefully diluted to create a machine furnish containing less than 1 part solid material per 100 parts of total water. This dilute stock is evenly spread over a large porous forming cylinder or belt. Water drains through the forming wire and is recycled back to the headbox where it is mixed with the incoming stock. Water is also removed from the sheet during pressing and in the form of trim; this water is also recycled, generally via a saveall which thickens the stock. The thickened

TABLE III-6

WASTE LOADS AND WASTEWATER QUANTITIES IN TYPICAL PULP AND PAPER MILLS(35)

	Waste Load, in lb/t of Product											
	Suspended Solids[a]		Dissolved Solids		Total Solids		BOD5		pH		gal/ton	
Process	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Wood Preparation	1.9-40	9		4	4-50	13	2-10	3	6.5-8.0	7.0	1,000-10,000	3,400
Pulping												
Groundwood												
Sulfate (kraft)												
Blow tower	(3.7)	4		17	(21.0)	21	(1.3)	1	(12)	12.0	(1,000)	1,000
Dirty condensate	0-0.5	0.1		4	6-11	7	6.5-9.0	8	9.5-10	10.0	950-1,900	1,200
Evaporator ejector	0.06-0.2	0.1		2	1-3	2	1.6-4.5	3	9-10	9.5	290-640	300
Causticizing waste	2.2-5.7	5		96	46-240	101	8.0-10.5	9	9-11.0	10.0	600-9,600	2,500
Green dreg	(1.0)	1		21	(22)	22	(1.0)	1	(12)	12.0	(200)	200
Floor drain	0.5-10	6		1	11.0-11.5	11	0.3-1.7	1	11.6-12	12.0	340-580	400
SUBTOTAL		17		141		164		23				5,600
Sulfite												
Blow tower	0.42-1.9	1		246	36-348	247	29-194	116	2.2-2.9	2.7	1,840-1,950	1,900
Condensate	0.05-0.2	0.1		47	18-87	47	48-71	66	2.3-3.1	2.6	750-1,700	1,100
Uncollected liquor	0.3-43	21		84	50-515	105	50-61	53	2.2-2.6	2.4	2,000-10,000	7,500
Acid plant wastes	(5)	5	(5)	5	(10)	10			(1.2)	1.2	(300)	300
Boiler blowdown	(2)	2			(22)	22	(0.05)	0.05		11.0	(100)	100
SUBTOTAL		29		382		411		235	12-2.9			10,900
Semi-Chemical												
Blow tower	(2)	2	(6)	6	(8)	8	(1)	1		4.0	(1,000)	1,000
Condensate	(0.1)	0.1	(2)	2	(2)	2	(3)	3		3.5	(2,000)	2,000
Recovery system	(9)	9	(111)	111	(150)	150	(8)	8			(2,000)	2,000
Uncollected liquor	(11)	11	(29)	29	(40)	40	(18)	18		2.5	(2,000)	2,000
SUBTOTAL	(22)	22		148		200		30	2.5-4.0			7,000
Deinking (all sources)[b]							11-25				9,700-36,000	
Pulp screening												
Groundwood												
Sulfate (kraft)	5-8	4		58	60-63	62	10-18	14	9-10	10.0	900-9,600	3,600
Sulfite	1.7-14	8		19		27	22-10.7	8	5.4-5.7	5.6	1,700-14,300	6,000
Semi-Chemicals												
Deinking												
Pulp washing and thickening												
Groundwood (no washing)	9-14	11		44	51-107	75	22-46	33	5.0-6.25	6.0	4,800-10,000	7,500

TABLE III-5 (Continued)

Process	Suspended Solids Range[a]	Suspended Solids Mean	Dissolved Solids Range	Dissolved Solids Mean	Total Solids Range	Total Solids Mean	BOD5 Range	BOD5 Mean	pH Range	pH Mean	gal/ton Range	gal/ton Mean
	Waste Load, in lb/t of Product											
Sulfate (kraft)	10–30	15		127	94–180	142	10–35	25	8.9–9.4	9.0	3,000–11,000	7,000
Sulfite	6.5–9.0	8		123	68–1037	131	7.4–34.0	18	2.4–3.9	2.9	1,800–15,000	7,500
Semi-Chemical	0.9–6.0	3		90	42–141	93	10–42	24	7.0–7.9	7.4	2,400–7,800	5,400
Deinking												
Bleaching												
Groundwood												4,000
Sulfate (kraft)	14–124	60	92–280	180	216–294	240	8–88	30		2.9	12,000–32,000	19,000
Sulfite	4–44	15	126–409	205	131–415	220	17–44	25	2.9–6.8	3.8	9,000–30,000	15,000
Semi-Chemical												
Deinking		6		119		125		12		2.2		5,500
Papermaking[c]												
General	10–166	46	21–425	73	31–591	119	3–80	16	4.3–6.9	5	5,700–40,000	13,000
Related products												
Newsprint	20–60	40					10–12	15			37,000	
Uncoated groundwood												
Coated printing paper												
Uncoated book paper		30		66		116		16			8,000–28,000	14,000
Fine paper	47–100	73		80		153	15–40	20			9,000–40,000	18,000
Coarse paper	10–30	20					10–25	15			2,000–29,000	10,000
Special industrial paper	200–400	300					140–170	155			20,000–100,000	
Sanitary and tissue paper	50–100	50		150		200	15–30	22			8,000–37,000	14,000
Total mill effluent (integrated pulp and paper mills)												
Bleached sulfite and paper	50–200	170	150–1130	640	200–1300	810	30–220	120			39,000–54,000	45,000
Unbleached sulfate and paper[d]		50		460		510						27,000
Bleached sulfite and paper	40–100	100	560–1600	1040	600–1700	1140	235–430	330			40,000–70,000	55,000

[a] Single pieces of data are entered under the "Range" column in parentheses. The mean values shown are not truly statistical averages; they are considered to be probable average values based on the available data.
[b] The deinking process includes pulping, screening, washing, and thickening.
[c] Wastewaters from papermaking include those from stock preparation, paper-machining, and finishing and converting operations.
[d] Data for integrated unbleached sulfate pulp and paper mills are generated by subtracting the data for bleaching from those for the integrated bleached sulfate pulp and paper mill.

stock is pumped back to the machine chest, along with the accompanying new stock to be formed into a sheet.

The relatively clear filtrate which passes through the sheet on the saveall is subsequently utilized for showers, for stock dilution on the paper machine, or for stock preparation. Also, the clarified whitewater from the machine system can be discharged to the sewer system or recycled to the pulp mill for dilution purposes. An attempt can be made to recycle as many of these streams as possible and minimize discharge from the paper machine area.

After the paper has been formed, it may be further treated by coating to improve printing and writing characteristics or to achieve desired color characteristics. The surface coating of adhesives or pigments contributes little or no effluent during normal operations. However, on order changes, and as a result of upsets, breaks, spills, washups, or dumps due to contamination, high sudden loadings of suspended solids and high BOD_5 (resulting from the starch adhesive utilized) may be suddenly discharged to the mill sewer system.

Improved instrumentation can be used to control flow rates and thus minimize losses from coating and sizing operations. Spill collection systems can be designed to reclaim and reuse as much of these materials as possible. It is also possible to design systems to enable discharge to the mill treatment system at a controlled rate. Because the pigments and adhesives are so expensive, there is an economic incentive for the mill to minimize losses. As a total contribution in terms of flow, BOD_5, and TSS, such losses are generally minimal compared to the pulping, liquor recovery and papermaking operations.

Summary

Table III-6 shows typical effluents for major manufacturing areas in integrated pulp and paper mills. As shown, the highest losses per ton of product are experienced by sulfite pulp mills, from the bleacheries of both sulfite and alkaline pulp mills, and from the papermaking operations for most types of fine papers.

A more detailed discussion of the generation of wastewater in pulp, paper, and paperboard mills is presented by subcategory in Section V of this report.

SECTION IV

REVIEW OF INDUSTRY SUBCATEGORIZATION AND PROFILE

INDUSTRY OVERVIEW

At the time of this study, the pulp, paper, and paperboard industry consisted of approximately 730 operating facilities. These operations vary from large integrated kraft pulp, paper, and paperboard mills producing over 1,814 kkg/day (2,000 tons/day), to small nonintegrated single machine mills making less than 0.9 kkg/day (1 ton/day) of product.

There are three general classifications of mills: integrated mills; secondary fiber mills; and nonintegrated mills. At integrated mills pulp is produced from wood and nonwood raw materials (i.e., hemp or flax); paper and board products are produced on site. At secondary fiber mills no pulp is produced on-site; most of the furnish is derived from waste paper. At nonintegrated mills, the furnish consists of purchased wood pulp (or other fibers). No pulp is made on-site, but some waste paper can be used, as long as the mill does not have a full deink process.

Pulping processes at the integrated mills range from simple groundwood operations, using only mechanical defibration of full logs and limited bleaching operations, to the complex dissolving pulp mills employing extensive chemical pulping operations and attendant recovery systems coupled with multi-stage bleaching operations. Also included with the integrated pulp mills are those producing pulps from a variety of nonwood fibers such as flax, hemp, cotton, abaca, and sisal. Pulping operations include groundwood and modified groundwood operations, sulfite (acid) processes, unbleached and bleached kraft or soda processes (alkaline), and modified high-yield processes utilizing mild chemical treatments coupled with mechanical defibration.

Mills using secondary fiber are a large and growing segment of the industry. At these mills waste paper in various forms is utilized. At one extreme are processes involving the direct slushing of waste papers with no additional processing, followed by conversion into coarse products such as construction papers, corrugating media and other coarse board stock. At the other extreme are mills utilizing high quality waste papers which subsequently are deinked by chemical means, screened, cleaned, and processed through multi-stage bleaching systems in a manner very similar to wood pulping. High quality deink pulps are utilized in the production of fine quality tissue, printing, and business papers.

Fibers are purchased by nonintegrated mills, where a wide range of products are manufactured. The products range from specialty board items through the highest quality fine papers.

INDUSTRY SUBCATEGORIZATION

Purpose

The purpose of subcategorization is to group together mills with similar production and process patterns. This allows for the development of representative raw waste loads and production characteristics for a relatively homogeneous groups of mills. In this manner, the technical investigations and national effluent limitations guidelines and standards can focus on typical operations which can be found throughout the industry. The resulting data can then form a statistically valid basis for estimating costs and writing effluent discharge permits which are reasonable for each mill in the industry, based on the operation of other mills with similar characteristics.

Existing Subcategorization and Factors Considered

The two segments of the industry are presently subcategorized as shown in Table IV-1. Factors which were considered in establishing these subcategories include:

- raw materials;
- mill age;
- production processes;
- products produced;
- mill size and complexity; and
- mill location.

These factors and their relationship to subcategorization are discussed in the following paragraphs.

Raw Materials. In most pulping processes, wood species native to the geographical area of the mill under evaluation are the primary raw material. Blends of local species, usually separated with respect to hardwood and softwoods, are pulped to produce either market pulps or papers with specific physical and optical properties.

Hardwoods are generally pulped more readily than softwoods in alkaline processes, yielding more bleached pulp in a less intense pulping and bleaching process. Mills may utilize nonwood materials to produce both the pulp and papergrades derived. Cotton linters may be converted into highly purified cellulose fibers used in fine papers, filter papers and specialty products. Likewise, fibers derived from hemp, sisal, abaca and flax yield the pulps required in items as diverse as cigarette papers and tea bags. Processing characteristics and inherent cellulose content vary widely.

TABLE IV-1

CURRENT INDUSTRY SUBCATEGORIZATION

Phase I
Unbleached Kraft
NSSC - Ammonia
NSSC - Sodium
Unbleached Kraft-NSSC
Paperboard from Wastepaper
Phase II
Dissolving Kraft
Market Kraft
BCT-Kraft
Fine Kraft
Papergrade Sulfite
- Blow Pit Wash (plus allowances)
- Drum Wash (plus allowances)
Dissolving Sulfite (allowances by grade)
Groundwood Chemi-Mechanical
Groundwood Thermo-Mechanical
Groundwood CMN
Groundwood Fine
Soda
Deink
Nonintegrated-Fine
Nonintegrated-Tissue
Nonintegrated-Tissue
- from Waste Paper
Builders Paper and Roofing Felt

Although there are inherent differences in cellulose content of the original wood or nonwood fiber source used, the pulping and liquor recovery systems and the bleaching sequence applied are far more significant in influencing raw waste characteristics.

In nonintegrated mills, no pulp is produced on-site. This eliminates the potential losses associated with recovery of pulping liquors and bleachery effluents in integrated mill operations. Only the losses inherent with stock preparation and the papermachine operations are significant.

If waste paper is used for the furnish, the raw waste load depends greatly on the subsequent processing performed. If waste paper is used without deinking, as in board or construction papers, losses are very small. However, when waste paper is fully deinked and bleached to produce stock suitable for fine or tissue papers, raw waste losses are among the highest in the industry.

Thus, while inherent differences exist in terms of possible fibrous yield from different raw materials, the raw waste loads are more significantly influenced by the processing of the material(s) than by the inherent differences in cellulose levels in the raw materials. For example, at a mill with (say 93 percent) liquor, a 10 percent difference in cellulose content represents less than a 1 percent change in raw waste BOD_5 load.

Quantitative information on raw materials or mix of grades of waste paper used is not usually provided in adequate detail to establish a consistent relationship to raw waste load. Thus, while raw waste factors may be influenced by raw materials used, the combined effect of both raw material and production process must be considered in developing a subcategorization scheme.

Pulping Processes. The processes used to produce pulp from wood or other substrates significantly influence raw waste loads. For example, the raw waste BOD_5 load for alkaline (kraft) pulp mills is generally lower for unbleached pulp mills than for fine paper mills; however, the BOD_5 load is higher still for mills making highly purified alkaline dissolving pulps. The basic process difference is the intensity of the bleaching system, and the inability to recover dissolved substrate in the alkaline dissolving pulping process. The liquors from the alkaline pulping operations are generally evaporated and recovered. To further illustrate the effect of production process, sulfite dissolving pulp mills generally have a much higher BOD_5 loading than alkaline dissolving pulp mills. This reflects both a high degree of purification during bleaching and a less effective liquor recovery system than in the corresponding alkaline operations. Thus the production process is a key factor in subcategorization.

Products Produced. While pulping process variations are the key to the inherent raw waste load generation, the next most significant factor is the product(s) produced.

Coarse grades of paper and board generally can accept higher levels of dirt, shives and other contaminants. Therefore, it is possible to operate with extensive whitewater recycle, and to extensively recycle effluent from the mill's treatment plant. As the demand for quality increases, increasing levels of dirt must be purged from the system with attendant higher losses. Electrical grades must be highly uniform and free of dissolved metal salts; this makes higher raw waste loads and water use inevitable. Production of thin electrical papers involves the use of 50 percent more fresh water per ton than comparable thin grades. The type of product thus often helps to delineate a particular group or subcategory of mills.

Clearly, products of increasing quality standards require more extensive processing with respect to bleaching, pulp screening and cleaning. The recycling of contaminated materials cannot be tolerated in fine paper operations, but provides a ready source of raw material for production of many unbleached and coarse grades of board and industrial grades.

Age and Size of Mills. The age of a mill appears to have minimal impact upon raw or final waste load characteristics. Process and product differences far overshadow age and size factors. For example, deink mills which produce newsprint are relatively new, but exhibit the highest TSS loads in the entire industry. Nonintegrated paperboard mills are the oldest, but have very low raw waste loads. Equipment age, rather than mill age, has a more measurable correlation with waste characteristics. But even old equipment may not result in high waste loads if the equipment is well maintained, properly sized and properly operated with respect to current process demands. Mill size, as shown in earlier development documents, also has little relationship to waste load.(2)(37)

Geographical Location. Mill location may have a significant bearing upon wood species availability, land availability or suitability for proper effluent disposal and solids disposal, availability of receiving waters to assimilate the final effluent, and climate. However, factors affecting effluent treatment can be minimized by proper design of the biological treatment systems.

As indicated by U.S. Department of Commerce information, cost factors, such as fuels, construction labor and electric power vary by region in the U.S.(38) However, such factors do not influence raw waste load characteristics, and can be accounted for in development of cost data for implementation of control and treatment technologies. Because regional factors are not significant in terms of raw waste loads and water usage, no additional subcategorization by geographical location is warranted.

Review of Existing Subcategorization

As part of the BATEA review program, an updated and more complete data base has been collected from 644 mills in the pulp, paper and paperboard industry. A review of existing subcategorization was undertaken in order to determine the adequacy of the existing subcategorization scheme in representing current industry practices. Based on this review, it was apparent that the previous subcategorization scheme should be revised. A revised subcategorization scheme has been developed and is presented in Table IV-2. Revisions are based primarily on review of production processes and the products produced.

Also as part of the review, raw waste loads were assessed taking into account the size and age of the mills, the treatability of the wastes produced, and the effect of unique geographical factors such as climate.

The existing Phase I and Phase II subcategories recognize two classifications of mills: integrated and nonintegrated mills. Review of the industry's operations showed that a large number of mills are using significant quantities of waste paper as a major portion of their furnish. At some of these mills waste paper is slushed to form coarse boards or molded items; at others complete deinking systems are operated including all the unit operations common to most pulp mills. Thus, some waste paper mills could be called integrated and some nonintegrated. To separately recognize the waste paper mills, a third major grouping has been developed: secondary fiber mills. Secondary fiber subcategories include Deink-Fine and Tissue, Deink-Newsprint, Wastepaper-Tissue, Wastepaper-Board, Wastepaper-Molded Products, and Wastepaper-Construction Products. The subcategories replace the current subcategories, Deink, Non-Integrated-Tissue (from Waste Paper), Builders Paper and Roofing Felt, and Paperboard from Wastepaper.

As a result of the review of subcategorization, several subcategories have been redefined. Integrated mill subcategories which have been redefined include kraft, neutral sulfite semi-chemical (NSSC), and sulfite. The kraft subcategories have been redefined as alkaline and include soda mills.

Existing Phase I and II subcategories included special allowances for process variations in dissolving and papergrade sulfite subcategories. These allowances, which were based on limited data, tended to allow higher discharges, although technology existed for achievement of consistently lower discharges. Mill-to-mill variations are more significant than established differences by grade. Since the earlier survey, many of these mills have revised their processes or have shut down, further obviating the need for allowances for grades produced within the subcategories.

Furthermore, the existing Phase I subcategories do not recognize the various types of semi-chemical pulping operations that now exist. NSSC is only one type and is decreasing in its application. Also, there are integrated mills specifically producing both groundwood and alkaline pulps in the desired ratio to make newsprint on-site; thus, a new Alkaline-Newsprint subcategory has been recommended for these mills.

Previous subcategorization efforts did not address all nonintegrated mills; consequently, the data for nonintegrated mills was reviewed to develop a logical subcategorization scheme. As a result of this review, subcategories were developed for nonintegrated production of fine paper, tissue paper, lightweight paper, filter and nonwoven papers, and paperboard products. In this subcategorization scheme the latter three product groupings are new subcategories.

TABLE IV-2

REVISED INDUSTRY SUBCATEGORIZATION

A. Integrated Mills

011 Alkaline-Dissolving
012 Alkaline-Market
013 Alkaline-BCT (for paperboard, coarse and tissue (BCT)
014 Alkaline-Fine
015 Alkaline-Unbleached
016 Semi-Chemical
017 Alkaline-Unbleached and Semi-Chemical
019 Alkaline-Newsprint
021 Sulfite-Dissolving
022 Sulfite-Papergrade
032 Thermo-Mechanical Pulp
033 Groundwood-CMN
034 Groundwood-Fine

B. Secondary Fiber Mills

101 Deink-Fine and Tissue
102 Deink-Newsprint
111 Wastepaper-Tissue
112 Wastepaper-Board
113 Wastepaper-Molded Products
114 Wastepaper-Construction Products

C. Nonintegrated Mills

201 Nonintegrated-Fine
202 Nonintegrated-Tissue
204 Nonintegrated-Lightweight
205 Nonintegrated-Filter & Nonwoven
211 Nonintegrated-Paperboard

D. Miscellaneous Mill Groupings

Integrated-Miscellaneous, including
- o Alkaline-Miscellaneous
- o Groundwood Chemi-Mechanical
- o Nonwood Pulping

Secondary Fiber-Miscellaneous
Nonintegrated-Miscellaneous

As a result of the subcategorization review, groups of mills have been identified which do not logically fit into the subcategorization scheme. In each of the three mill classifications (i.e., integrated, secondary fiber and non-integrated) there are mills which do not fit the subcategorization scheme because of the complex variety of pulping processes and products produced. These are grouped into the Integrated-Miscellaneous, Secondary Fiber-Miscellaneous and Nonintegrated-Miscellaneous groupings shown in Table IV-2. Also included within the miscellaneous mill groupings are mills which have no common rational process identity and mills for which too little data is available to develop typical process characteristics (e.g., high-yield acid pulping and nonwood pulping). Effluent limitations guidelines and standards for mills in the miscellaneous groupings may be pro-rated or established for an individual mill by the permitting authority.

With the revised and expanded subcategorization, 512 of the 644 mills responding to the data request program are included in the subcategorization scheme. Presented below are descriptions of the types of processes and products associated with each subcategory within the integrated, secondary fiber, and nonintegrated mill classifications.

Description of Subcategories - Integrated Mills

Integrated mill operations are those where pulp is produced and processed into pulp, pulp bales, paper, or paperboard at the same site.

011 Alkaline-Dissolving. At these mills a highly bleached wood pulp is produced in a full cook process using a sodium hydroxide and sodium sulfide cooking liquor and a pre-cook operation called "pre-hydrolysis". The principal product is a highly purified dissolving pulp used mostly for the manufacture of rayon and other products requiring the virtual absence of lignin and a very high alpha cellulose content.

012 Alkaline-Market. At mills in this subcategory, a bleached papergrade market wood pulp is produced in a full cook process using a highly alkaline sodium hydroxide cooking liquor. Sodium sulfide is also usually present in the cooking liquor in varying amounts.

013 Alkaline-BCT. At these mills, bleached alkaline pulp is produced and manufactured into paperboard, coarse, and tissue (BCT) grades of paper. Bleached alkaline pulp is produced by a process similar to that presented for the Alkaline-Market subcategory.

014 Alkaline-Fine. At these mills, bleached alkaline pulp is produced and manufactured into fine papers, including business, writing, and printing papers. The pulping process is as discussed in the previous two subcategories.

015 Alkaline-Unbleached. At these mills, an unbleached wood pulp is produced in a full cook process using a highly alkaline sodium hydroxide cooking liquor. Sodium sulfide is also usually present in the cooking liquor in varying amounts. The products are coarse papers, paperboard, and may include market pulp, unbleached kraft specialties, towels, corrugating medium and tube stock.

016 Semi-Chemical. At semi-chemical mills, a high-yield wood pulp is produced and manufactured into corrugating medium, insulating board, partition board, chip board, tube stock, and specialty boards. A variety of cooking liquors are used to cook the wood chips under pressure; the cooked chips are usually refined before being converted into board or similar products.

017 Alkaline-Unbleached and Semi-Chemical. At mills in this subcategory, high-yield semi-chemical pulp (as defined in the Semi-Chemical subcategory) and unbleached kraft pulp (as defined in the Alkaline-Unbleached subcategory) are produced. Cooking liquors from both processes are recovered in the same recovery furnace. Major products include linerboard, corrugating medium, and market pulp.

019 Alkaline-Newsprint. At these mills bleached alkaline pulp (as defined in Alkaline-Market subcategory) and groundwood pulp (as defined in the Groundwood-CMN and Thermo-Mechanical Pulp subcategories) are produced. Newsprint is the principal product produced.

021 Sulfite-Dissolving. At mills in this subcategory, a highly bleached and purified wood pulp is produced in a full cook process using strong solutions of calcium, magnesium, ammonia or sodium bisulfite, and sulfur dioxide. The pulps produced are viscose, nitration, cellophane or acetate grades; and they are used principally for the manufacture of rayon and other products that require the virtual absence of lignin and a high alpha cellulose content.

022 Sulfite-Papergrade. At mills in this subcategory, sulfite pulp and paper or papergrade market pulp are produced. The sulfite wood pulp is produced by a full cook process using strong solutions of calcium, magnesium, ammonia or sodium bisulfite, and sulfur dioxide. Purchased groundwood, secondary fibers or virgin pulp are commonly used in addition to sulfite pulp to produce tissue paper, fine paper, newsprint, market pulp, chip board, glassine, wax paper, and sulfite specialties.

032 Thermo-Mechanical Pulp (TMP). At mills in this subcategory, wood pulp is produced in a process using rapid steaming followed by refining. A cooking liquor, such as sodium sulfite, is added. The principal products are fine paper, newsprint and tissue papers.

033 Groundwood-CMN. At these mills, groundwood pulp is produced using stone grinders or refiners; no separate steaming vessel is used before the defibration. Purchased fibers are used in addition to groundwood pulp to produce coarse papers, molded fiber products, and newsprint (CMN).

034 Groundwood-Fine. At mills in this subcategory, groundwood pulp is produced using stone grinders or refiners; no separate steaming vessel is used before the defibration. Purchased fibers are used in addition to groundwood pulp to produce fine papers, including business, writing and printing papers.

Integrated-Miscellaneous. This mill grouping includes three types of miscellaneous mills: 1) mills employing more than one pulping process (exceptions are the Alkaline-Newsprint and Alklaline-Unbleached and Semi-Chemical subcategories); 2) miscellaneous processes not described above (i.e., nonwood pulping, chemi-mechanical, miscellaneous acid and alkaline pulping mills); and 3) mills producing a wide variety of products not covered above.

Description of Subcategories - Secondary Fiber Mills

No pulp is produced at secondary fiber mills; most of the new material furnish is waste paper. Some secondary fiber mills include deinking to produce a pulp, paper or paperboard product.

101 Deink-Fine and Tissue. At mills in this subcategory, a deink pulp is produced from waste paper. The principal products made from the deinked pulp include printing, writing, business and tissue papers, but may also include products such as wallpaper, converting stock and wadding.

102 Deink-Newsprint. Mills in this subcategory produce newsprint from deink pulp derived mostly from over-issue and waste news.

111 Wastepaper-Tissue. In this subcategory, paper stock furnish is derived from waste paper without deinking. The principal products are facial and toilet paper, paper towels, glassine, paper diapers and wadding.

112 Wastepaper-Board. Mills in this subcategory use a furnish derived from waste paper without deinking. A wide range of products are made, including setup and folding boxboards, corrugating medium, tube stock, chip board, gypsum liner and linerboard. Other board products include fiber and partition board, building board, shoe board, bogus, blotting, cover, auto, filter, gasket, tag, liner, electrical board, fiber pipe, food board, wrapper, and specialty boards.

113 Wastepaper-Molded Products. At these mills, most of the furnish is obtained from waste paper without deinking. The principal products are molded

items, such as fruit and vegetable packs and similar throwaway containers and display items.

114 Wastepaper-Construction Products. In this subcategory are mills primarily producing saturated and coated building paper and boards. Waste paper is the furnish; no deinking is employed. The principal products include roofing felt, shingles, rolled and prepared roofing. Asphalt may be used for saturating, and various mineral coatings may be used. Some asbestos and nonwood fibers (fiberglass) may also be used. At many mills some groundwood, defibrated pulp or wood flour may be processed and used in production of the final product.

Secondary Fiber-Miscellaneous. These mills manufacture products or product mixes not included in the Wastepaper-Tissue, Wastepaper-Board, Wastepaper-Molded Products and Wastepaper-Construction Products subcategories. Their furnish is more than 50 percent waste paper without deinking.

Products may include market pulp from waste paper and polycoated waste, filters, gaskets, mats, absorbent papers, groundwood specialties and other grade mixtures. A mill producing less than 50 percent construction paper or any other combination of products, other than secondary fiber subcategory products, would be classified in this grouping.

Description of Subcategories - Nonintegrated Mills

Nonintegrated mills purchase wood pulp or other fiber source(s) to produce paper or paperboard products.

201 Nonintegrated-Fine. These nonintegrated mills produce fine papers from wood pulp or secondary fibers, prepared at another site. No deinking is employed at the papermill site. The principal products are printing, writing, business, technical papers, bleached bristols, and rag papers.

202 Nonintegrated-Tissue. Mills in this subcategory produce sanitary or industrial tissue papers from wood pulp or secondary fiber prepared at another site. No deink pulp is prepared at the papermill site. The principal products are facial and toilet paper, paper towels, glassine, paper diapers, wadding and wrapping.

204 Nonintegrated-Lightweight. These mills produce lightweight or thin papers from wood pulp or secondary fiber prepared at another site, as well as from nonwood fibers and additives. The principal products are uncoated thin papers, such as carbonizing, cigarette papers and some special grades of tissue such as capacitor, pattern, and interleaf.

205 Nonintegrated-Filter and Nonwoven. Mills in this subcategory produce filter papers and nonwoven items using a furnish of purchased wood pulp, waste paper and nonwood fibers. The principal products are filter and blotting paper, nonwoven packaging and specialties, insulation, technical papers and gaskets.

211 Nonintegrated-Paperboard. Mills in this subcategory produce various types of paperboard from purchased wood pulps or secondary fibers. Products include linerboard, folding boxboard, milk cartons, food, chip, stereotype, pressboard, electrical and other specialty board grades.

Nonintegrated-Miscellaneous. This grouping includes any nonintegrated mill not included in the above subcategories. Included are mills making mostly asbestos and synthetic products; paper and paperboard products that are too diverse to be classified; or products with unique process or product specifications, commonly called specialty items.

The Model Mill and Pure Mill Concepts

The concept of subcategorization assumes that mills can be grouped based on their similarities. Ideally, within a particular grouping, there would be close similarity in processes employed, products manufactured, and effluent treatment technologies employed. As outlined previously, the purpose of subcategorization is to group together mills with similar production characteristics and processes employed. In conducting the project investigations, two representative mills have been conceptualized for each subcategory: the "pure" mill and the "model" mill.

Pure Mill. The "pure mill" concept establishes a basis for the development of effluent limitations, guidelines and standards which can be used in pro-rating guidelines for mills not fitting the subcategorization scheme. A mill may be termed "pure" if its characteristics completely fit the subcategory definition.

For example, a mill producing only fine quality printing papers from on-site alkaline pulps may be called a "pure" mill in the Alkaline-Fine subcategory. In this situation the effluent loads from wood processing, pulping, bleaching and papermaking are totalled to give a characteristic raw waste load for the balanced mill operation. Commonly, however, mills that have been generally placed within a subcategory cannot be considered "pure". Often these mills may make a small quantity of a different product type; pulp mill output may not match the papermill requirements; and/or the production process may differ substantially from that used at a pure mill.

For each subcategory, "pure mill" data are developed for the basis of pro-rata effluent guidelines development. Some subcategories contain more than one pure mill, reflecting more than one distinct product or production process within the subcategory.

Data from the pure mills can be used to develop guidelines on a pro-rated for unique mill operations which have not been included in the subcategorization scheme. For example, a mill may operate two separate pulping processes, called Process A and Process B. Pure mill guidelines established for each process can be applied to the unique mill combination by establishing which proportion of its operations consists of Process A or Process B. Final effluent waste loads projected for the pure Process A mill and the pure Process B mill can be mathematically combined and weighted to match the ratio of production using each process at the unique mill. This approach to guidelines development requires the use of pure mill data. To establish such data where none presently exists, the following approaches can be taken:

1. Where data over a wide range exists, graphical interpretation may be made from plots of raw waste loads like those shown in Figures IV-1, IV-2 and IV-3. For example BOD_5 curves for a mixture of deinked and virgin pulp can be used to extrapolate BOD_5 for 100 percent deink furnish.

2. If insufficient data is available from which to plot a curve, then pure mill data can be generated from the subcategory model mill and related pure mill data from another subcategory. For example, mills in the Groundwood-Fine subcategory average 59 percent groundwood and 41 percent purchased pulp in their furnish. The purchased pulp/fine paper component of the raw waste load would be comparable to that from a pure nonintegrated fine mill, for which "pure" mill data is available. The purchased pulp component of the Groundwood-Fine operation can thus be isolated and subtracted from the subcategory average. The remaining load is from the groundwood operation and can be extrapolated from 59 percent to 100 percent to generate Groundwood-Fine "pure" mill data.

It should be noted that linear graphical extrapolation of "pure" mill data may not accurately reflect efficiencies or process balances which might be achieved in an actual pure mill operation. Thus, the pure mill projections may in some cases result in raw waste loadings that are higher than would occur in actual practice.

<u>Model Mill</u>. For each of the revised subcategories, a "model" mill has also been established based on a review of data collected during the data request program. Model mill statistics are based on average, median or representative production and raw waste load characteristics. The purpose of the model mill is to establish a statistical base which can be used in developing average raw waste characteristics and in developing cost and energy data for a representative mill to achieve effluent limitations guidelines and standards. The model mill concept does not develop a basis for establishing guidelines on a prorated basis.

The purpose and application of pure mill and model mill data are described more fully in Section V, Waste Characterization.

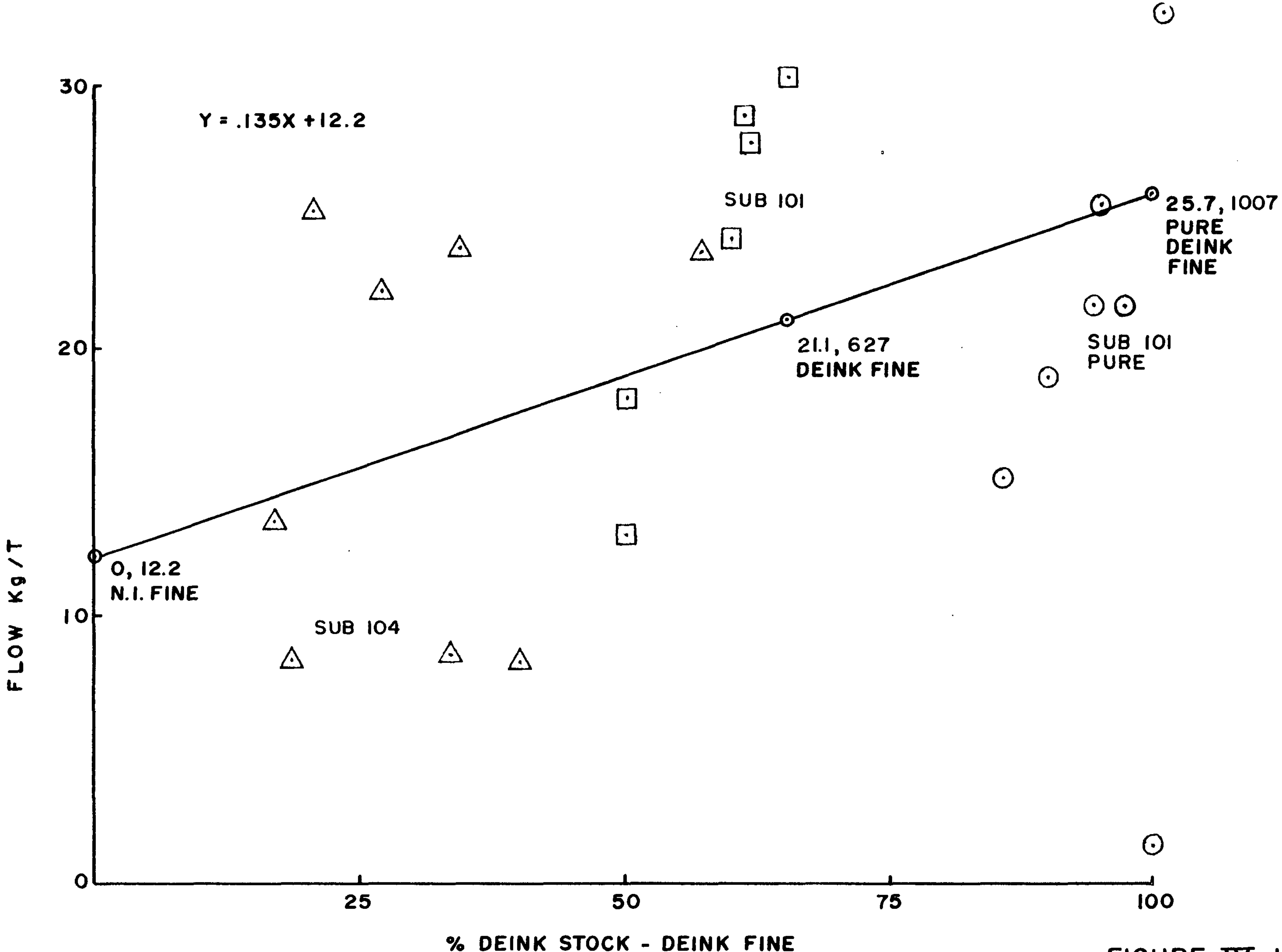


FIGURE IV-1
AVERAGE FLOW VARIATION WITH
AVERAGE % DEINK STOCK

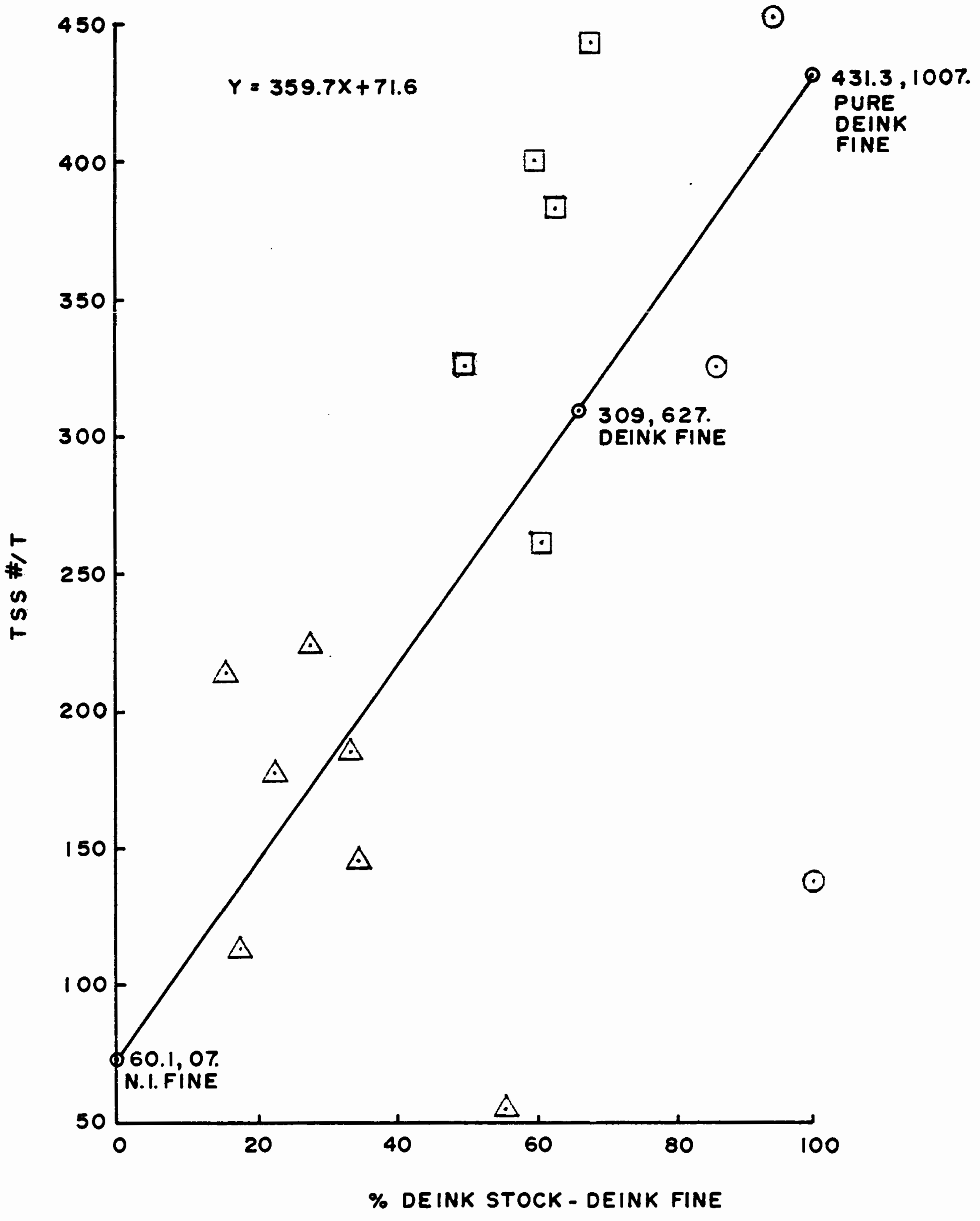


FIGURE IV-2
TSS VARIATION WITH
% DEINK STOCK USED

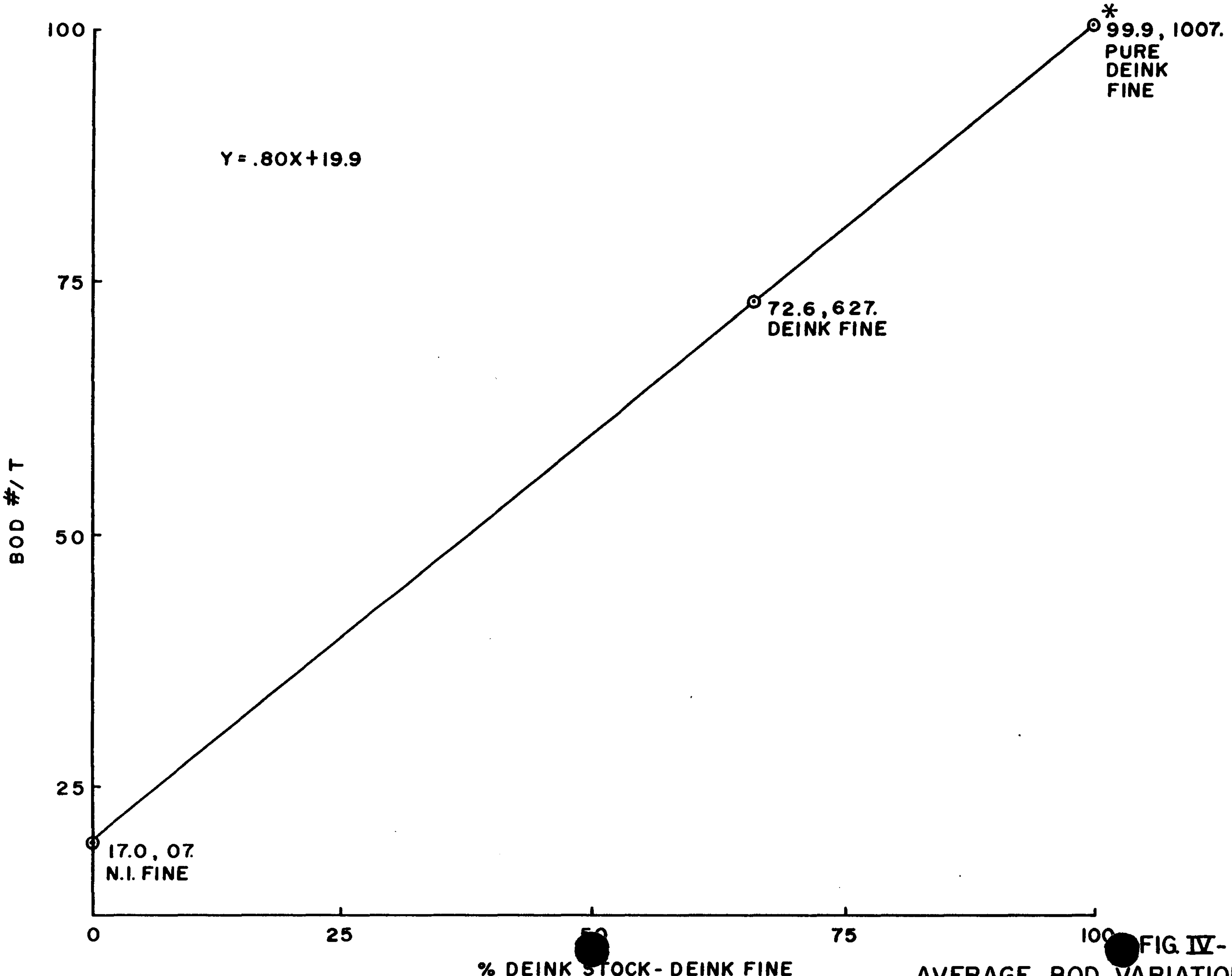


FIG. IV - 3
AVERAGE BOD VARIATION

GEOGRAPHIC DISTRIBUTION OF MILLS BY SUBCATEGORY

Table IV-3 shows the geographical distribution of pulp and paper mills throughout the United States. The largest single concentration of mills is in the upper Midwest area, including the states of Ohio, Indiana, Illinois, Michigan, Wisconsin and Minnesota. In total, 169 mills are located in these states, including one-third of the total number of U.S. Wastepaper-Board mills. Other significant subcategory groupings in the upper Midwest include 15 Nonintegrated-Fine papermills and over half the existing operating Sulfite-Papergrade mills. Nearly half the total U.S. Deink-Fine and Tissue mills are also located in this region, which generally corresponds to EPA's Region V. This region is characterized by a large number of small mills which are generally older than mills in the southern and western regions of the United States.

The northeastern region of the United States also has a large number of mills, many of which are small, nonintegrated mills operating on sites where they were first established more than 75 years ago. The area is characterized by relatively few large integrated pulp mills. There are significant concentrations of small Wastepaper-Board operations, Nonintegrated-Fine mills utilizing rag pulping operations, and a variety of other small nonintegrated pulp mills.

The third major production area in the United States is the southern region, which is the area of prime concentration of large integrated alkaline pulp mills. There are no sulfite operations in the region. The southern states support a large number of Wastepaper-Board operations and builders paper mills. However, the major subcategory represented is the Alkaline-Unbleached subcategory, primarily producing a wide variety of board grades on large machines.

The central states area, comprising the plains area and the mountain states, covers nearly half of the land area of the United States. This area supports very few pulp or papermaking operations and has very few productive forests. With the exception of locally-based board and builders paper mills, there is minimal activity.

The West Coast region is also characterized by locally-based Wastepaper-Board and builders paper manufacturing operations. However, the Pacific Northwest features the second largest concentration of sulfite mills, including both papergrade and dissolving pulp production. Five of the six operating Sulfite-Dissolving mills in the U.S. are in the Pacific Northwest. This subcategory has the highest raw waste load of the industry. One third of the U.S. Sulfite-Papergrade mills are located in this region. The region also supports a general distribution of alkaline pulp mills. Figure IV-4 shows the number of pulp, paper and paperboard mills located in each of the 50 United States and Puerto Rico.

PRODUCTION BY SUBCATEGORY

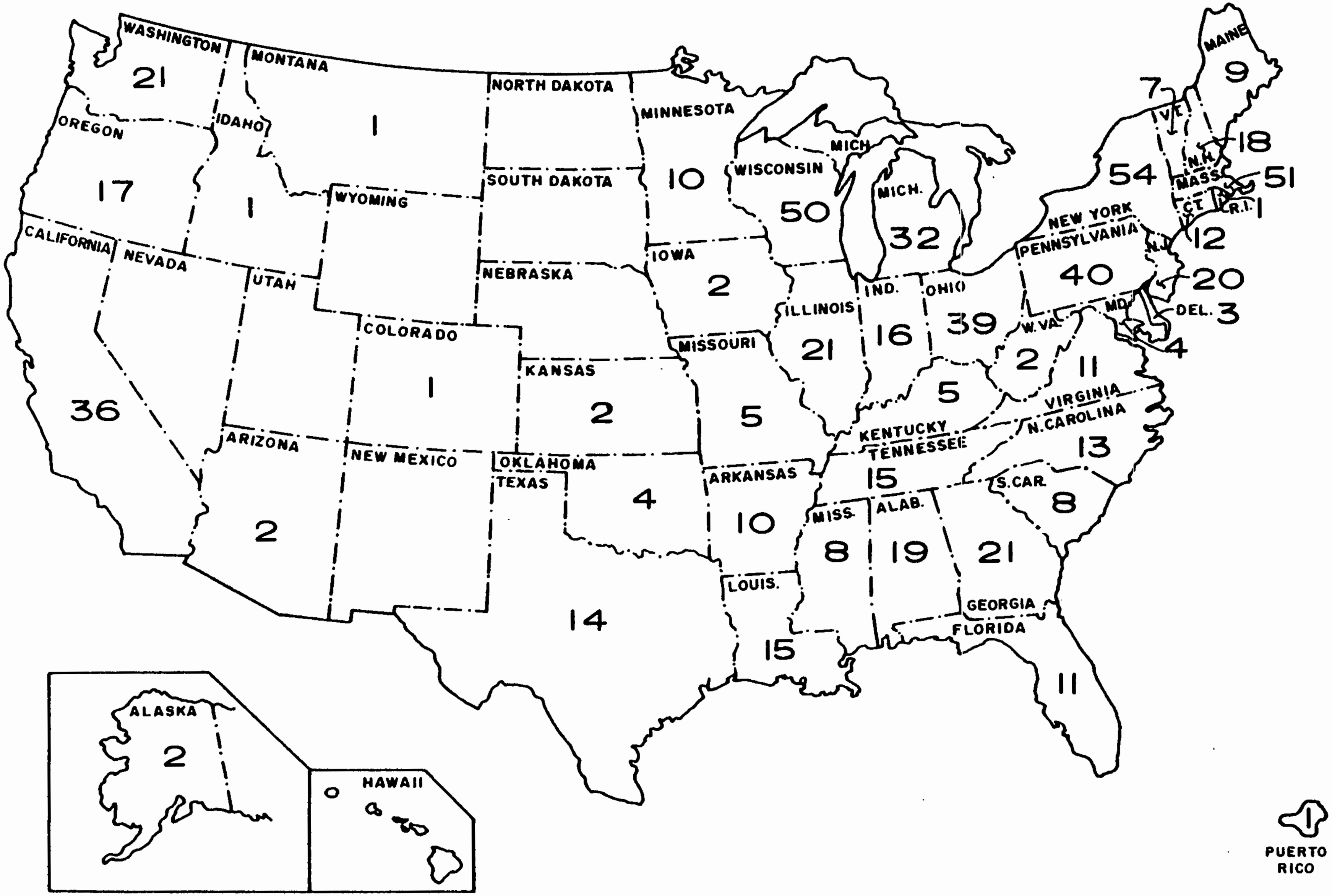
In Table IV-4 reported production data is summarized by subcategory. As shown, the greatest tonnage (9,072,000 tons/year) is produced at the Alka-

TABLE IV-3

U.S. PULP, PAPER AND PAPERBOARD MILLS BY REGION

Subcategory	EPA Region Number										
	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
011 - Alkaline-Dissolving				3							3
012 - Alkaline-Market	1			3	1	1			2	1	9
013 - Alkaline-BCT				4		2				2	8
014 - Alkaline-Fine	3	1	5	1	4	3			1		18
015 - Alkaline-Unbleached				17	2	7				3	29
016 - Semi-Chemical	1		2	5	8	1	1			1	19
017 - Alkaline-Unbleached and Semi-Chemical			1	3		3				3	10
018 - Alkaline-Newsprint				2		1					3
021 - Sulfite-Dissolving				1						5	6
022 - Sulfite-Papergrade		1	1		10					6	18
032 - Thermo-Mechanical Pulp	1										
033 - Groundwood-CMN	2	2		1						1	6
034 - Groundwood-Fine	1	1			6						8
101 - Deink-Fine and Tissue	5		2		8				2		17
102 - Deink-Newsprint			1		1				1		3
111 - Wastepaper-Tissue	5	4	4	3	4				2		22
112 - Wastepaper-Board	20	10	33	14	49	3	4	1	12	1	147
113 - Wastepaper-Molded Products	3			1	6	1			2	2	15
114 - Wastepaper-Construction Products	2		6	12	15	11	4		5	3	58
201 - Nonintegrated-Fine	12	5	6		15				1		39
202 - Nonintegrated-Tissue	3	6	4	4	5				4		26
204 - Nonintegrated-Lightweight	7	4	1	1	5						18
205 - Nonintegrated-Filter and Nonwoven	5	3	2	2	3				1		16
211 - Nonintegrated-Paperboard	6	1	1		3	1					12
* - Integrated-Miscellaneous	19	10	6	21	11	7		1	3	10	88
* - Secondary Fiber-Misc.	2	3			5				2	1	13
* - Nonintegrated-Misc.	12	4	5	2	8						31
Total	110	55	80	100	169	41	9	2	38	40	644

*Groupings of mills with mixed or unique processes or products.



2 NUMBER OF MILLS IN STATE

FIGURE IV-4
PULP AND PAPER MILLS
IN THE U.S. — BY STATES

TABLE IV-4

REPORTED PULP AND PAPER PRODUCTION BY SUBCATEGORY

Subcategory	No. of Mills	Average Mill Production kg/day	(t/d)	Average Production Per Machine kg/day	(t/d)	Total Annual Production kkg	(1,000 t)
011 Alkaline-Dissolving	3	1,022	(1,127)	432	(476)	1,107	(1,221)
012 Alkaline-Market	9	752	(829)	471	(519)	2,436	(2,686)
013 Alkaline-BCT	8	790	(871)	250	(276)	2,275	(2,508)
014 Alkaline-Fine	18	639	(705)	55	(61)	4,143	(4,568)
015 Alkaline-Unbleached	29	788	(869)	404	(445)	8,228	(9,072)
016 Semi-Chemical	19	414	(456)	241	(266)	1,638	(1,806)
017 Alkaline-Unbleached & Semi-Chemical	10	1,194	(1,316)	338	(373)	4,297	(4,738)
019 Alkaline-Nesprint	3	1,214	(1,338)	303	(334)	1,311	(1,445)
021 Sulfite-Dissolving	6	493	(544)	493	(544)	1,066	(1,175)
022 Sulfite-Papergrade	18	324	(357)	83	(91)	2,098	(2,313)
032 Thermo-Mechanical Pulp	2	257	(283)	102	(113)	185	(204)
033 Groundwood-CMN	6	249	(275)	74	(82)	539	(594)
034 Groundwood-Fine	8	421	(464)	125	(138)	1,212	(1,336)
101 Deink-Fine	17	152	(168) 39	52	(57) 39	932	(1,028)
102 Deink-Newsprint	3	325	(358)	244	(269)	351	(387)
111 Wastepaper-Tissue	22	30	(33)	12	(13)	237	(261)
112 Wastepaper-Board	147	133	(147)	127*	(140)*	7,056	(7,779)
113 Wastepaper-Molded Products	15	44	(49)	5	(5)	240	(265)
114 Wastepaper-Construction Products	58	74	(82)	54	(60)	1,553	(1,712)
201 Nonintegrated-Fine	39	188	(207)	73	(81)	2,095	(2,310)
202 Nonintegrated-Tissue	26	114	(126)	58	(64)	1,193	(1,315)
204 Nonintegrated-Lightweight	18	52	(57)	19	(21)	317	(349)
205 Nonintegrated-Filter and Nonwoven	16	18	(19.4)	39	(43)	102	(112)
211 Nonintegrated-Paperboard	12	33	(35.9)	20	(22)	164	(181)
SUBTOTAL	512					226,172	(249,363)
Miscellaneous Groups	134					13,344	(14,712)
TOTAL	646					239,516	(264,075)

Source: Data Request Response
*Estimated

line-Unbleached mills followed by Wastepaper-Board mills at 7,779,000 tons/year. The smallest production is reported by the Nonintegrated-Filter and Nonwoven mills (112,000 tons/year).

The three largest subcategories in terms of tonnage produce packaging materials. The smallest subcategories in terms of tonnage generally produce consumer products with unique characteristics.

The largest average size mills are the Alkaline-Newsprint operations, followed closely by the Alkaline-Unbleached and Semi-Chemical board mills, and the Alkaline-Dissolving pulp mills. The nonintegrated subcategories, Wastepaper-Tissue, and Wastepaper-Molded Products mills, represent the smallest average size mills. Generally, the more unique the product, the smaller the mill.

In terms of the number of mills in the respective subcategories, the largest (at 147) occurs in the Wastepaper-Board subcategory, followed by Wastepaper-Construction Products with 58 mills. There are several small subcategories with three or fewer mills: Alkaline-Dissolving, Alkaline-Newsprint, Thermo-Mechanical Pulp and Deink-Newsprint.

SECTION V

WASTE CHARACTERIZATION

INTRODUCTION

Characterization Strategy

The purpose of this section is to define the wastewater characteristics for mills in the subcategories identified in Section IV. As outlined previously, three categories of pollutants are under investigation: 1.) conventional pollutants; 2.) toxic pollutants; and 3.) nonconventional pollutants.

The data-gathering strategy has included a literature review, industry response to the data request program, and a mill sampling program. This section will summarize the data gathered through these efforts for each category of pollutants.

Model and Pure Mill Concepts

Raw waste load data has been collected and tabulated for mills in each subcategory of the pulp, paper and paperboard industry. This data will be used:

1. to develop representative mills in each subcategory, so that the cost of achieving effluent limitations guidelines and standards can be estimated; and

2. to develop wastewater data that can be used by the EPA to establish specific effluent limitations guidelines and standards for each mill in the industry.

To meet these objectives, two representative mills have been conceptualized for each subcategory: the "model mill" and the "pure mill." These concepts are defined below.

Model Mill. A "model mill" is developed for each subcategory in order to present a typical operation of mills within the subcategory. The model mill has been selected to serve as the basis for subsequent cost and energy evaluations, which are part of the BCT cost test required to judge the economic impact of various levels of effluent control which may be specified by EPA in accordance with the Clean Water Act.

The raw waste load presented for the model mill in some subcategories is the average raw waste load of mills within the subcategory. In other cases, the model mill raw waste load may reflect an operation or set of operations which typify the subcategory, but which may not be the arithmetic average of the subcategory.

In all cases, model mill raw waste loads for the subcategories form the basis for projected raw waste load reductions which can be achieved by implementing designated production process controls and effluent treatment technologies at the model mill in each subcategory.

Model mill raw waste loads do not serve as the basis for effluent limitations guidelines and standards development. As outlined they are used to estimate the cost of implementing selected production process controls and effluent treatment technologies.

Pure Mill. The "pure mill" concept establishes a basis for the development of effluent limitations guidelines and standards which can be applied to each mill in the pulp, paper and paperboard industry. Because most mills are characterized by complex combinations of processes and products, it is necessary to isolate distinct operations which can be found in the industry. Raw waste loads attributable to each distinct process can then be pro-rated to match the combination of processes which may be found at a particular mill.

Pure mill raw waste loads represent the operation of distinct processes or, in some cases, the manufacture of particular products using a distinct process. These waste loads may be based on actual operations by a group of mills which produce a particular product using a distinct process, or they may be based on mathematical interpretation of data from more complex operations.

Pure mill raw waste loads are presented for each subcategory. For some subcategories which are particularly well-defined and discrete, the pure mill and model mill raw waste loads may be the same. However, there are many subcategories where pure mill data and model mill data differ. Also, some subcategories are represented by more than one pure mill, thus recognizing a variety of processes or products which can be isolated within those subcategories.

In the following text on conventional pollutants, raw waste loads will be presented first for the model mill situation in each subcategory, and then for the pure mill situations.

CONVENTIONAL POLLUTANTS

The Clean Water Act defined four conventional pollutants: BOD_5, TSS, pH, and fecal coliform. An additional three conventional pollutants - COD, phosphorus and oil and grease - have been proposed by EPA. As a result of past efforts, effluent limitations have been promulgated for the industry for BOD_5, TSS and pH. For these pollutants considerable long-term data exists, while there is only limited available data on the other conventional pollutants, including those proposed. The primary pollutants discussed in this section are BOD_5 and TSS. COD data will be subsequently presented with the verification sampling program data. COD is presented as a nonconventional pollutant since it has not been promulgated as a conventional pollutant.

This section will present conventional pollutant characterization for the model mill and pure mill facilities. The legend presented earlier in the report provides the reference for abbreviations used in presenting model and pure mill raw waste loads.

Model Mill Raw Waste Loads by Subcategory

011 Alkaline-Dissolving. With an average initial construction date of 1952, the three mills in the Alkaline-Dissolving subcategory produce blends of dissolving pulps, as well as market pulps for papermaking. These mills use hardwood and/or softwood species, ranging from 100 percent hardwood to 100 percent softwood. Although the bleaching sequences vary even within individual mills, all three generally practice jump-stage countercurrent washing. Calculated net bleached yield approximates 40 percent for bleached softwood and 46 percent for hardwood.

As shown in Table V-1, the mill which processes 100 percent hardwood species exhibits higher BOD5 and TSS loadings per ton of product than the two mills using softwood as their principal raw material. This contradicts the expected higher BOD5 loading for softwood production, which is demonstrated by a large number of mills in the Alkaline-Market and Alkaline-Fine subcategories.

The model mill raw waste load for this subcategory is: 198.1 kl/kkg (47.5 kgal/t) flow; 53.8 kg/kkg (107.6 lb/ton) BOD5; and 76.8 kg/kkg (153.7 lb/ton) TSS. The flow and TSS loads are the average for the three mills in the subcategory. The BOD5 load for the model mill is the median BOD5 for the three-mill group, which was selected because of the apparent disparity in the BOD5 data for the mill using 100 percent hardwood as its raw material.

012 Alkaline-Market. The nine mills in the Alkaline-Market subcategory have an average chronological age of 23 years, making this one of the more modern subcategories in the industry. These mills primarily produce market pulp, at an average production of 570.5 kkg/day (629 tons/day). Four mills produce pulp from predominately softwood, three use mostly hardwood, and two use a mixture of hardwood and softwood.

Raw waste loads for mills in this subcategory are presented in Table V-2. As shown, the softwood mills generate higher waste loads per ton of product than the hardwood or mixed species mills. The loadings from three predominantly softwood mills have been averaged to establish the following model mill raw waste load:

Flow 178.2 kl/kkg (42.8 kgal/t);
BOD5 41.5 kg/kkg (83.0 lb/ton); and
TSS 31.8 kg/kkg (63.6 lb/ton).

The predominantly softwood mills average 85 percent softwood and 15 percent hardwood as their raw material. For mills generally exceeding 15 percent hardwood production, raw waste load allowances can be decreased to reflect the lower inherent potential loading from hardwood production. For each percentage of hardwood production in excess of 15 percent, allowances can be decreased 0.18 kg/kkg (0.36 lb/ton) for BOD5 and 0.14 kg/kkg (0.28 lb/ton) for TSS.

013 Alkaline-BCT. In this subcategory of eight mills, bleached alkaline pulps are produced for use on-site in paperboard, tissue and coarse grade-

TABLE V-1

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 011 - ALKALINE-DISSOLVING

Production Profile			Raw Waste Load					
			Flow		BOD5		TSS	
Mill No.	Raw Material[a]	Dissolving Pulp (%)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
032001	100% HW	72	136.8	(32.8)	109.5	(219.0)	120.4	(240.7)
032002	100% SW	45	218.1	(52.3)	35.4	(70.8)	28.7	(57.3)
032003	88% SW	59	238.9	(57.3)	53.8	(107.6)	81.6	(163.2)
Average	--	58.7	198.1	(47.5)	61.2	(132.4)	76.8	(153.7)
Median					53.8	(107.6)		
Model Mill			198.1	(47.5)	53.8	(107.6)	76.8	(153.7)

[a] HW = Hardwood; SW = Softwood.

TABLE V

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 012 - ALKALINE-MARKET

Production Profile					Raw Waste Load					
	Pulp (t/d)				Flow		BOD5		TSS	
Mill No.	Hardwood	Softwood	Product	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Softwood Mills										
030006	--	582	bales	582	179.4	(43.1)	41.3	(82.5)	22.4	(44.7)
030018	103	441	bales	544	184.4	(44.3)	39.2	(78.3)	48.40	(96.8)
030030	153(a)	570(a)	bales	723	171.1	(41.1)	44.1	(88.1)	24.7	(49.4)
030031	87(a)	254(a)	bales	341	332.2	(79.8)(b)	44.0	(88.0)(b)	132.0	(264.0)(b)
Average	86	462	bales	548	178.2	(42.8)	41.5	(83.0)	31.8	(63.6)
Hardwood Mills										
030005	369	--	bales	369	73.3	(17.6)	17.5	(35.0)	20.4	(40.8)
030009	592	--	bales	592	134.9	(32.4)	--	(--)	--	(--)
030012	383(a)	45(a)	bales & tissue	455	154.0	(37.0)	35.7	(71.4)	98.0	(196.0)(b)
Average	448	15		472	120.7	(27.0)	26.6	(53.2)	20.4	(40.8)
Mixed Mills										
030028	438	1210	board/ bales/roll	1,649	149.1	(35.8)	35.5	(71.0)	24.0	(47.9)
030042	261	148	slush	409	78.3	(18.8)	37.4	(74.8)	14.35	(28.7)
Average	350	679		1,029	113.7	(27.3)	36.45	(72.9)	19.2	(38.3)
Subcategory Average				629	134.7	(32.3)	32.7	(65.3)	29.2	(58.3)
Model Mill					178.2	(42.8)	41.5	(83.0)	31.8	(63.6)

(a) Adjusted to equal total production, revised per discussion with mill.
(b) Not included in average because of apparent inconsistency in reported data.

papers (bag, packaging, etc.). The average original construction date of these mills is 1958. Average production is about 789 kkg/day (870 tons/day).

Based on data shown in Table V-3, the ratio of hardwood to softwood has little effect on raw waste load parameters. Mills making all softwood average the same flow and lower BOD5 than the eight-mill average.

The model mill raw waste load for this subcategory is the average for the eight mills:

Flow: 152.2 kl/kkg (36.5 kgal/t);
BOD5: 45.7 kg/kkg (91.3 lb/ton); and
TSS: 42.6 kg/kkg (85.0 lb/ton).

The predominantly softwood mills average 85 percent softwood and 15 percent hardwood as their raw material. For mills generally exceeding 15 percent hardwood production, raw waste load allowances can be decreased to reflect the lower inherent potential loading from hardwood production. For each percentage of hardwood production in excess of 15 percent, allowances can be decreased 0.18 kg/kkg (0.36 lb/ton) for BOD5 and 0.14 kg/kkg (0.28 lb/ton) for TSS.

014 Alkaline-Fine. The 18 mills in this subcategory have an average initial construction date of 1911. Most of these mills produce both hardwood and softwood pulps on-site, enabling the blending of pulps to give the desired strength and optical properties to a variety of fine printing, writing, and business papers. Both coated and uncoated papers are produced. Typically, clay, titanium dioxide, and other mineral fillers are used extensively in the base sheet, as well as in the coatings to give the desired appearance and printing properties.

Table V-4 summarizes the raw waste load data from the 18 mills in this subcategory. While there are observable differences between mills with respect to filler loading, the pattern is not consistent except for a possible decline in BOD5 as total filler (or coating pigment) in the furnish increases. Surprisingly, there is not a clear indication of the expected increase in TSS with the increased addition of filler.

Three mills make some groundwood pulp in addition to alkaline pulp; these three mills have BOD5 loads nearly 88 percent higher than the average of other mills in the Alkaline-Fine subcategory. The higher BOD5 loads possibly reflect difficulty in adequately balancing whitewater systems in the more complex mills.

Product requirements apparently have a significant influence on raw waste loads. To recognize the unique papermaking requirements in most fine paper mills, the subcategory average is selected to serve as the model mill raw waste load. This subcategory average excludes the three mills making some groundwood, and one mill which reported data which appear inconsistent with the remaining mills in the subcategory. The model mill average raw waste load is:

TABLE V-3

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 013 - ALKALINE-BCT

	Production Profile						Raw Waste Load					
	Pulp (t/d)		Product (t/d)				Flow		BOD5		TSS	
Mill No.	HW	SW	Board	Tissue	Coarse	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
030004	436	535	548	343	69	960	186.5	(44.8)	57.5	(115.0)	41.7	(83.3)
030010	--	335	--	231	84	315	191.5	(46.0)	37.2	(74.3)	42.9	(85.7)
030022	352	943	907	--	394	1,301	156.5	(37.6)	33.2	(66.4)	--	(--)
030024	512	368	714	--	106	820	137.4	(33.0)	57.5	(115.0)	--	(--)
030026		1,073	727	59	367	1,153	120.7	(29.0)	44.1	(88.2)	14.7	(29.3)
030047	306	204	583	--	--	583	130.3	(31.3)	64.0	(128.0)	79.5	(159.0)
030032	584	576	895	--	348	1,243	137.8	(33.1)	42.6	(85.2)	48.3	(96.5)
030039	291	238	487	--	107	594	154.9	(37.2)	29.2	(58.4)	24.0	(47.9)
Average	310	534	608	80	184	871	152.2	(36.5)	45.7	(91.3)	42.5	(85.0)
Model Mill							152.2	(36.5)	45.7	(91.3)	42.5	(85.0)

TABLE V-4

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 014 - ALKALINE-FINE

	Production Profile								Raw Waste Load					
	Pulp (t/d)		Purchased (t/d)		Product (t/d)				Flow		BOD5		TSS	
Mill No.	HW	SW	Pulp	Broke	Ctd	Unctd	Other	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Mills making more than 95 percent of their own pulp and using high clay														
030027	232	199	18	78	110	310	345	765	72.0	(17.3)	21.5	(43.0)	32.9	(65.8)
030049	499	224	9	33	1,137	41		1178	72.4	(17.4)	21.5	(43.0)	54.95	(109.9)
030015	124	123	11	45	370	--	--	370	123.7	(29.7)	50.95	(101.9)	81.0	(162.0)(a)
Average	305	182	13	52	539	117	115	771	89.5	(21.5)	31.3	(62.6)	56.3	(112.6)
Mills making more than 95 percent of their own pulp and using low clay														
030013	146	129	25	154	68	120	322	510	122.4	(29.4)	--	(--)	--	(--)
030037	449	476	60	102	--	114	914	1028	118.2	(28.4)	--	(--)	--	(--)
030046	408	232	4	-	348	342	50	748	132.4	(31.8)	31.12	(62.3)	80.5	(161)
030052	237	311	--	72		600	87	687	127.4	(30.6)	--	(--)	--	(--)
Average	310	287	22	82	104	294	343	741	124.9	(30.0)	31.12	(62.3)	80.5	(161)
Mills - High Softwood														
030051	113	218	194	-	-	-	612	612	93.7	(22.5)	32.67	(65.3)	40.85	(81.7)
Mills Making Some Groundwood(b)														
030033	216	334	130	28	412	242	184	838	139.4	(33.4)	75.4	(150.7)	--	(--)
030045	270	460	55	139	524	51	388	963	148.2	(35.6)	65.2	(130.4)	126.0	(252)
030048	359	240	72	10	--	--	956	956	111.2	(26.7)	31.5	(63.0)	90.0	(180)
Average	282	345	86	46	312	98	509	919	132.8	(31.9)	57.4	(114.7)	108.0	(216)
High Clay Mills - High Softwood														
030020	--	174	118	27			417	417	115.7	(27.8)	25.5	(51.0)(c)	78.5	(157)
High Clay Mills - High Hardwood														
030034	341	109	90				708	708	119.1	(28.6)	--	(--)	--	(--)
Low Clay Mills - High Hardwood														
030001	101	35	23	10			191	191	101.6	(24.4)	22.7	(45.3)	46.6	(93.2)
030057	181	-	132			378		378	106.6	(25.6)	39.9	(79.8)	79.5	(159.0)
030059	540	-	370	100		1160		1160	122.4	(29.4)	39.1	(78.1)	147.5	(295.0)
030060	193	110	102	5		456	54	510	163.2	(39.2)	39.2	(78.3)	101.5	(203.0)
130001	535		129	70		458	233	691	74.1	(17.8)	39.8	(79.5)	23.7	(47.4)
Average	310	29	151	37		490	96	586	113.7	(27.3)	36.1	(72.2)	8.0	(160.0)
Model Mill (d)									110.5	(26.5)	30.5	(61.0)	66.2	(132.3)

(a) Data appears inconsistent; not included in average.
(b) Not producing enough groundwood to be included in groundwood subcategory; because of high loadings, these mills not included in Alkaline-Fine subcategory average for model mill.
(c) Calculated data.
(d) Average of subcategory, excluding Mills No. 030015, 030033, 030045, and 030048.

Flow 110.5 kl/kkg (26.5 kgal/t);
BOD_5 30.5 kg/kkg (61.0 lb/ton); and
TSS 66.2 kg/kkg (132.3 lb/ton).

015 Alkaline-Unbleached. The Alkaline-Unbleached subcategory includes 29 mills, having an average chronological age of 29 years. Fifteen of these mills produce linerboard plus some market pulp; however, one mill makes linerboard but uses too much waste paper to be considered typical for this subcategory. The typical linerboard mill produces about 907 kkg/day (1,000 tons/day). Eleven mills make bag paper or a mixture which includes bag paper; these eleven average 797 kkg/day (879 tons/day production). Three other mills make greater than 50 percent specialty packaging, carbonizing or tissue papers.

These 29 mills are large, but relatively simple in process. Unbleached softwood pulp is produced with only a trace of hardwood. Waste paper use is minimal (averaging 3 percent), but is apparently increasing in this subcategory as a cost reduction step. The impact of waste paper use on raw waste loads can not be determined because of the low levels now used.

As shown in Table V-5, average raw waste load data is presented separately for the 15 linerboard mills, the 3 specialty mills and the 11 bag mills. The average raw waste load for the linerboard mills is:

Flow 46.6 kl/kkg (11.2 kgal/t);
BOD_5 14.2 kg/kkg (28.3 lb/ton); and
TSS 16.3 kg/kkg (32.5 lb/ton).

The 11 bag mills have a slightly higher average raw waste loads, reflecting modified processing conditions, more refining and less tolerance for low quality, or off-specification stock. The average raw waste load for the bag mills is:

Flow 70.5 kl/kkg (16.9 kgal/t);
BOD_5 18.9 kg/kkg (37.7 lb/ton); and
TSS 20.7 kg/kkg (41.4 lb/ton).

The three mills making consumer items, packaging and industrial tissue grades from unbleached pulp demonstrate much higher raw waste loads than the linerboard or bag mills. These three specialty mills are not representative of the subcategory and may be considered for transfer to the Integrated-Miscellaneous mill grouping.

Because linerboard mills are the most numerous within this subcategory, their average raw waste load is chosen to represent the model mill in the cost evaluations presented later in this report. Effluent limitations guidelines and standards development will separately recognize the two major products (i.e., linerboard and bag) produced by mills in this subcategory. The average raw waste load for the model mill in the Alkaline-Unbleached subcategory is:

TABLE V-5

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 015 - ALKALINE-UNBLEACHED

Linerboard:

	Production Profile						Raw Waste Load					
	Furnish		Purch.	Production (t/d)			Flow		BOD5		TSS	
Mill No.	Kraft	WP	Broke	Liner Bd	Other	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010001	450		20	450		450	46.2	(11.1)	8.3	(16.5)	26.9	(53.7)
010002	923			934		934	44.1	(10.6)	12.7	(28.3)	24.7	(49.4)
010018	1,170	30		1,081		1,081	44.1	(10.6)	18.1	(36.1)	14.1	(28.2)
010019	1,127	39	27	1,141	7	1,151	35.0	(8.4)	9.6	(19.1)	4.8	(9.6)
010020	890	55	61	965	44	1,009	56.2	(13.5)	20.5	(41.0)	27.5	(55.1)
010025	523	39		563	4	567	44.5	(10.7)	13.9	(27.8)	9.8	(19.6)
010038	750	68	5	789		789	104.9	(25.2)	16.5	(32.9)	15.9	(31.7)
010049	1,195	85		1,220		1,220	64.9	(15.6)	14.7	(29.4)	11.4	(22.7)
010042	965			965		965	22.9	(5.5)	11.1	(22.2)	5.7	(11.3)
010043	1,539	10		1,549		1,549	44.1	(10.6)	21.7	(43.4)	13.9	(27.7)
010046	1,176		27	1,102	21	1,123	49.1	(11.8)	14.1	(28.2)	20.1	(40.2)
010047	1,299			1,194		1,194	26.2	(6.3)	6.7	(13.4)	10.8	(21.5)
010057	540		85	620		620	38.3	(9.2)	—	(--)	—	(--)
010063	615	78		694		694	31.7	(7.6)	46.3	(92.6)	9.9	(19.8) (a)
010064	644	51	—	666	5	666	33.7	(8.1)	14.8	(29.6)	24.3	(49.6)
Average	942	27	16	946	5	951	46.6	(11.2)	14.2	(28.3)	16.3	(32.5)

Packaging Item:

	Production Profile						Raw Waste Load					
	Furnish		Purch.	Production (t/d)			Flow		BOD5		TSS	
Mill No.	Kraft	WP	Broke	Bag	Other	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010034	948	--	48	—	925	925	94.6	(17.9)	36.8	(73.5)	24.3	(48.6)
010035	249	--	17	--	231	231	227.3	(54.5)	34.2	(68.4)	56.3	(112.6)
010048	347	--	57	--	402	402	223.1	(53.5)	32.8	(65.7)	23.2	(146.3)
Average	519	--	41	—	519	519	175.1	(42.0)	34.6	(69.2)	81.3	(102.5)

Bag:

	Production Profile						Raw Waste Load					
	Furnish		Purch.	Production (t/d)			Flow		BOD5		TSS	
Mill No.	Kraft	WP	Broke	Bag	Other	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010003	243	108	12	350	—	350	33.4	(8.0)	—	(--)	—	(--)
010005	1,286	--	8	332	898	1,230	61.3	(14.7)	18.8	(37.6)	18.9	(37.8)
010006	1,685	--	--	478	1,115	1,593	52.5	(12.6)	12.5	(25.0)	--	(--)
010008	1,895	--	51	434	1,540	1,974	73.8	(17.7)	18.8	(37.6)	45.7	(91.3)
010028	400	10	--	279	120	399	110.1	(26.4)	—	(--)	13.3	(26.6)
010032	372	—	--	323	--	323	47.1	(11.3)	18.3	(36.5)	17.4	(34.8)
010033	865	—	--	825	--	825	48.4	(11.6)	19.4	(38.8)	—	(--)
010044	1,020	—	32	709	365	1,074	57.1	(13.7)	12.5	(24.9)	17.8	(35.6)
010055	748	2	12	726	--	726	58.4	(14.0)	30.5	(60.9)	23.2	(46.4)
010060	470	--	25	443	--	443	85.1	(20.4)	—	(--)	—	(--)
010062	231	--	10	234	--	234	151.4	(36.3)	20.5	(41.0)	8.6	(17.2)
Average	883	11	18	512	367	879	70.5	(16.9)	18.9	(37.7)	207	(41.4)

	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Subcategory Average	70.0	(16.8)	19.1	(38.1)	28.3	(56.6)
Model Mill	46.6	(11.2)	14.2	(28.3)	16.3	(32.5)

(a) Mill No. 010063 produces linerboard but uses too much waste paper to be considered typical for this subcategory; data not included in average.

Flow 46.6 kl/kkg (11.2 kgal/t);
BOD5 14.2 kg/kkg (28.3 lb/ton); and
TSS 16.3 kg/kkg (32.5 lb/ton).

016 Semi-Chemical. The 19 mills in the Semi-Chemical subcategory have an average initial construction date of 1926. These mills produce corrugating media and other paperboard products. Pulping processes, chemical bases, and liquor recovery systems vary within this subcategory.

Raw waste loads for the 19 mills in this subcategory are presented in Table V-6. As can be seen, mills without liquor recovery generally exhibit much higher raw waste BOD5 and TSS loads than mills with suitable recovery systems. Mills without liquor recovery systems are not meeting existing BPT model mill raw waste loads and therefore are not included as part of the base for the updated model mill in this subcategory.

Differences in raw waste load related to pulping processes are addressed in Table V-7 for neutral sulfite semi-chemical (NSSC) versus no-sulfur processing. Except for the new no-sulfur process, earlier allowances for differing semi-chemical bases are not warranted. NH_3 base is nearly gone except for two mills, and no-sulfur and green liquor (cross-recovery) pulping methods are rapidly displacing NSSC. Such approaches are being taken in the industry to: 1) enable more semi-chemical production relative to kraft; or 2) to facilitate recovery of liquor, which was difficult to recover in the desired chemical form with NSSC.

Based on the very limited data shown in Table V-7, a slightly lower BOD5 and TSS raw waste loading appears to result from no-sulfur processing. Since the survey, many mills have switched to modified processes and the acquisition of additional confirmatory data would be useful. The model mill raw waste flow and BOD5 load for the Semi-Chemical subcategory are based on the average raw waste loads for mills No. 020002, 020003, 020008, 020009, 020017 and 060004. The model mill TSS data is the average of Mills No. 020002, 020003, 020008 and 020009. These mills have liquor recovery systems and produce about 80 percent of their furnish as Semi-Chemical; average flow, BOD5 and TSS loads are:

Flow 32.5 kl/kkg (7.8 kgal/t);
BOD5 18.5 kg.kkg (36.9 lb/ton); and
TSS 21.6 kg/kkg (43.1 lb/ton).

017 Alkaline-Unbleached and Semi-Chemical. The ten mills making alkaline-unbleached and semi-chemical pulps have an average initial construction date of 1945. These mills have an average production of nearly 1,360.5 kkg/day (1500 tons/day), ranging from 649 kkg/day (716 tons/day) to a high of 2,356 kkg/day (2,598 tons/day). The mills all produce unbleached kraft pulps together with high-yield unbleached semi-chemical pulps, utilized primarily in the manufacture of linerboard and corrugated media. Often other types of kraft board, bag and converting papers are also made on-site.

TABLE V-6

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 016 - SEMI-CHEMICAL

Mill No.	Production Profile: Furnish (t/d) Semi-Chem	WP	Broke	Total Prod. (t/d)	Raw Waste Load: Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
Mills With Liquor Recovery										
020002	248	90	20	331	24.1	(5.8)	12.9	(25.7)	30.2	(60.4)
020003	582 (a)	61		618	40.0	(9.6)	25.3	(50.5)	13.2	(26.3)
020008	231 (a)	125		318	22.9	(5.5)	9.6	(19.2)	6.0	(13.7)
020009	691 (a)	100		583	28.7	(6.9)	14.4	(28.8)	14.9	(29.8)
020017	506	173		595	30.4	(7.3)	21.0	(41.3)	44.5	(89.0)
060004	385 (a)	98	9	492	48.7	(11.7)	27.8	(55.6)	54.6	(109.1)
Average	442	108	5	490	32.5	(7.8)	18.5	(36.9)	27.4	(54.7)
									21.6	(43.1)(b)
Mills With No Liquor Recovery										
020005	137	46		183	47.0	(11.3)	56.0	(111.9)	52.3	(104.5)
020014	394	117		511	26.6	(6.4)	31.2	(62.3)	18.8	(37.6)
020015	118	50		169	21.0	(5.0)	33.2	(66.3)	27.9	(55.7)
Average	216	71		283	32.0	(7.6)	40.1	(80.2)	33.0	(65.9)
Mills With More Than One-Third Wastepaper and Liquor Recovery										
020001	204	116		302	19.2	(4.6)	23.6	(47.1)	8.1	(16.1)
020004	160	106		266	25.8	(6.2)	1.4	(2.7)	0.15	(0.3)
020006	190	99		291	16.2	(3.9)	21.7	(48.3)	--	(--)
020007	183 (a)	123		346	11.7	(2.8)	--	(--)	--	(--)
020011(c)	235	157		377	34.1	(8.2)	22.6	(45.2)	5.9	(11.9)
Average	194	120		316	18.2	(4.4)	16.4	(32.7)	4.1	(8.2)
Mills Producing Products Which Are Not Representative of Subcategory										
020018	217	450		673	30.4	(7.3)	62.7	(125.5)	61.5	(123.0)
020010	542 (a)	80		622	60.5	(14.5)	17.9	(35.7)	49.3	(98.5)
020012	388 (a)	243		604	28.4	(6.8)	--	(--)	--	(--)
020013	472	173		599	58.0	(13.9)	38.9	(77.8)	37.7	(75.4)
020016(d)	200	221		525	55.5	(13.3)	50.5	(101.0)	9.5	(19.0)
Model Mill					32.5	(7.8)	18.5	(36.9)	21.6	(43.1)

(a) No-sulfur pulping.
(b) TSS data is the average of four mills in this subgroup excluding mills No. 020017 and 060004, which appear inconsistent).
(c) Mill No. 020011 combines effluent with other mills; data not included in subgroup average.
(d) Mill No. 020016 is not typical and has poor liquor recovery; data not included in subgroup average.

TABLE V-7

RAW WASTE LOAD COMPARISON - NSSC VS NO-SULFUR PULPING

Process Used	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Typical Semi-chemical Mill with recovery	32.5	(7.8)	18.5	(36.9)	21.6	(43.1)
No Sulfur with recovery	36.2	(8.7)	16.2	(32.5)	19.3	(38.6)

As shown in Table V-8, the typical mill produces about four times as much kraft pulp as NSSC. This reflects a typical balanced cross-recovery system, with fresh liquor make-up to the NSSC side counterbalancing losses from that operation and from the kraft mill. The distribution of production, as well as the range in the ratio of NSSC to unbleached kraft, are reasonably constant in this subcategory, except for one mill which produces about 10 times as much kraft as NSSC.

There are no clear trends in raw waste effluent loads relative to either changes in the semi-chemical pulp production or to variations in the products produced. Six mills in this subcategory are utilizing varying levels of green liquor for pulping in the semi-chemical operation; however there appears to be no statistical basis for any appreciable difference in the raw waste loads of the NSSC type cook compared to the increasingly popular green liquor cook.

The model mill, based on the ten mill average, has the following raw waste load:

Flow 55.8 kl/kkg (13.4 kgal/t);
BOD5 18.7 kg/kkg (37.3 lb/ton); and
TSS 23.5 kg/kkg (47.0 lb/ton).

019 Alkaline-Newsprint. There are three mills in this new subcategory, all producing newsprint from blends of kraft and groundwood pulps prepared on-site. Production ranges from 816.3 to 1,269.8 kkg/day (900 to 1,400 tons/day). The average mill in this subcategory was built in 1947. Operation of these reasonably modern mills is simplified because of the relatively few and minor changes in the grades commonly produced. Bleaching operations generally consist of only three stages, using CEH; thus, total water use is significantly reduced compared to multi-stage full bleach operations.

In two of the mills, a small portion of the pulp is sold as market kraft, and in one about 6 percent of the production is sold as other groundwood-containing printing grades. As shown in Table V-9, the bleached kraft production in all three ranges from 32 to 39 percent of the total furnish. Groundwood is refiner and stone groundwood, ranging from 54 to 68 percent of the furnish.

TABLE V-8

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 017 - ALKALINE-UNBLEACHED AND SEMI-CHEMICAL

	Production Profile						Raw Waste Load					
	NSSC[d]	UBK	Corrug.	Brd	Bag	Prod.	Flow		BOD5		TSS	
Mill No.	(%)	(%)	(%)	(%)	(%)	(t/d)	kl/kkg	(kg/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
015001(a)	17	86	21	74	5	1,745	58.3	(14.0)	23.6	(47.5)	27.5	(55.0)
015002	20	67	24	60	17	873	47.0	(11.3)	13.5	(27.0)	13.5	(26.9)
015003	16	85	20	80	0	1,792	50.1	(12.2)	18.8	(37.6)	29.0	(58.0)
015004	16	77	18	70	12	1,509	67.4	(16.2)	17.1	(34.1)	47.0	(37.3)(b)
015005(a)	16	84	21	0	79	1,394	38.7	(9.3)	12.4	(24.8)	33.5	(67.0)
015006(a)	9	90	12	50	38	2,598	50.4	(12.1)	18.9	(37.7)	9.8	(19.5)
015007(a)	14	76	21	79	0	1,700	52.0	(12.5)	16.3	(32.6)	25.1	(50.1)
015008(a)	18	84	16	84	0	1,133	80.7	(19.4)	19.0	(38.0)	20.7	(41.4)
015009(a)	28	65	38	62	0	716	57.5	(13.8)	28.1	(56.1)	29.2	(58.4)
010017(c)	13	91	16	58	26	1,428	36.6	(8.8)	17.5	(34.9)	38.3	(76.5)
Average	17	79	21	62	17	1,494	55.8	(13.4)	18.7	(37.3)	23.5	(47.0)
Model Mill							55.8	(13.4)	18.7	(37.3)	23.5	(47.0)

(a) Market pulp production is included with board production data; production of converting papers is included with bag production.

(b) Mill No. 015004 produces coated board; therefore TSS data is not included in subcategory average.

(c) Mill No. 010017 is in litigation and provided late data; this data is not included in subcategory average.

(d) Calculated percentage based on claimed product production. Other fibers and/or losses not accounted for.

TABLE V-9

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 019 - ALKALINE-NEWSPRINT

	Furnish								
	Bl.Kr.		Ref./ Stone G.W.		TMP, Cold Soda		Broke		Total
Mill No.	(%)	(t/d)	(%)	(t/d)	(%)	(t/d)	(%)	(t/d)	(t/d)
054005	32	565	56	987	12	219	0	0	1,771
052010	39	578	54	801	8	113	0	4	1,496
054003	32	348	68	755	-	-	-	0	1,103

	Production								
	Newsprint		Market Kraft		Printing		GW Specialties		Total
Mill No.	(%)	(t/d)	(%)	(t/d)	(%)	(t/d)	(%)	(t/d)	(t/d)
054005	91	1412	3	54	6	99	-	0	1,565
052010	84	1190	16	221	-	0	-	0	1,411
054003	89	919	-	0	-	0	11	118	1,037

	Raw Waste Load					
	Flow		BOD5		TSS	
Mill No.	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
054005	97.6	(23.5)	26.6	(53.2)	44.8	(89.5)
052010	107.4	(25.8)	24.7	(49.4)	67.0	(133.9)
054003	93.8	(18.2)	12.0	(24.0)	55.8	(111.5)
Average	93.8	(22.5)	21.1	(42.2)	56.7	(113.3)
Model Mill	93.8	(22.5)	21.1	(42.2)	56.7	(113.3)

In two mills, thermo-mechanical type pulps are also produced, ranging from 8 to 12 percent.

Even with the complex operations noted, water use per ton averages only 93.8 kl/kkg (22.5 kgal/t) for the three mills. Raw waste load BOD5 averages 21.1 kg/kkg (42.2 lb/ton), and raw waste load TSS averages 56.7 kg/kkg (113.3 lb/ton). The three-mill average serves as the model mill raw waste load for this subcategory.

021 Sulfite-Dissolving. The Sulfite-Dissolving subcategory consists of six operating mills with an average age of 36 years. Most of the mills produce a range of products including papergrade pulps, as well as several types of high alpha cellulose content dissolving pulps. The mills average 493 kkg/day (544 tons/day) production, typically utilizing all roundwood (predominantly softwood) with a small amount of associated hardwood.

Batch digesters are generally utilized, followed by brown stock washers and evaporators. Both magnesium and ammonium base pulping operations are noted. Extensive evaporation systems are required and usually entail two evaporator lines operating in series. The magnesium base operation facilitates the use of MgO to neutralize spent sulfite liquor and subsequently results in a reduction of BOD5 from the evaporator condensate. Presently, this is only done in one of the six mills.

Bleaching sequences vary widely; however, sequential or mixed stage bleaching is commonly employed, using chlorine and chlorine dioxide followed by extraction, and typically one or more hypochlorite and dioxide stages. A typical mill would operate two separate bleach lines to accommodate the product mix.

Average raw waste flow and BOD5 for the mills in this subcategory are higher than those in any other subcategory of the pulp, paper and paperboard industry. The high BOD5 results from the bleaching operations. Because of the very high wood substrate loss occurring during bleaching, any material subsequently dissolved and discharged as filtrate appears as a high BOD5 load, even though the spent sulfite liquors resulting from the cooking operations are effectively evaporated and recovered in efficient recovery furnaces. One mill also has provision for the reclamation of the caustic bleach stage filtrate, thus significantly reducing its BOD5 discharge.

As shown in Table V-10, the raw waste load for the six mills in this subcategory averages 256.9 kl/kkg (61.6 kgal/t) flow, 153 kg/kkg (306 lb/ton) BOD5, and 90.3 kg/kkg (180.6 lb/ton) TSS. This average serves as the model mill raw waste load for this subcategory.

022 Sulfite-Papergrade. This subcategory consists of 18 mills with an average initial construction date of 1908. These mills utilize the sulfite cooking process to produce pulps from which writing, printing, business, and tissue papers are made. Mills included in this subcategory produce pulps using calcium, sodium, ammonium and magnesium base in cooking. Production ranges from 97 to 874 kkg/day (107 to 964 tons/day).

TABLE V-10

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 021 - SULFITE-DISSOLVING

Mill No.	Production (t/d)	Raw Waste Load Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
046001	451	200.3	(48.1)	132.5	(265)	44.0	(88.0)
046002	557	289.4	(69.5)	156.0	(312)	--	(--)
046003	620	290.6	(69.8)	114.5	(229)	--	(--)
046402	787	190.3	(45.7)	97.0	(194)	39.6	(79.2)
046403	464	357.3	(85.9)	276.0	(552)	15.2	(30.4)
046050	387	210.3	(50.5)	142.5	(285)	140.9	(281.9)
Average	544	256.5	(61.6)	153.0	(306)	90.3	(180.6)
Model Mill		256.5	(61.6)	153.0	(306)	90.3	(180.6)

Mill operations range from those without any recovery system to those utilizing evaporation and modern recovery furnaces. As shown in Table V-11, mills which had blowpit (BP) washing and no recovery systems (such as mill No. 040006) had high raw waste flow and BOD_5 loads. Since the survey period, two mills without recovery systems and with blow pit washing have been shut down thus leaving only one calcium base pulping operation without a recovery system.

Earlier BPT model mill raw waste load characteristics for this subcategory were high, thus reflecting the presence of mills without recovery systems. However, updated model mill characteristics are based on the operation of effective recovery systems or provisions for disposal of the evaporated liquor from the pulping operations. Thus, Table V-11 presents the following model mill raw waste load:

Flow	152.6 kl/kkg	(36.6 kgal/t);
BOD_5	48.7 kg/kkg	(97.3 lb/ton); and
TSS	33.1 kg/kkg	(66.2 lb/ton).

Based on the raw waste load data provided presented in Table V-11, there is not adequate justification for establishing different allowances reflecting the type of base used in pulping, although such allowances have been made in the past. Factors such as the percent of pulp produced relative to the total furnish requirements, and the impact of sulfite liquor recovery, far overshadow differences in the base used.

032 Thermo-Mechanical Pulp (TMP). This subcategory contains only two mills. However, the use of TMP type pulps is increasing rapidly. Therefore, a raw waste load analysis is made to serve as a basis for guidelines which subsequently would be required in writing discharge permits for larger complex mills employing the thermo-mechanical pulping process. The two mills now in this subcategory make 140 and 373 kkg (155 and 411 tons) per day, respectively. One mill produces coarse uncoated printing grades, with 90 percent of its furnish consisting of TMP pulp produced from softwood as roundwood and chips. At this mill pulp is bleached with sodium hydrosulfite to approximately 61 GE brightness. An increasing use of purchased chips is noted; the barking system is operated dry but with an extensive chip washing system.

The second mill produces newsprint exclusively, with only 55 percent of its furnish consisting of TMP pulp. Raw wastewater data for this mill is incomplete.

Because the first mill reported complete raw and final effluent data, and because it produces a greater percentage of TMP, it serves as the basis for the model mill BOD_5 and TSS raw waste load determinations. The average raw waste flow for the two mills is about 60 kl/kkg (14.4 kgal/t), which serves as the model mill raw waste load flow. Typical raw waste load characteristics, as reported in Table V-12, are lower than those postulated for the model mill during earlier guidelines development.

TABLE V-11

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 022 - SULFITE-PAPERGRADE

	Production Profile				Raw Waste Load					
	Production		Process		Flow		BOD5		TSS	
Mill No.	(t/d)	Product	Wash[a]	Base[d]	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
040001	107	Corrug. Market	BP	NH3 BS	113.9	(32.1)	68.0	(136)	--	(--)
040002	547	Market Tissue	DR	Ca,Na A, BS	312.8	(75.0)	84.0	(168)	21.0	(42)
040003	493	Newsprint Market	DR	MgO,BS	93.0	(22.3)	39.5	(79)	93.5	(187)
040006	131	Tissue Market	BP	NH3,A	346.5	(83.1)	25.1	(502)	--	(--)
040007	135	Market	BP	NH3,A	196.0	(47.0)	421.5	(843)	--	(--)
040008	964	Tissue Market	DR	NH3,A	239.4	(47.4)	--	(--)	--	(--)
040009	566	Write Market	DR	MgO,BS	83.8	(20.1)	49.0	(98)	28.5	(57)
040010	224	Glassine Package	DR	Ca,A	316.5	(75.9)	30.5	(61)	56.0	(112)
040011	284	Write Thin	DR	Ca,A	97.2	(23.3)	45.0	(90)	26.0	(52)
040012	270	Write Print	DR	NH3,A	247.3	(49.3)	63.5	(127)	16.5	(33)
040013	334	Printing	DR	MgO,BS	118.0	(28.3)	50.5	(101)	27.5	(55)
040014	146	Write Laminating	BP	Ca,A	170.0	(40.8)	109.5	(219)	19.5	(39)
040015	155	Market	--	Ca,BS	--	(--)	--	(--)	--	(--)
040016	437	Writing	DR	NH3,BS	159.3	(38.2)	109.0	(218)	140.0	(280)
040017	412	Print Market	DR	Ca,A	116.3	(27.9)	97.0	(194)	37.0	(74)
040018	359	Tissue	DR	Ca,A	93.0	(22.3)	--	(--)	--	(--)
040019	769	Tissue	DR	NH3,A	58.8	(14.1)	44.0	(88+)	19.5	(39+)
040020	671	Tissue	DR	NH3,A	100.5	(24.1)	36.5	(73)	12.0	(24)
Average[b]	389	Tissue			143.0	(34.3)	57.5	(115)	45.6	(91.3)
Model Mill[c]					152.6	(36.6)	48.7	(97.3)	33.1	(66.2)

(a) BP = blow pit washing (these mills do not have recovery systems); DR = drum washing.
(b) Excludes Mills No. 040006, 040007, and 040014, which have blow pit washing.
(c) Model mill flow and BOD5 data is the average of Mills No. 040008, 040012, 040013, 040018, and 040019, which use NH3 and MgO bases with good drum washing and effective recovery systems; model mill TSS data is the average of the same five mills plus six additional mills with drum washing.
(d) A = acid, BS = bisulfite, Ca = calcium, NA = sodium, NH3 = ammonia, MgO - magnesium oxide

TABLE V-12

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 032 - THERMO-MECHANICAL PULP

	Production Profile				Raw Waste Load					
					Flow		BOD5		TSS	
Mill No.	% TMP	Total % GW	(t/d)	Product	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
070001	90	90	155	Coarse, Uncoated Printing	79.1	(19.0)	18.3	(36.5)	38.7	(77.4)
070002	55	72	411	Newsprint	48.0	(9.8)	--	(--)	--	(--)
Average					60.0	(14.4)				
Model Mill					60.0	(14.4)	18.3	(36.5)	38.7	(77.4)

033 Groundwood-CMN. This subcategory consists of six mills with an average age since initial construction of 41 years. The mills range in size from 10 to 892 kkg/day (11 to 983 tons/day) total production, including newsprint, molded products and groundwood specialty and printing grades. Both refiner and stone groundwood processes are in use. Approximately one-third of the furnish is purchased softwood baled pulps.

Two molded pulp mills are the smallest, at 10 and 45 kkg/day (11 and 50 tons/day) capacity, while the newsprint operations range from 421.8 to 891.6 kkg/day (465 to 983 tons/day). The typical mill uses predominantly softwoods for the manufacture of on-site groundwood.

The woodroom operation generally utilizes a dry barking system. The present technology and the typical grinding and screening operations entail the use of a central whitewater tank and reuse of thickener filtrate for dilution at the grinders and the screen room. The only major continuous sources of wastewater are from the screens and centricleaners. Papermachines typically do not utilize savealls, and reuse of whitewater is consequently limited in the papermaking operations. Therefore, average effluent loads are slightly higher in terms of water use and BOD_5 discharge than loads from mills in the Groundwood-Fine subcategory.

Raw waste load factors and production data are shown on Table V-13. As shown, the three mills making newsprint are the largest in this subcategory. Their average raw waste flows and BOD_5 loads are selected for the model mill raw waste load. However, TSS data for these three mills is not adequate; therefore, the model mill TSS load has been taken from model mill characteristics established in earlier BPT guidelines development for this subcategory. Model mill raw waste loads are:

Flow 88.4 kl/kkg (21.2 kgal/t);
BOD_5 18.6 kl/kkg (37.1 lb/ton); and
TSS 48.5 kl/kkg (97.0 lb/ton).

034 Groundwood-Fine. The subcategory consists of eight mills, the average of which was built in 1902. These mills produce an average of 421.8 kkg/ day (465 tons/day) of printing and publication grades, both coated and uncoated. The percent of the furnish produced as groundwood ranges from 52 to 73 percent. The average mill produces a product containing approximately 22 percent total filler.

Although a wide range of production is noted, the raw waste characteristics of these mills per ton of production are closely grouped compared to many other subcategories. As shown in Table V-14, average raw waste characteristics for the whole subcategory are: 68.4 kl/kkg (16.4 kgal/t) flow; 17.6 kg/kkg (35.2 lb/ton) BOD_5; and 53.9 kg/kkg (107.9 lb/ton) TSS.

Total suspended solids loss for this subcategory is high, reflecting the loss of pigments from the predominantly filled and coated sheets produced. However, the BOD_5 loading is among the lowest of integrated mills, reflecting the simple operation and almost complete retention of the wood in the finished

TABLE V-13

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 033 - GROUNDWOOD-CMN

Production Profile				Raw Waste Load					
	G.W.	Production		Flow		BOD5		TSS	
Mill No.	(t/d)	(t/d)	Type	kl/kkg	(kgal/t)	(kg/kkg	(lb/t)	kg/kkg	(lb/t)
052015	74	94	Newsprint, Fine	99.5	(23.9)	--	(--)	--	(--)
052016	369	465	Newsprint	46.6	(11.2)	19.5	(38.9)	--	(--)
054006	36	50	Molded	108.3	(26.0)	19.0	(38.0)	56	(112.0)
054010	8	11	Molded	121.6	(29.2)	15.1	(30.1)[a]	--	(--)
054013	30	45	G.W. Specialty	180.3	(43.3)	17.9	(35.8)	97.5	(195.0)
054015	693	983	Newsprint G.W. Spec	118.7	(28.5)	21.4	(42.7)	47.25	(94.5)
Average	202	275	Newsprint/Molded	112.4	(27.0)	19.4	(38.9)	66.9	(133.8)
Model Mill[b]			Newsprint	88.4	(21.2)	18.6	(37.1)	48.5	(97.0)

[a] Calculated data, based on final effluent; not included in average.

[b] Model mill flow and BOD5 loads are based on three newsprint mills. Because of lack of TSS data and wide variation in the three mills, the BPT model mill TSS load of 48.5 kg/kkg (97 lb/ton) was used as the updated model mill TSS loading.

TABLE V-14

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 034 - GROUNDWOOD-FINE

	Production Profile			Raw Waste Load					
	Production		Groundwood	Flow		BOD5		TSS	
Mill No.	(t/d)	Type	(%)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
052003	536	Printing	62	87.8	(21.1)	12.2	(24.3)	60.9	(121.8)
052004	481	Coated	55	65.8	(15.8)	28.6	(57.2)	79.2	(158.4)
052005	755	Printing	52	55.4	(13.3)	27.8	(55.6)	56.7	(113.3)
052007	224	Printing	67	96.6	(23.2)	--	--	--	--
052008	787	Coated	58	54.5	(13.1)	10.1	(20.1)	56.0	(112.0)
052013	572	Coated	54	69.9	(16.8)	15.6	(31.2)	41.4	(82.7)
052014	285	Coated	53	54.5	(13.1)	12.0	(24.0)	36.9	(73.7)
054014	76	Printing Specialties	73	61.2	(14.7)	16.9	(33.7)	46.7	(93.4)
Average	465		59	68.4	(16.4)	17.6	(35.2)	53.9	(107.9)
Model Mill				68.4	(16.4)	17.6	(35.2)	53.9	(107.9)

product. Likewise, compared to other integrated operations, water use per ton is generally low. Average raw waste flow is considerably lower than that for the model mill established earlier for BPT guidelines development. The updated model mill raw waste load is the average of the eight mills in this subcategory.

101 Deink-Fine and Tissue. The 17 mills in this subcategory are among the oldest in the industry, dating back to an average mill construction date of 1908. Nine of these mills produce essentially 100 percent deink stock on-site for conversion into sanitary tissue. The remaining eight mills incorporate higher percentages of purchased pulp in their furnish. Five of these eight produce a variety of uncoated and coated printing and writing grades. The other three produce sanitary tissue.

The difference in raw waste load between these three groups of mills is relatively minor. As shown in Table V-15, raw waste averages for nine tissue mills predominantly utilizing deinked stock are: 81.3 kl/kkg (19.5 kgal/t) flow; 48.7 kg/kkg (97.4 lb/ton) BOD_5; and 143.0 kg/kkg (286.0 lb/ton) TSS. These nine mills comprise the largest subgroup within this subcategory and their average raw waste load is chosen for the representative model mill.

A predominant characteristic of this deink subcategory is the high TSS loss per ton of production. This loss exceeds that from every other subcategory, including Sulfite-Dissolving. It is difficult to deink mixed waste papers to produce tissue with essentially no filler content, or fine papers with a very low controlled level of filler acceptable to meet the final product specifications. Excess filler is received along with the fiber source for these deink mills, and this imbalance results in high TSS discharges from the production process.

102 Deink-Newsprint. There are three mills in this subcategory, all operated by the same company. The deinking process is proprietary. All of these mills are of modern design, with an average construction date of 1965. Likewise, they were constructed emphasizing water recycle and minimum water use and designed with minimal BOD_5 and TSS loss in the raw effluent, which in every case goes to a POTW.

Raw waste loads from the three mills in this subcategory are significantly lower than those for the Deink-Fine and Tissue subcategory. BOD_5 loads are approximately one-third as high, and TSS is about 40 percent that of the Deink-Fine and Tissue subcategory. This is to be expected, as the furnish for these operations is essentially 100 percent waste and over-issue news, which is prepared, screened, cleaned and deinked and subsequently reconverted into newsprint. This uniformity of raw material is in contrast to the mixed waste paper which is utilized in tissue grade deinking operations. Raw waste loads average: 67.6 kl/kkg (16.2 kgal/t) flow, 15.9 kg/kkg (31.7 lb/ton) BOD_5, and 123.0 kg/kkg (246.0 lb/ton) TSS. These averages represent the model mill raw waste loads for this subcategory.

TABLE V-15

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 101 - DEINK-FINE AND TISSUE

	Production Profile						Raw Waste Load					
	Furnish (t/d)				Production		Flow		BOD5		TSS	
Mill No.	Deink	W.P.	Purch.	Broke	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Tissue and Market Pulp Mills Utilizing Predominantly Deink Furnish												
140011	124	--	1	3	92	San. Tissue	90.3	(21.7)	104.5	(209)	292.5	(585)
140014	824	--	49	--	845	San. Tissue	90.3	(21.7)	73.0	(146)	225.5	(451)
140015	54	--	--	--	51	Tissue	138.6	(33.3)	17.5	(35)	14.5	(29)
140016	146	--	--	--	146	Mkt. Pulp	8.3	(2.0)	34.5	(69)	69.0	(138)
140018	36	--	--	1	36	Ind.Wrap,Tiss.	25.4	(6.1)	1.5	(3)	1.5	(3)
140021	170	--	--	20	150	San.Tissue	77.9	(18.7)	10.5	(21)	3.5	(7)
140024	35	--	--	--	23	San.Tissue	199.8	(48.0)	145.5	(291)	315.0	(630) [a]
140025	92	--	4	11	100	San.Tissue	62.4	(15.0)	36.0	(72)	161.5	(323)
140028	168	--	--	2	147	San.Tissue Mkt. Pulp	155.7	(37.4)	112.0	(224)	374.0	(748)
Average	183	--	6	4	177	San.Tissue	81.3	(19.5)	48.7	(97.4)	143.0	(286)
Fine Paper Mills Utilizing Mixed Furnish												
140005	188	--	166	19	379	Unctd.Print Writing	99.9	(24.0)	17.4	(34.8)	197.0	(394)
140007	155	55	54	41	349	Ctd & Unctd Print	53.7	(12.9)	55.0	(110.0)	162.0	(324)
14[illegible]	77	9	10	29	128	Unctd.Print Writing	114.5	(27.5)	72.5	(145.0)	188.5	(377)
140017	96	--	37	23	152	Ctd Print	126.2	(30.3)	20.5	(41.0)	216.5	(433)
140019	43	--	8	18	65	Unct.Print	44.5	(10.7)	16.0	(32.0)	8.0	(16)
Average	111	13	55	26	215	Print	87.8	(21.1)	36.3	(72.6)	154.5	(309)
Tissue Mills Utilizing Mixed Furnish												
140010	46	4	28	6	76	San.Tissue	118.2	(28.4)	56.0	(112.0)	134.0	(268)
140029	20	--	6	--	22	San.Tissue	--	(--)	--	--	--	(--)
140030	60	30	30	--	100	San.Tissue	74.9	(18.0)	56.5	(113.0)	166.5	(333)
Average	42	11	21	2	66	San.Tissue	96.6	(23.2)	56.5	(113.0)	150.5	(301)
Subcategory Average							92.6	(22.2)	51.8	(103.6)	158.1	(316.2)
Model Mill							81.3	(19.5)	48.7	(97.4)	143.0	(286.0)

[a] Raw waste load data for Mill No. 140024 appears inconsistent with other data for this subgroup; therefore not included in subgroup average.

111 Wastepaper-Tissue. This subcategory comprises 22 mills which produce industrial tissue, sanitary tissue, industrial packaging, wadding, and packaging and wrapping tissue. The average mill age since initial construction is 33 years. The typical mill utilizes 100 percent mixed waste paper, which is generally processed with little preparation, except for screening and cleaning prior to the papermachine.

There are more mills making industrial grades than sanitary tissue; furthermore, these mills have a lower effluent load than the sanitary tissue mills. As shown in Table V-16, the average raw effluent load for 13 industrial tissue mills, excluding those which are self-contained, is 56.6 kl/kkg (13.6 kgal/t) flow, 13.2 kg/kkg (26.3 lb/ton) BOD5 and 40.5 kg/kkg (81.0 lb/ton) TSS. There are four self-contained mills in this group. If these are included, the average becomes 39.2 kl/kkg (9.4 kgal/t) flow, 8.8 kg/kkg (17.5 lb/ton) BOD5 and 27.0 kg/kkg (54 lb/ton) of TSS. The selected model mill raw waste load is the average of the industrial tissue mills, including those which are self-contained.

A number of mills in both the sanitary and industrial tissue groupings have been able to achieve self-contained systems; therefore, this should be a realistic goal for all mills in the Wastepaper-Tissue subcategory. Recycle of clarifier overflow as well as sludge is being practiced in many of these mills.

The BOD5 raw waste load from these mills is considerably higher than from either Nonintegrated-Tissue or Nonintegrated-Fine subcategories, even though the flow is somewhat less. The high BOD5 appears to be inherent with the use of waste paper and the subsequent shrinkage that results.

112 Wastepaper-Board. With 147 operating mills, this is the largest subcategory in the pulp, paper and paperboard industry. The average mill age is 43 years. Mill size ranges from 2.3 to 871 kkg/day (2.5 to 960 tons/day), averaging 133 kkg/day (147 tons/day). Products made by mills in this subcategory include linerboard, corrugated board, chip and filler, folding boxboard, set-up box, gypsum board, and other construction boards, packaging materials, and automotive boards. Most mills produce three or more types of products on-site.

For the whole subcategory, raw waste characteristics are low compared to other industry subcategories. Only the Wastepaper-Construction Products subcategory has a lower flow per ton; BOD5 and TSS loads are among the lowest in the industry. Mill performance on average surpasses existing BPT model mill characteristics. Attempts were made to determine the relative raw waste load characteristics by product grouping. Results are tabulated in Table V-17 for mills which produced 80 percent or more of a given type of product. As shown, the linerboard operations have the highest raw waste flow and BOD5 per ton, with an intermediate level of TSS discharge. The groups of products with the lowest flow per ton are the corrugated and chip and filler boards. As mills make combinations of grades, BOD5 losses generally increase above those from the individual pure mills. TSS loss for combined grades approximate the average for the whole subcategory.

TABLE V-16

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 111 - WASTEPAPER-TISSUE

		Raw Waste Load					
	Prod	Flow		BOD5		TSS	
Mill No.	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Industrial Tissue Mills							
040002	19.5	72.4	(17.4)	5.2	(10.4)	--	(--)
085004	47.0	32.1	(7.7)	6.8	(13.7)	32.6	(65.2)
085006	46.3	137.8	(33.1)	37.5	(75.1)	103.2	(206.5)
090006	10.5	29.1	(7.0)	--	--	46.8	(93.5)
100008	6.9	68.7	(16.5)	6.5	(13.0)	13.2	(26.6)
100003	83.0	51.6	(12.4)	8.6	(17.3)	9.2	(18.4)
100005	15.2	62.0	(14.9)	14.2	(28.4)	38.0	(76.1)
100008	16.0			Self-contained			
100011	11.2			Self-contained			
100012	7.0	35.4	(8.5)	--	(--)	--	(--)
100013	20.0			Self-contained			
100015	5.5			Self-contained			
105017	11.9	22.1	(5.3)	--	(--)	--	(--)
Average (excl. self-cont.)		56.6	(13.6)	13.2	(26.3)	40.5	(81.0)
Average (incl. self-cont.)		39.2	(9.4)	8.8	(17.5)	27.0	(54.0)
Sanitary Tissue Mills							
090004	20.0	59.6	(14.3)	--	(--)	--	(--)
090010	165.0	76.7	(18.4)	18.9	(37.6)	59.3	(118.7)
100002	7.5			Self-contained			
100004	15.0			Self-contained			
100007	20.0			Self-contained			
100016	7.3	287.7	(57.0)	53.5	(107.0)	128.0	(256)
140022	50.0	166.8	(40.0)	--	(--)	--	(--)
090014	--	9.2	(2.2)	--	(--)	--	(--)
100014	20.7	0.2	(0.1)	--	(--)	--	(--)
Average		135.1	(32.4)	36.4	(72.3)	93.7	(187.4)
Model Mill		39.2	(9.4)	8.8	(17.5)	27.0	(54.0)

TABLE V-17

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 112 - WASTEPAPER-BOARD
(BY PRODUCT TYPE)[a]

Product	Raw Waste Load: Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
Linerboard	27.9	(6.7)	8.9	(17.8)	10.3	(21.5)
Corrugated	4.2	(1.0)	5.4	(10.7)	3.9	(7.9)
Chip & Filler	10.0	(2.4)	3.5	(6.9)	4.5	(8.9)
Folding	16.3	(3.9)	6.1	(12.1)	7.1	(14.1)
Set-up	20.4	(4.9)	7.3	(14.6)	5.7	(11.4)
Gypsum	11.7	(2.8)	5.9	(11.6)	15.9	(31.8)

[a] Mills making more than 80% of particular product type.

Because 29 percent of the mills are either completely self-contained (with zero discharge) or have extremely low flow (less than 1.6 kgal/ton), it is clear that the other mills in this subcategory could achieve significantly greater close-up than has been attained thus far. Table V-18 presents raw waste load data corresponding to mills with zero, low, medium or high flows per ton of product. If mills with low or zero discharge are included, the average raw waste load for the whole subcategory is 15.4 kl/kkg (3.7 kgal/t) flow, 6.5 kg/kkg (12.9 lb/ton) BOD5, and 7.7 kg/kkg (15.3 lb/ton) TSS. These averages are selected for the model mill representing this subcategory.

TABLE V-18

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 112 - WASTEPAPER-BOARD
(BY DISCHARGE LEVEL)

No. of Mills	Type	t/d	Raw Waste Load: Flow kg/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
21	Self Contained	98	0	(0)	0	(0)	0	(0)
22	Low Flow	116	2.1	(0.5)	3.5	(6.9)	2.9	(5.8)
85	Medium Flow	163	16.7	(4.0)	8.2	(16.3)	9.2	(18.4)
9	High Flow	136	67.1	(16.1)	12.5	(25.0)	22.3	(44.5)
10	Insufficient Data	--	--	(--)	--	(--)	--	(--)
Subcategory Average			15.4	(3.7)	6.5	(12.9)	7.7	(15.3)
Model Mill			15.4	(3.7)	6.5	(12.9)	7.7	(15.3)

113 Wastepaper-Molded Products. This subcategory consists of 15 mills making a variety of molded products mainly from waste paper. This is a new subcategory and comprises a group of mills which has expanded significantly in recent years in the consumer market. The average initial construction date is 1942. Typical products include food packs such as meat display trays, egg cartons and other containers of special design. Also included are items such as molded sewer pipe and flower pots. These mills range in size from 1.8 kg/day (2 tons/day) up to 168.7 kg/day (186 tons/day), and have an average age of 37 years. While these operations utilize a furnish prepared from waste paper, some grades also incorporate filler and sizing materials, as would many types of heavier paper products. However, these operations do not utilize fourdrinier papermachines; typically they utilize forming machines on which several vacuum pick-up forming dies are located. The individual products are formed in one operation, pressed and then subsequently dried in drying ovens.

In terms of water use, the operations are simple compared to most papermaking systems. Effluent loads vary widely from completely self-contained operations, up to as much as 172.8 kl/kkg, (41.5 kgal/t) of production. The high water usage per ton generally correlates with the low production capabilities of these units.

As noted in Table V-19, nine mills utilize 100 percent waste paper in the furnish. The others incorporate varying amounts of purchased pulp. The model mill raw waste load is the average of the nine mills utilizing waste paper exclusively in the furnish as shown below:

Flow - 47.1 kl/kkg (11.3 kgal/t)
BOD_5 - 5.7 kg/kkg (11.4 lb/ton)
TSS - 10.7 kg/kkg (21.3 lb/ton)

114 Wastepaper-Construction Products. This is a large subcategory (58 operating mills) producing a variety of construction building papers such as roofing felt and shingles for the building trade. The typical mill is about 40 years old, and utilizes predominantly mixed waste paper for its furnish. Generally, this is very low grade material, consisting of some corrugating and a great deal of mixed waste.

Twenty-five of these mills also produce some coarse defibrator groundwood type pulp on the premises; this is similar to a TMP pulp, only it is very coarse and has little, if any, subsequent screening. The refiner pulp produced has over a 90 percent yield. Even in these mills, well over half the total furnish is waste paper. The BOD_5 average in this group is somewhat higher than that for the mills that utilize essentially all waste paper for the furnish. There are five other mills that make groundwood as part of the furnish (not TMP). These five mills have lower effluent characteristics than the subcategory average.

Model mill raw waste loads for this subcategory are the average of all mills shown in Table V-20:

TABLE V-19

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 113 - WASTEPAPER-MOLDED PRODUCTS

Production Profile				Raw Waste Load					
				Flow		BOD5		TSS	
Mill No.	Furnish	Production (t/d)	Product(s)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
150002	Wastepaper	20.0	Pipe & Conduit	20.4	(4.9)	4.6	(9.2)	20.1	(40.2)
150004	Mix Wasteppr	2.8	Egg Cartons	74.5	(17.9)	--	(--)	--	(--)
150005	Wastepaper	5.5	Containers	25.0	(6.0)	2.85	(4.7)	8.9	(16.7)
150006	GW & Pulp Subst.	43.7	Molded Prod.	46.2	(11.1)	10.35	(20.7)	18.9	(37.7)
150007	Wastepaper	81.0	Molded Prod.	89.5	(21.5)**	15.9	(31.8)	23.7	(47.4)
150009	News & GW Subst.	50.5	Molded Prod.	18.7	(4.5)	--	(--)	0.5	(1.0)
150010	News	60.0	Molded Prod.	31.2	(7.5)	9.5	(18.8)	15.0	(30.0)
150011	News & Black Pur GW & Fr	68.0	Egg Cartons & Trays	70.8	(17.0)	10.35	(20.7)	23.2	(46.4)
150021	News, GW Peat Moss	16.8	Molded Prod & Peat Moss	172.8	(41.5)	5.2	(10.4)	11.2	(22.3)
150022	Box Cut GW Subst.	62.0	Molded Prod.	54.5	(13.1)	7.55	(15.1)	16.8	(33.5)
150023	GW, BL Kr 9% Wastepaper	186.0	Molded Prod.	86.6	(20.8)	8.6	(17.2)	10.9	(21.7)
150024	Kr, GW, 55% Wastepaper	93.0	Molded Prod.	84.9	(20.4)	5.05	(10.1)	12.8	(25.6)
150025	News	26.5	Molded Prod.	109.1	(26.2)	0.2	(0.4)	1.0	(1.9)
150028	Kr, GW Subst Spec-Waste	11.0	Flower Pots	Self-contained					
150030	News	3.0	Molded Prod.	Considered Self-contained					
Average	49.0			67.9	(16.3)	7.25	(14.5)	13.5	(27.0)
Model Mill (a)				47.1	(11.3)	5.7	(11.4)	10.7	(21.3)

(a) Model mill raw waste load is the average of Mills No. 150002, 150004, 150005, 150007, 150009, 150010, 150022, 150025, and 150030. These mills use only wastepaper (i.e., wastepaper, GW substitute, news, and/or box cut) in the furnish.

TABLE V-20

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 114 - WASTEPAPER - CONSTRUCTION PRODUCTS

Production Profile						Raw Waste Load					
						Flow		BOD5		TSS	
Mill No.	Furnish	Production (t/d)	Product	Finish[a]	Subgroup Code[b]	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
120001	WP, WF	32	Construction Paper	S	W	65.0	(15.6)				
120002	WP, WF, Rag	116	Construction Paper	U	W	3.3	(0.8)				
			Roofing Felt								
120003	WP, Chips	100	Construction Paper		T	8.3	(2.0)				
120004	WP, Rags, GW	69	Construction Paper	S	G						
120005	WP, GW	170	Asbestos Felt	U	G	4.2	(1.0)	5.5	(10.9)	1.5	(2.9)
			Organic Felt								
120006	WP, GW	123	Construction Paper	U	G	1.3	(0.3)	4.2	(8.3)	2.2	(4.3)
120007	WP, GW	90	Construction Paper	S	G	Self-Contained					
120008	WP, WF	75	Construction Paper	S	W	Self-Contained					
			Roofing Felt								
120009	WP, WF	40	Construction Paper	S	W	26.3	(6.3)				
120010	WP, WF	29	Construction Paper	S	W						
120011	WP, Chips	325	Construction Paper	S	T	28.8	(6.9)	2.1	(4.2)	2.3	(4.6)
120012	WP, TMP	228	Construction Paper	S	T	7.4	(1.8)	12.8	(25.5)	5.1	(10.1)
120013	WP, Chips	97	Construction Paper	U	T	2.8	(0.7)	8.9	(17.8)	2.9	(5.8)
120014	WP, Baled Pulp	21	Construction Paper	U	W	13.8	(3.3)	33.4	(66.8)	10.1	(20.2)
120015	WP, Chips	92	Construction Paper	U	T						
120016	WP, RW	30	Roofing Felt	U	T	5.0	(1.2)	11.2	(22.3)	4.1	(8.2)
120017	WP, TMP	73	Roofing Felt	S	T	7.0	(1.7)				
120018	WP, TMP	88	Roofing Felt	U	T	Self-Contained					
120019	WP, TMP	156	Roofing Felt	U	T	Self-Contained					
120020	WP, Chips, TMP	82	Roofing Felt	U	T	4.0	(1.0)			7.4	(14.7)
120021	WP, RW	172	Roofing Felt	U	T	Self-Contained					
120022	WP, WF, Rag	51	Construction Paper	U	W	0.8	(0.2)	1.7	(3.3)	0.2	(0.4)
120023	WP, Chips	74.5	Roofing Felt	U	T	19.2	(4.6)				
120024	WP, TMP	126	Roofing Felt	U	T	2.0	(0.5)	3.4	(6.8)	2.4	(4.7)
120025	WP, WF, Rag	44	Roofing Felt	U	W	9.6	(2.3)	24.0	(48.0)	71.6	(143.2)
			Construction Paper								
120026	TMP, Chips	76	Construction Paper	S	T	Self-Contained					
120027	WP, GW	20	Construction Paper	S	G	Self-Contained					
120028	WP, TMP	193	Roofing Felt	U	T	40.8	(9.8)	22.1	(44.2)	17.7	(35.4)
120029	WP, TMP	39	Roofing Felt	U	T	Self-Contained					
120030	WP, WF, Rag	28	Roofing Felt	S	W	5.8	(1.4)	2.2	(4.3)	6.9	(13.8)
			Construction Paper								
120031	TMP, Chips	167	Construction Paper	S	T	16.6	(4.0)	6.2	(12.4)	6.0	(12.0)
120032	WP, TMP	77	Construction Paper	U	T	43.4	(10.4)	25.7	(51.4)	40.9	(81.8)
120033	WP, TMP	60	Construction Paper	U	T	0.8	(0.2)				
120034	WP, WF, Rag	30	Construction Paper	U	W	Self-Contained					
			Construction Felt								

TABLE V-20 (Continued)

		Production Profile				Raw Waste Load					
		Production			Subgroup	Flow		BOD5		TSS	
Mill No.	Furnish	(t/d)	Product	Finish[a]	Code[b]	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
120035	WP, WF, Rag	71	Construction Paper Construction Felt	S	W						
120036	WP, WF, Rag	54	Construction Paper Construction Felt	S	W						
120037	WP, WF, Rag	49	Construction Paper Construction Felt	U	W						
120038	WP, WF, Rag	51	Construction Paper Construction Felt	S	W	5.4	(1.3)				
120039	WP	350	Gypsum Wallboard Construction Paper	U	T	14.2	(3.4)			15.7	(31.4)
120040	WP, WF, Rag	44	Construction Paper	S	W	Self-Contained					
120041		30	Construction Paper	S	W	Self-Contained					
120042	WP, WF, Rag	55	Construction Paper	S	W						
120043		43	Construction Paper	S	W	4.6	(1.1)				
120044	WP, WF, Rag	21	Construction Paper	S	W						
120045	WP, WF, Rag	36	Construction Paper	S	W	0.4	(0.1)				
140046	WP, WF, Rag	72	Construction Paper	S	W						
140047	WP, WF, Rag	63	Construction Paper	U	W	4.6	(1.1)				
140048	WP, WF, Rag	40	Construction Paper	S	W	Self-Contained					
140049	WP,WF	22	Construction Paper	S	W						
140050	WP, WF, Rag	55	Construction Paper	U	W	10.0	(2.4)	4.6	(9.1)	7.6	(15.2)
140051	WF, Purch. Pulp	60	Construction Paper	U	O	Self-Contained					
140052	WP, WF	39	Construction Paper	U	W						
140054		60	Builders Board	U	O	8.9	(1.9)	3.9	(7.7)	6.5	(13.0)
140055	TMP	334	Construction Paper	S	T	Self-Contained					
140056		242	Builders Board	S	O	Self-Contained					
140057	TMP	125	Construction Paper			13.8	(3.3)	14.1	(28.2)	15.3	(30.5)
140058	TMP	118	Construction Paper	U	T	Self-Contained					
140059	TMP	140	Builders Paper	U	T	Self-Contained					
Subgroup W Average (excluding self-contained mills)						14.6	(3.5)	7.6	(15.2)	19.3	(38.7)
Subgroup T Average (excluding self-contained mills)						12.5	(3.0)	13.9	(27.8)	10.2	(20.4)
Subgroup G Average (excluding self-contained mills)						2.9	(0.7)	4.8	(9.6)	1.8	(3.6)
Subcategory Average						9.2	(2.2)	5.8	(11.5)	8.2	(16.3)
Model Mill						9.2	(2.2)	5.8	(11.5)	8.2	(16.3)

[a] S = Saturated; U = Unsaturated

[b] W = Predominantly wastepaper furnish
T = Furnish includes TMP
G = Furnish includes other types of groundwood
O = Other furnish

Flow:	9.2 kl/kkg (2.2 kgal/t)
BOD5:	5.8 kg/kkg (11.5 lb/ton)
TSS:	8.2 kg/kkg (16.3 lb/ton)

Raw waste loads for this subcategory are already among the lowest in the whole industry. Because quality requirements in most of the products are very minimal, the opportunity exists for recycling and reusing sludge and effluents in the final product. Physical separation of large metallic objects and contaminants is the main process requirement in the preparation of the waste paper furnish. As shown in Table V-20, there is no significant difference in the raw waste load characteristics between the saturated and unsaturated mill operations. Such operations frequently are done in a separate off-site converting plant. Generally the asphalt saturator utilizes a closed-cycle application system.

Further significant reductions in raw waste loads appear possible in this subcategory, as 17 mills are completely self-contained.

201 Nonintegrated-Fine. With 39 mills, this is the largest nonintegrated subcategory. The mills are generally very old, dating back to 1892 as the average original year of construction. Products include high-quality coated and uncoated printing, writing and other business papers. The mills range in size from 11.8 kkg/day (13 tons/day) to nearly 998 kkg/day (1,100 tons/day). At the average mill, 170 tons/day of product is produced. Pulp is not produced on-site, although a small amount of waste paper may be used, depending on the relative market conditions.

As shown in Table V-21, the raw waste averages for the model mill are as follows:

Flow	48.5 kl/kkg (11.6 kgal/t);
BOD5	8.5 kg/kkg (17.0 lb/ton); and
TSS	30.1 kg/kkg (60.1 lb/ton).

Mills in this subcategory generally use small machines, typically of ancient vintage, in facilities not usually planned for most efficient flow of materials. Process inefficiencies and upsets due to weight changes, color changes, and frequent grade changes are prevalent. Raw waste loads are variable, particularly in terms of flow.

202 Nonintegrated-Tissue. Twenty-six mills are in this subcategory, mostly producing sanitary and industrial tissues. Production ranges from 5.0 kkg/day (5.5 tons/ day) to 807.2 kkg/day (890 tons/day), averaging 113.4 kkg/day (125 tons/day). The mills utilize purchased pulps and up to 25 percent waste paper in their furnish. The average mill was originally built 54 years ago. They are equally split between direct and indirect dischargers. Several nonintegrated mills that were previously grouped with tissue operations have now been put into a separate Nonintegrated-Lightweight subcategory, including electrical papers.

TABLE V-21

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 201 - NONINTEGRATED-FINE

Production Profile							Raw Waste Load					
	Furnish (t/d)				Prod.		Flow		BOD5		TSS	
Mill No.	Purch.	GW	WP-Broke	%Clay	(t/d)	Products	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
080001	148		0.2	5	156	Uncoated Printing	26.7	(6.4)	8.9	(17.8)	14.0	(27.9)
080007	139		13	8	165	Uncoated Printing	68.4	(16.4)	7.6(a)	(15.1)	19.8	(39.6)
080009	658	270	8	14	1,088	Coated & Uncoated Printing	76.7	(18.4)	5.9	(11.8)	25.0	(50.0)
080017	88		30	6	125	Coated Printing	Self-contained					
080019	41		0.3	23	54	Uncoated Printing	17.9	(4.3)	4.7	(9.4)	2.6	(5.2)
080028	59		18	5	81	Uncoated Printing & Writing	81.7	(19.6)	—	(--)	44.9	(89.7)
080031	29			0	29	Uncoated Printing	43.0	(10.3)	—	(--)	—	(--)
080038	164		4	24	221	Coated & Uncoated Printing	44.6	(10.7)	10.5	(20.9)	43.5	(87.0)
080040	393		133	10	587	Coating Printing & Uncoated Writing	85.9	(20.6)	16.9	(33.8)	115.2	(230.3)
080045	100	1	31	8	144	Uncoated Printing & Writing	32.9	(7.9)	10.8	(21.6)	41.7	(83.3)
080046	332		68	12	455	Uncoated Printing & Writing	61.3	(14.7)	13.8	(27.6)	31.5	(62.9)
080047	153		31	4	191	Uncoated Writing	11.7	(2.8)	3.3	(6.5)	4.5	(8.9)
080048	88		39	27	173	Uncoated Printing	50.5	(12.1)	11.1	(22.1)	18.3	(36.5)
080051	22		8.6	13	35	Uncoated Printing	73.8	(17.7)	—	(--)	—	(--)
Average							48.5	(11.6)	8.5	(17.0)	30.1	(60.1)
Model Mill							48.5	(11.6)	8.5	(17.0)	30.1	(60.1)

(a) Assume 85% raw BOD5 out of primary clarifier.

Table V-22 shows raw waste load data for all 26 mills in the Nonintegrated-Tissue subcategory. The model mill is based on nine sanitary tissue mills using only purchased pulps and waste paper for furnish (no purchased deink fiber). The only distinctly different grouping of mills consists of the industrial tissue mills, which exhibit markedly lower BOD5 and TSS loads, reflecting the lower quality items produced and the higher degree of close-up possible.

The model mill raw waste load is:

Flow 73.4 kl/kkg (17.6 kgal/t);
BOD5 13.3 kg/kkg (26.5 lb/ton); and
TSS 39.0 kg/kkg (77.9 lb/ton).

204 Nonintegrated-Lightweight. After extensive review of the Nonintegrated-Tissue subcategory, it was observed that the raw waste load associated with very dense lightweight sheets (such as carbonizing, cigarette papers and electrical papers) was far greater than that associated with the sanitary tissue mills. The lightweight mills are predominantly small manufacturers utilizing plants which were initially constructed over 70 years ago. A typical mill in this subcategory makes approximately 54.5 kkg/day (60 tons/day) of product.

The papers in this subcategory are characterized by very severe refining conditions and, in the case of electrical papers, extremely high quality parameters that must be met in the final sheet. It is difficult to close up mills producing electrical papers because of the build-up of salts in recycled whitewaters.

These mills have been reviewed in four groupings, as shown in Table V-23. The first group consists of those mills making only electrical papers. This group exhibits the highest load in the subcategory, averaging 407.0 kl/kkg (97.6 kgal/t). Only one mill in this group reported BOD5 data - at 11.6 kg/kkg (23.1 lb/ton). Average TSS, based upon two mills, is 37.7 kg/kkg (75.3 lb/ton). Results such as this are not unexpected, as these grades are made free of filler and with a very open system to minimize contamination due to build-up of salts in the water.

The second grouping of mills produces miscellaneous grades of tissue and carbonizing papers utilizing higher percentages of waste paper. These mills exhibit lower flow characteristics than the electrical papers subgroup; however, BOD5 and TSS loadings are higher, apparently due to the incorporation of the waste paper totaling nearly 40 percent of the furnish.

The third grouping consists of those making some printing grades, as well as thin paper from essentially 100 percent purchased pulp. Again, flow characteristics were less than the preceding two subcategories; BOD5 was approximately the same as the prior group; but TSS is 71.3 kg/kkg (142.6 lb/ton), reflecting the production of filled sheets with very low basis weights.

The fourth grouping uses some waste paper and miscellaneous fibers in the production of such products as cigarette papers. This grouping has the lowest raw waste characteristics.

TABLE V-22

SUMMARY RAW WASTE LOAD DATA

SUBCATEGORY 202 - NONINTEGRATED-TISSUE

	Production Profile						Raw Waste Load					
			Furnish				Flow		BOD5		TSS	
Mill No.	(t/d)	Product	Pur.	GW	D-1	WP	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
090001	20	Industrial-Tissue	23	--	--	5	104.3	(25.0)	4.5	(9.0)	5.0	(10.0)
090005	41	Sanitary-Tissue	38	--	--	--	22.5	(5.41)	5.6	(11.2)	11.5	(22.9)
090007	246	Sanitary-Tissue	150	--	88	24	107.2	(25.7)	8.0	(115.9)	28.5	(57.0)
090008	194	Sanitary-Tissue	133	--	75	20	96.6	(23.2)	15.3	(30.6)	47.1	(94.2)
090009	290	Sanitary-Tissue	159	--	--	163	89.5	(21.5)	9.9	(19.7)	25.7	(51.4)
090011	70	Sanitary Tissue	62	--	--	12	78.8	(18.9)	--	(--)	--	(--)
090012	59	Sanitary-Tissue	62	--	--	--	35.9	(8.6)	--	(--)	--	(--)
090013	37	Sanitary-Tissue	35	1	--	3	41.6	(10.0)	4.2	(8.3)	27.3	(52.6)
090016	176	Sanitary-Tissue	179	--	--	13	56.7	(13.6)	18.0	(36.4)	53.2	(106.4)
090017	22	Sanitary-Tissue	--	--	22	1	56.3	(13.5)	14.9	(29.7)	48.3	(965.0)
090018	17	Sanitary-Tissue	--	--	7	11	79.6	(19.1)	12.8	(25.6)	43.9	(87.8)
090019	159	Sanitary-Tissue	139	19	--	48	105.1	(25.2)	--	(--)	--	(--)
090020	890	Sanitary-Tissue	887	57	--	5	79.5	(19.1)	22.8	(45.6)	54.5	(108.9)
090021	176	Mixed Product	119	11	--	40	170.6	(40.9)	--	(--)	31.2	(62.3)
090022	189	Mixed Product	154	7	--	--	66.6	(16.0)	9.1	(18.2)	26.9	(53.8)
090023	67	Mixed Product	40	--	--	33	31.3	(7.5)	--	(--)	15.8	(31.6)
090024	103	Sanitary-Tissue	85	--	--	18	45.5	(10.9)	--	(--)	--	(--)
090025	6	Mixed Product	6	--	--	--	286.5	(68.7)	14.6	(29.1)	14.6	(29.1)
090026	50	Sanitary-Tissue	21	--	5	28	72.1	(17.3)	16.9	(33.8)	52.2	(104.4)
090027	140	Sanitary-Tissue	140	--	--	--	17.9	(4.3)	0.7	(1.3)	4.1	(8.2)
090028	61	Sanitary-Tissue	42	--	23	1	143.4	(34.4)	--	(--)	--	(--)
090029	44	Industrial-Tissue	41	--	--	14	94.7	(22.7)	--	(--)	--	(--)
090030	255	Sanitary-Tissue	263	--	--	--	32.5	(7.8)	1.7	(3.3)	6.6	(13.1)
090031	17	Mixed Product	14	--	--	4	98.0	(23.5)	--	(--)	--	(--)
090032	27	Mixed Product	26	--	--	4	177.6	(42.6)	--	(--)	--	(--)
090033	14	Mixed Product	14	--	--	1	29.6	(7.1)	1.0	(2.0)	5.8	(11.5)
Subcategory Average	129.6	Sanitary & Industrial Tissue	109.3	3.7	8.5	17.2	85.4	(20.5)	10.0	(20.0)	27.9	(55.8)
090001 + 090029 (31 t/d)		Industrial Tissue Only	32	--	--	9	95.9	(23.0)	4.5	(9.0)	5.0	(10.0)
Model Mill[a]		Sanitary Tissue Only	212	11	--	32	73.4 (No	(17.6)	13.3	(26.5)	39.0 Deink)	(77.9)

[a]Average of Mills No. 090007,9,11,13,16,19,20,22, and 24

TABLE V-23

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 204 - NONINTEGRATED-LIGHTWEIGHT

	Production Profile					Raw Waste Load					
	Furnish (t/d)				Product	Flow		BOD5		TSS	
Mill No.	Purch	W.P.	Misc.	Broke	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Electrical Paper											
105003	11.2	--	--	--	11.2	445.9	(107.1)	--	(--)	--[a]	(--)[a]
105015	13.0	--	--	--	12.0	312.3	(75.0)	--	(--)	56.0[a]	(112)[a]
105017	3.2	--	--	--	3.1	268.5	(64.5)	--	(--)	--	(--)
105018	11.1	--	--	1.8	11.6	749.8	(180.1)	--	(--)	--	(--)
105071	26.0	--	--	--	26.0	256.1	(61.5)	11.55	(23.1)	19.25	(38.5)
Average	12.9	--	--	0.4	12.8	406.6	(97.6)	11.5	(23.1)	37.65	(75.3)
Miscellaneous Tissue and Carbonizing											
090015	47.4	25.6	--	--	64.0	146.9	(55.0)	2.9	(115.7)	150.5	(301.0)
15057	33.0	5.1	--	--	34.0	208.2	(35.3)	11.8	(5.7)	5.2	(10.3)
15058	34.0	4.9	--	--	35.0	529.2	(50.0)	6.5	(23.6)	25.7	(51.4)
15061	213.0	217.0	--	--	409.0	529.1	(127.1)		(12.9)	48.8	(97.6)
Average	82.0	63.0	--	--	135.0	277.3	(66.6)	19.8	(39.5)	57.55	(115.1)
Printing & Thin Paper											
080039	33.8	--	--	3.2[c]	36.0	307.7	(73.9)	33.3	(66.6)	127.0	(254.0)
1[illegible]	36.0	--	--	10.5	46.5	170.3	(40.9)	--	(--)	--	(--)
1[illegible]0	203.0	4	2	--	203.0	201.1	(48.3)	8.2	(16.4)	15.55	(31.1)
Average	91.0	1	1	5.0	95.0	226.5	(54.4)	20.75	(41.5)	71.3	(142.6)
Carbonize, Thin, Cigarette - Less Wastepaper											
080024	29.6	--	--	5.3	32.5	61.2	(14.7)[c]	--	(--)[b]	--	(--)[b]
080021	30.3	0.04	--	--	26.9	10.8	(2.6)[b]	0.2	(0.3)[b]	.1	(0.15)[b]
080022	102.4	11.3	--	--	10.5	112.8	(27.1)	1.2	(2.4)	1.8	(3.5)
090003	12.0	1.6	--	4.4[c]	18.0	129.5	(31.1)	--	(--)	--	(--)
105013	15.1	--	5.3	--	20.4	134.9	(32.4)	19.9	(39.7)	57.0	(114.0)
105016	21.8	--	5.2	--	25.0	516.3	(124.0)	--	(--)	--	(--)
Average	35.2	2.2	1.8	1.6	38.9	161.1	(38.7)	7.1	(14.1)	19.6	(39.2)
Subcategory Average	49.0	15.0	1	2	62.0	266.5	(63.9)	15.3	(30.6)	45.6	(91.2)
Model Mill						266.5	(63.9)	15.3	(30.6)	45.6	(91.2)

(a) Estimated from other data.
(b) Recycled treated effluent.
(c) Estimated to balance.

Raw waste loads for this subcategory differ based on the product (in particular, the manufacture of high quality electrical papers) and also the effect of significant levels of waste paper in the furnish. The model mill raw waste load is the average of all mills in the subcategory, thus representing a composite of products. For the subcategory, average raw waste load characteristics, used as the model mill raw waste load are: 266.5 kl/kkg (63.9 kgal/t) flow, 15.3 kg/kkg (30.6 lb/ton) BOD_5, and 45.6 kg/kkg (91.2 lb/ton) TSS.

205 Nonintegrated-Filter and Nonwoven. Sixteen mills comprise this new subcategory. They produce a variety of filter, blotting, absorbent, and nonwoven papers using both wood pulps and synthetic fibers and resin combinations. Although these mills date back to a typical original construction date of 1905, they make extensive use of innovative technologies. The mills are small, averaging 17.2 kkg/day (19 tons/day) production. Two-thirds of the average furnish consists of purchased pulps and one-third consists of miscellaneous materials, including artificial fibers.

As shown in Table V-24, average raw waste flow for the subcategory is 171.8 kl/kkg (41.2 kgal/t), which is selected as the model mill raw waste load flow. Median subcategory values are used for model mill BOD_5 and TSS, more nearly reflecting typical conditions. Model mill BOD_5 and TSS loads are 5.0 kg/kkg (10.0 lb/ton) and 25.0 kg/kkg (50 lb/ton), respectively. The TSS appears high for the type of product, primarily reflecting the low production rates. Effluent flow also tends to be high, reflecting the difficulty in closing up these operations while meeting product specifications.

211 Nonintegrated-Paperboard. This subcategory consists of 12 mills producing a variety of special board grades from purchased pulps and synthetic materials. The average mill has an original construction date of 1899. Average production is 31.7 kkg/day (35 tons/day). Many of these mills operate small updated single cylinder machines.

As shown in Table V-25, the following raw waste loads are selected for the model mill:

Flow 102.4 kl/kkg (24.6 kgal/t);
BOD_5 10.0 kg/kkg (20.0 lb/ton); and
TSS 42.3 kg/kkg (84.5 lb/ton).

Flow and TSS values are subcategory averages, while model mill BOD_5 load is a median value selected to better represent the subcategory.

Raw waste load characteristics vary significantly in the two mills producing electrical board. As was noted earlier with electrical tissue papers, the water requirements per ton of electrical board are distinctly higher than average for the subcategory. Approximately a 179.3 kl/kkg (43 kgal/t) allowance is suggested for mills manufacturing 100 percent electrical board.

TABLE V-24

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 205 - NONINTEGRATED-FILTER AND NONWOVEN

Production Profile			Raw Waste Load					
	Production		Flow		BOD5		TSS	
Mill No.	(t/d)	Product(s)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
105005	5.9	Saturated Filter & Non-Woven	329.7	(79.7)	--	(--)	24.6	(49.2)
105029	4.1	Technical & Filter	142.0	(34.4)	18.2	(36.3)	14.6	(29.3)
105030	0.4	Filter	588.6	(50.0)	--	(--)	--	(--)
105031	0.7	Filter	407.8	(98.6)	--	(--)	--	(--)
105033	33.5	Filter, Wall Cover Miscellaneous	222.1	(53.7)	--	(--)	--	(--)
105034	10.2	Filter	170.4	(41.2)	--	(--)	--	(--)
105035	44.0	Asbestos Gasket, Elec. Insul.	162.1	(39.2)	--	(--)	30.2	(60.3)
105043	17.4	Filter, Blotting, Photo	278.0	(67.2)	24.9	(49.9)	54.8	(109.5)
105044	22.4	Filter, Blotting, Pkg.	25.6	(6.2)	3.8	(7.5)	12.8	(25.5)
105045	13.2	Filter, Pkg.	30.7	(9.6)	3.6	(7.1)	0.7	(1.4)
[illegible]51	12.2	Filter, Satur. Tech.	169.6	(41.0)	4.9	(9.9)	19.5	(38.9)
105052	16.1	Filter	17.8	(4.3)	--	(--)	--	(--)
105053	39.1	Filter	42.2	(10.2)	--	(--)	--	(--)
105054	10.5	Filter, photo, wrap.	6.6	(1.6)	--	(--)	--	(--)
105055	43.4	Filter, saturated	285.8	(69.1)	8.9	(17.9)	38.3	(76.5)
105066	27.0	Lightweight, technical, asbestos papers	220.5	(53.3)	4.3	(8.6)	156.0	(312.0)
Average			171.8	(41.2)	9.8	(19.6)	39.1	(78.1)
Median[a]					5.0	(10.0)	25.0	(50.0)
Model Mill			171.8	(41.2)	5.0	(10.0)	25.0	(50.0)

[a] Median BOD5 and TSS values selected as more typical of subcategory.

TABLE V-25

SUMMARY RAW WASTE LOAD DATA
SUBCATEGORY 211 - NONINTEGRATED-PAPERBOARD

	Production Profile				Raw Effluent					
	Furnish		Production		Flow		BOD5		TSS	
Mill No.	Purch.	W.P.	(t/d)	Product(s)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
085001	60.0	12	82.0	Bag, Wrapping	30.4	(7.3)	--	(--)	--	(--)
085007	7.0	--	12.2	Matrix Board	133.2	(30.0)	0.8	(1.6)	1.4	(2.8)
085003	32.0	22	50.0	Bag, Specialty	62.5	(15.0)	10.0	(20.0)	25.0	(50.0)
085010	2.1	--	2.7	Matrix	169.5	(40.7)	7.0	(14.1)	46.9	(93.7)
105001	33.5	--	38.2	Ctd. Food Board, Gift	30.0	(7.2)	8.2	(16.4)	43.2	(86.4)
105002[a]	9.2	--	8.4	Hi-Density Electrical Board	272.7	(65.5)	--	(--)	--	(--)
105039	--	--	7.0	Latex & Sat. Gaskets	48.7	(11.7)	1.4	(2.7)	0.4	(0.7)
105048	46.0	--	62.0	Impreg. Fiber	38.7	(9.3)	--	(--)	--	(--)
105049	44.0	--	51.0	Impreg. Fiber	52.9	(12.7)	--	(--)	--	(--)
105070[a]	5.0	7	216.0	Electrical Board, Asbestos spec.	221.0	(53.1)	87.5	(175.0)	136.5	(273.0)
105073	17.1	--	15.0	Sat. paper for vulcanizing	105.3	(25.3)	13.0	(26.0)	42.4	(84.7)
110021	32.2	17	76.0	Press board	62.9	(15.1)	--	(--)	--	(--)
Average	24.0	5			102.4	(24.6)	10.0	(20.0)[b]	42.3	(84.5)
Model Mill					102.4	(24.6)	10.0	(20.0)[b]	42.3	(84.5)

[a] High raw waste flows are noted for Mills No. 105002 and 105070, which produce electrical board. A flow allowance of 179.3 kl/kkg (43 kgal/t) is therefore suggested for mills manufacturing 100 percent electrical board.

[b] BOD5 value is a median value, not an average.

Summary of Raw Waste Loads for Model Mills. Table V-26 summarizes raw waste load data developed for model mills in the preceding subcategories.

Pure Mill Raw Waste Loads by Subcategory

While the model mill concept has been developed to present representative raw waste loads for each subcategory, it must be recognized that model mill raw waste loads are used for cost and energy impact analyses, and not for the development of effluent limitations guidelines and standards.

Most pulp, paper and paperboard mills are complex and difficult to categorize. Many mills operate unique combinations of production processes. To present data in a form which can be applied to the development of effluent limitations guidelines and standards for the complex mills, Table V-27 presents raw waste loads for pure mills. The "pure mill" concept allows for the isolation of distinct processes, so that raw waste loads for mills with combined operations can be pro-rated in accordance with the percentage of production attributable to each distinct process. The following text explains how the pure mill data has been developed for each subcategory.

011 Alkaline-Dissolving. Raw waste loads for the pure Alkaline-Dissolving mill are based on data for the model mill and data from the Alkaline-Market subcategory. The model Alkaline-Dissolving mill produces 58.7 percent dissolving pulp. To determine loadings at a mill producing 100 percent dissolving pulps, projections have been made on an assumption that 41.3 percent of the model mill production is responsible for the generation of a raw waste loading equivalent to that generated in the manufacture of Alkaline-Market pulp. This allows the calculation of raw waste loadings attributable to a pure mill producing 100 percent Alkaline-Dissolving pulp, as shown in Table V-27.

Flow	221.4 kl/kkg (53.1 kgal/t);
BOD_5	65.2 kg/kkg (130.3 lb/ton); and
TSS	96.8 kg/kkg (193.5 lb/ton).

Previous limitations guidelines have recognized that some dissolving pulp grades with higher level alpha cellulose content reflect an inherently more intense processing condition. However, data collected for this review of earlier guidelines limitations provides insufficient justification for further delineation based on either the grade produced or its alpha cellulose content. Likewise, the data does not indicate significant differences attributable to raw material used, i.e., hardwood or softwood. If additional data is provided in the comment period to justify differentiation by grade and/or wood specie, then such data can be incorporated in further review prior to finalizing effluent limitations guidelines for this subcategory.

012 Alkaline-Market. For the Alkaline-Market subcategory, pure mill raw waste loads presented in Table V-27 reflect the average loadings for the seven mills in this subcategory which produce only alkaline market pulps:

TABLE V-26

SUMMARY OF MODEL MILL RAW WASTE LOADS

			Raw Waste Load					
		Model Mill	Flow		BOD5		TSS	
	Subcategory	Size (t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
011	Alkaline-Dissolving	1,000	198.1	(47.5)	53.8	(107.6)	76.8	(153
012	Alkaline-Market	600	178.2	(42.8)	41.5	(83.0)	31.8	(63
013	Alkaline-BCT	800	152.2	(36.5)	45.7	(91.3)	42.5	(85
014	Alkaline-Fine	800	110.5	(26.5)	30.5	(61.0)	66.2	(132
015	Alkaline-Unbleached	1,000	46.6	(11.2)	14.2	(28.3)	16.3	(32
016	Semi-Chemical	425	32.5	(7.8)	18.5	(36.9)	21.6	(43
017	Alkaline-Unbleached & Semi-Chemical	1500	55.8	(13.4)	18.7	(37.3)	23.5	(47
019	Alkaline-Newsprint	1400	93.8	(22.5)	21.1	(42.2)	56.7	(113
021	Sulfite-Dissolving	600	256.9	(61.6)	153.0	(306.0)	90.3	(180
022	Sulfite-Papergrade	450	152.6	(36.6)	48.7	(97.3)	33.1	(66
032	Thermo-Mechanical Pulp	350	60.0	(14.4)	18.3	(36.5)	38.7	(77
033	Groundwood-CMN	600	88.4	(21.2)	18.6	(37.1)	48.5	(97
034	Groundwood-Fine	500	68.4	(16.4)	17.6	(35.2)	53.9	(107
101	Deink-Fine and Tissue	180	81.3	(19.5)	48.7	(97.4)	143.0	(286.
102	Deink-Newsprint	400	67.6	(16.2)	15.9	(31.7)	123.0	(246.
111	Wastepaper-Tissue	45	39.2	(9.4)	8.8	(17.5)	27.0	(54.
112	Wastepaper-Board	160	15.4	(3.7)	6.5	(12.9)	7.7	(15.
113	Wastepaper-Molded Products	50	47.1	(11.3)	5.7	(11.4)	10.7	(21.
114	Wastepaper-Construction Products	100	9.2	(2.2)	5.8	(11.5)	8.2	(16.
201	Nonintegrated-Fine	215	48.5	(11.6)	8.5	(17.0)	30.1	(60.
202	Nonintegrated-Tissue	180	73.4	(17.6)	13.3	(26.5)	39.0	(77.
204	Nonintegrated-Lightweight	60	266.5	(63.9)	15.3	(30.6)	45.6	(91.
205	Nonintegrated-Filter	20	171.8	(41.2)	5.0	(10.0)	25.0	(50.
211	Nonintegrated-Paperboard	40	102.4	(24.6)	10.0	(20.0)	42.3	(84.

TABLE V-27

SUMMARY OF RAW WASTE LOADS
FOR PURE MILLS

	Subcategory	Raw Waste Load: Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
011	Alkaline-Dissolving	221.4	(53.1)	65.2	(130.3)	96.8	(193.5)
012	Alkaline-Market	164.7	(39.5)	37.7	(75.3)	48.4	(96.7)
013	Alkaline-BCT	152.2	(36.5)	45.7	(91.3)	42.5	(85.0)
014	Alkaline-Fine	108.0	(25.9)	28.7	(57.4)	53.4	(106.7)
015	Alkaline-Unbleached						
	. Linerboard	46.7	(11.2)	14.2	(28.3)	16.3	(32.5)
	. Bag	70.5	(16.9)	18.9	(37.7)	20.7	(41.4)
016	Semi-Chemical						
	. 80%	32.5	(7.8)	18.5	(36.9)	21.6	(43.1)
	. 100%	48.4	(11.6)	19.3	(38.6)	38.5	(76.9)
017	Alkaline-Unbleached & Semi-Chem.	55.9	(13.4)	18.7	(37.3)	23.5	(47.0)
019	Alkaline-News	93.8	(22.5)	21.1	(42.2)	56.7	(113.3)
021	Sulfite-Dissolving	266.4	(63.9)	168.5	(336.9)	100.1	(200.2)
022	Sulfite-Papergrade						
	. 67%	152.6	(36.6)	48.7	(97.3)	33.1	(66.2)
	. 100%	203.9	(48.9)	68.5	(136.9)	34.7	(69.3)
032	Thermo-Mechanical Pulp	60.0	(14.4)	18.3	(36.5)	38.7	(77.4)
033	Groundwood-CMN						
	. 74%	88.4	(21.2)	18.6	(37.1)	43.5	(97.0)
	. 100%	134.3	(32.2)	22.9	(45.8)	77.6	(155.1)
034	Groundwood-Fine						
	. 59%	68.4	(16.4)	17.6	(35.2)	53.9	(107.9)
	. 100%	110.9	(26.6)	18.6	(37.2)	55.2	(110.4)
101	Deink-Fine						
	. Pure Tissue	81.3	(19.5)	48.7	(97.4)	143.0	(286.0)
	. Pure Fine	107.2	(25.7)	50.0	(99.9)	215.7	(431.3)
102	Deink-Newsprint	67.6	(16.2)	15.9	(31.7)	123.0	(246.0)
111	Wastepaper Tissue[a]						
	. 100% Industrial	56.7	(13.6)	13.2	(26.3)	40.5	(81.0)
112	Wastepaper-Board						
	. Board	15.4	(3.7)	10.6	(21.2)	9.9	(19.7)
	. Linerboard	27.9	(6.7)	8.9	(17.8)	10.8	(21.5)
	. Corrugated	4.2	(1.0)	5.3	(10.7)	4.0	(7.9)
	. Chip & Filler	10.0	(2.4)	3.5	(6.9)	4.5	(8.9)
	. Folding Box	16.3	(3.9)	6.1	(12.1)	7.1	(14.1)
	. Set-Up Box	20.4	(4.9)	7.3	(14.7)	5.7	(11.4)
	. Gypsum	11.7	(2.8)	5.8	(11.6)	15.9	(31.8)
113	Wastepaper-Molded Products(a)	52.5	(12.6)	6.5	(13.0)	11.4	(22.7)
114	Wastepaper-Construction Products[a]						
	. 100% Waste Paper	14.6	(3.5)	7.6	(15.2)	19.4	(38.7)
	. 50% WP/50% TMP	12.5	(3.0)	13.9	(27.8)	10.2	(20.4)
201	Nonintegrated-Fine	48.4	(11.6)	8.5	(17.0)	30.1	(60.1)
202	Nonintegrated-Tissue	73.4	(17.6)	13.3	(26.5)	39.0	(77.9)
204	Nonintegrated-Lightweight	266.5	(63.9)	15.3	(30.6)	45.6	(91.2)
	. Lightweight-Electrical	407.0	(97.6)	11.6	(23.1)	37.7	(75.3)
205	Nonintegrated-Filter & Nonwoven	171.8	(41.2)	5.0	(10.0)	25.0	(50.0)
211	Nonintegrated						
	. Board	102.6	(24.6)	10.0	(20.0)	42.3	(84.5)
	. Electrical Board	247.3	(59.3)	--	(--)	--	(--)

(a) Excludes self-contained mills.

Flow 164.7 kl/kkg (39.5 kgal/t);
BOD5 37.7 kg/kkg (75.3 lb/ton); and
TSS 48.4 kg/kkg (96.7 lb/ton).

013 Alkaline-BCT. The mills in this subcategory produce paperboard, coarse products, and tissue grades of paper, either separately or in combination. This mixture of products is reflected in the model mill raw waste loads. The mills produce 100 percent alkaline pulp on-site. Therefore, Alkaline-BCT pure mill raw waste loads are the same as those for the model mill:

Flow 152.2 kl/kkg (36.5 kgal/t);
BOD5 45.7 kg/kkg (91.3 lb/ton); and
TSS 42.5 kg/kkg (85.6 lb/ton).

014 Alkaline-Fine. Raw waste loads for the pure Alkaline-Fine mill are based on the average data from eight mills which produce both high filler and low filler products from a furnish which consists of greater than 95 percent alkaline pulp manufactured on-site. Thus the pure mill data represents an average for the integrated production of alkaline fine papers. As shown in Table V-27, pure mill raw waste loads are:

Flow 108.0 kl/kkg (25.9 kgal/t);
BOD5 28.7 kg/kkg (57.4 lb/ton); and
TSS 53.4 kg/kkg (106.7 lb/ton).

015 Alkaline-Unbleached. The model mill raw waste load data for this subcategory was based upon the average data for those mills exclusively producing linerboard. Such mills comprise the largest subgroup within the subcategory. However, another major subgroup produces predominantly bag papers. As shown in the Table V-27, pure mill raw waste loads are presented for each of the two subgroups, thus allowing for the pro-rating of raw waste loads based on actual product mix:

Linerboard	Bag
Flow 46.7 kl/kkg (11.2 kgal/t);	Flow 70.5 kl/kkg (16.9 kgal/t);
BOD5 14.2 kg/kkg (28.3 lb/t); and	BOD5 18.9 kg/kkg (37.7 lb/t); and
TSS 16.3 kg/kkg (32.5 lb/t).	TSS 20.7 kg/kkg (41.4 lb/t).

016 Semi-Chemical. The typical mill in the Semi-Chemical subcategory produces its products using 80 percent semi-chemical pulp and 20 percent waste paper. Pure mill raw waste loads for a mill using 100 percent semi-chemical pulp have been projected graphically from curves showing the loads attributed to different percentages of semi-chemical production level, ranging from 60 percent to 97 percent.

The extrapolated raw waste loads for 100 percent semi-chemical pulp production are:

Flow 48.4 kl/kkg (11.6 kgal/t);
BOD5 19.3 kg/kkg (38.6 lb/ton); and
TSS 38.5 kg/kkg (76.9 lb/ton).

These loads should be utilized in pro-rating guidelines for mills which deviate significantly from the typical 80 percent semi-chemical operation, or for mills which use other types of alkaline pulping processes in combination with semi-chemical pulps. Pure mill raw waste load data is also presented for the 80 percent semi-chemical operation as follows:

Flow 32.5 kl/kkg (7.8 kgal/t);
BOD5 18.5 kg/kkg (36.9 lb/ton); and
TSS 21.6 kg/kkg (43.1 lb/ton).

From data made available for the year (1976), it appears that no-sulfur pulping operations may exhibit lower BOD5 and TSS raw waste loads than the classical NSSC operations. As more and newer data is accumulated, consideration should be given to establishing reduced raw waste load guidelines for the no-sulfur mills. Data pertaining to mills which have switched to no-sulfur processes since 1976 is solicited in the comment period.

017 Alkaline-Unbleached and Semi-Chemical. The average mill in this subcategory produces 17 percent semi-chemical and 79 percent unbleached alkaline pulp, or about four parts kraft to one part semi-chemical. This ratio remains fairly consistent, and shows a relatively small standard deviation with respect to raw waste loads. Therefore, this subcategory is considered pure at the 4:1 alkaline:semi-chemical production ratio, making raw waste loads for the model mill and the pure mill the same:

Flow 55.9 kl/kkg (13.4 kgal/t);
BOD5 18.7 kg/kkg (37.3 lb/ton); and
TSS 23.5 kg/kkg (47.0 lb/ton).

If the ratio of unbleached alkaline to semi-chemical pulp production varies significantly from the 4:1 ratio, then consideration should be given to developing limitatons guidelines based on the pro-rating technique.

019 Alkaline-Newsprint. This subcategory consists of three mills which, by definition, operate combined on-site groundwood and alkaline pulping processes in the ratios necessary to produce the finished newsprint sheet. Therefore, the model mill and the pure mill raw waste loadings are the same:

Flow 93.8 kl/kkg (22.5 kgal/t);
BOD5 21.1 kg/kkg (42.2 lb/ton); and
TSS 56.7 kg/kkg (113.3 lb/ton).

021 Sulfite-Dissolving. The typical Sulfite-Dissolving mill produces 85 percent dissolving sulfite pulp; the remaining production is papergrade sulfite. Raw waste loads for this level of production have been extrapolated to

yield an expected raw waste load for the pure 100 percent dissolving sulfite mill. As shown in Table V-27, the pure mill raw waste load is:

Flow 266.4 kl/kkg (63.9 kgal/t);
BOD_5 168.5 kg/kkg (336.9 lb/ton); and
TSS 100.1 kg/kkg (200.2 lb/ton).

022 Sulfite-Papergrade. Raw waste loads for the Sulfite-Papergrade model mill correspond to a mill where 67 percent of production is from papergrade sulfite pulps. The remaining production is from purchased pulps, thus comparable to nonintegrated operations. To determine raw waste loads at a mill producing paper from 100 percent papergrade sulfite pulp, projections are made based on an assumption that 33 percent of the model mill production is responsible for the generation of a raw waste loading equivalent to that produced in the nonintegrated manufacture of fine paper. The remaining loading, which corresponds to 67 percent typical sulfite pulp production, has been extrapolated to 100 percent sulfite production, thus representing the pure mill. The extrapolated raw waste load data, as indicated in Table V-27, is:

Flow 203.9 kl/kkg (48.9 kgal/t);
BOD_5 68.5 kg/kkg (136.9 lb/ton); and
TSS 34.7 kg/kkg (69.3 lb/ton).

032 Thermo-Mechanical Pulp. The pure mill raw waste loads are reflected in the model mill loadings representative of this subcategory. These loadings are based on a mill which is producing 90 percent of its required furnish as TMP pulp:

Flow 60.0 kl/kkg (14.4 kgal/t);
BOD_5 18.3 kg/kkg (36.5 lb/ton); and
TSS 38.7 kg/kkg (77.4 lb/ton).

033 Groundwood-CMN. The pure mill raw waste loads for this subcategory are estimated from model mill data which shows an average of 74 percent groundwood furnish with the remaining production from purchased pulp. Projections are made based on the assumption that 26 percent of the model mill production is responsible for the generation of raw waste loads equivalent to those produced in nonintegrated manufacture of fine paper. The remaining production from groundwood is extrapolated from 74 percent to 100 percent to yield the pure mill raw waste loads for this subcategory:

Flow 134.3 kl/kkg (32.2 kgal/t);
BOD_5 22.9 kg/kkg (45.8 lb/ton); and
TSS 77.6 kg/kkg (155.1 lb/ton).

034 Groundwood-Fine. The model mill in the Groundwood-Fine subcategory produces approximately 59 percent of its furnish as groundwood pulp. The remaining furnish consists of purchased kraft and other long-fiber pulps,

which are required to meet product specifications. Because product requirements necessitate this proportion of groundwood and long-fiber pulps, the model mill data for the Groundwood-Fine subcategory also can be interpreted as pure mill data, even though the pulp furnish is less than 100 percent groundwood.

However, in order to present data which can be used in establishing mill-specific effluent limitations guidelines, it is necessary to establish pure mill data for a mill in this subcategory producing fine paper from 100 percent groundwood pulp. To establish such data, the typical 59 percent groundwood level has been extrapolated to 100 percent. Although no fine paper can be produced in this manner, the 100 percent extrapolation can be used in prorating raw waste load data for mills producing less than the typical 59 percent groundwood, or for mills producing groundwood as part of a more complex operation. The extrapolated raw waste loads are:

Flow 110.9 kl/kkg (26.6 kgal/t);
BOD_5 18.6 kg/kkg (37.2 lb/ton); and
TSS 55.2 kg/kkg (110.4 lb/ton).

101 Deink-Fine and Tissue. For the Deink-Fine and Tissue subcategory, a grouping of nine mills producing sanitary tissue was chosen as the basis for development of model mill raw waste loadings. This data can be considered as pure mill data representing the production of sanitary tissue grades from 100 percent deink stock:

Flow 81.3 kl/kkg (19.5 kgal/t);
BOD_5 48.7 kg/kkg (97.4 lb/ton); and
TSS 143.0 kg/kkg (286.0 lb/ton).

The second largest group of mills consists of those where fine papers are produced using approximately 88 percent deink stock in the furnish. The furnish consists of waste paper and purchased pulps. When the data is extrapolated to reflect 100 percent deink stock for fine paper production, raw waste loads become:

Flow 107.2 kl/kkg (25.7 kgal/t);
BOD_5 50.0 kg/kkg (99.9 lb/ton); and
TSS: 215.7 kg/kkg (431.2 lb/ton).

102 Deink-Newsprint. Model mill raw waste loads for this subcategory represent three similar mills producing newsprint from 100 percent deinked over-issue and waste newspaper. In this homogenous subcategory, model mill data is reflective of the pure mill situation:

Flow 67.7 kl/kkg (16.2 kgal/t);
BOD_5 15.9 kg/kkg (31.7 lb/ton); and
TSS 123.0 kg/kkg (246.0 lb/ton).

111 Wastepaper-Tissue. For the Wastepaper-Tissue subcategory pure mill raw waste load data, as shown in Table V-27, is derived from the average of mills producing industrial tissue, and utilizing 100 percent waste paper for that production. In averaging this data, self-contained mills are excluded. No extrapolation is necessary, as these mills are producing tissue from 100 percent waste paper. The pure mill raw waste load is:

Flow 56.7 kl/kkg (13.6 kgal/t);
BOD5 13.2 kg/kkg (26.3 lb/ton); and
TSS 40.5 kg/kkg (81.0 lb/ton).

112 Wastepaper-Board. Pure mill raw waste load data for the Wastepaper-Board subcategory is derived from average data for mills where products are manufactured from 100 percent waste paper (self-contained mills were excluded from the analysis). Pure mill data is presented in Table V-27 for board mills, as well as for mills producing mostly (in excess of 80 percent) linerboard, corrugated, chip and filler board, folding box board, set-up box, and gypsum board grades. Pure mill raw waste loads for mills producing these products are as follows:

	Pure Mill Raw Waste Load					
	Flow		BOD5		TSS	
Product	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Board	15.4	(3.7)	10.6	(21.2)	9.9	(19.7)
Linerboard	27.9	(6.7)	8.9	(17.8)	10.8	(21.5)
Corrugated	4.2	(1.0)	5.3	(10.7)	4.0	(7.9)
Chip & Filler	10.0	(2.4)	3.5	(6.9)	4.5	(8.9)
Folding Box	16.3	(3.9)	6.1	(12.1)	7.1	(14.1)
Set-up Box	20.4	(4.9)	7.3	(14.7)	5.7	(11.4)
Gypsum Board	11.7	(2.8)	5.8	(11.6)	15.9	(31.8)

113 Wastepaper-Molded Products. As with the other waste paper subcategories, raw waste loads for the pure mill in the Wastepaper-Molded Products subcategory are based on average data for mills where molded products are made utilizing 100 percent waste paper (self-contained mills were excluded from the analysis). Pure mill raw waste loads are:

Flow 52.5 kl/kkg (12.6 kgal/t);
BOD5 6.5 kg/kkg (13.0 lb/ton); and
TSS 11.4 kg/kkg (22.7 lb/ton).

114 Wastepaper-Construction Products. Two sets of pure mill raw waste load data are presented in Table V-27 for this subcategory. The first set is based on the average raw waste loads for those mills utilizing 100 percent waste paper (self-contained mills were excluded from the analysis). The second set

is based on the average raw waste loads for mills where approximately 50 percent waste paper and 50 percent TMP pulp are used in production of the final product (self-contained mills were excluded from the analysis).

Pure Mill Utilizing 100% Waste Paper	Pure Mill Utilizing 50% Waste Paper and 50% TMP
Flow 14.6 kl/kkg (3.5 kgal/t);	Flow 12.5 kl/kkg (3.0 kgal/t);
BOD_5 7.6 kg/kkg (15.2 lb/t); and	BOD_5 13.9 kg/kkg (27.8 lb/t); and
TSS 19.4 kg/kkg (38.7 lb/t).	TSS 10.2 kg/kkg (20.4 lb/t).

201 Nonintegrated-Fine. Model mill raw waste load data for the Nonintegrated-Fine subcategory reflect the pure mill situation:

Flow 48.5 kl/kkg (11.6 kgal/t);
BOD_5 8.5 kg/kkg (17.0 lb/ton); and
TSS 30.1 kg/kkg (60.1 lb/ton).

202 Nonintegrated-Tissue. Model mill raw waste load data for the Nonintegrated-Tissue subcategory reflect the pure mill situation:

Flow 84.2 kl/kkg (20.2 kgal/t);
BOD_5 11.4 kg/kkg (22.8 lb/ton); and
TSS 33.3 kg/kkg (66.5 lb/ton).

204 Nonintegrated-Lightweight. Two pure mill situations have been developed for this subcategory. For most mills, pure mill raw waste load data is reflected in the average flow, BOD_5 and TSS loadings for the whole subcategory, (excluding mills making electrical papers):

Flow 266.5 kl/kkg (63.9 kgal/t);
BOD_5 15.3 kg/kkg (30 lb/ton); and
TSS 45.6 kg/kkg (91.2 lb/ton).

A separate set of pure mill raw waste load data is presented for a small group of mills within the subcategory where electrical papers are produced. These mills require higher water usage per ton, but contribute reduced BOD_5 and TSS discharges per ton:

Flow 407.0 kl/kkg (97.6 kgal/t);
BOD_5 11.6 kg/kkg (23.1 lb/ton); and
TSS 37.7 kg/kkg (75.3 lb/ton).

205 Nonintegrated-Filter and Nonwoven. The pure mill raw waste loading for this subcategory is reflected in the model mill raw waste load data, which is the average flow and median BOD_5 and TSS values for the 16 mills in this subcategory:

Flow 171.8 kl/kkg (41.2 kgal/t);
BOD5 9.8 kg/kkg (19.6 lb/ton); and
TSS 39.1 kg/kkg (78.1 lb/ton).

211 Nonintegrated-Paperboard. The pure mill raw waste loading for the Nonintegrated-Paperboard subcategory is generally reflected in the model mill raw waste loads:

Flow 102.6 kl/kkg (24.6 kgal/t);
BOD5 10.0 kg/kkg (20.0 lb/ton); and
TSS 42.3 kg/kkg (84.5 lb/ton).

However, recognition is given to mills where electrical board is produced, requiring greater water use to meet product specifications. The pure mill raw waste flow for a pure mill producing electrical board is:

Flow 247.3 kl/kkg (59.3 kgal/t).

TOXIC AND NONCONVENTIONAL POLLUTANTS

As a result of a settlement agreement between the EPA and the NRDC, a list of 129 toxic pollutants was developed for investigation as part of this study.(1)(16) Prior to undertaking these investigations, limited data was available on these pollutants and their presence in the pulp, paper and paperboard industry.

Nonconventional pollutants are those not named as conventional pollutants or included in the list of toxic pollutants. Pollutants in this category may be industry specific and may require regulation. Preliminary literature searches identified approximately 200 organic compounds identified as present in pulp, paper and paperboard wastewaters which were considered potentially toxic.(13) Of these 200 compounds, several of the more commonly found compounds have received considerable investigations by personnel at such research facilities as B.C. Research, Inc., in Vancouver, British Columbia; the Institute of Paper Chemistry, Appleton, Wisconsin; the Wisconsin Department of Natural Resources; EPA's Office of Research and Development; and the Pulp & Paper Research Institute of Canada (PPRIC). These nonconventional pollutants are generally known as fatty and resin acids and bleach plant derivatives. The fatty and resin acids identified include:

Abietic Acid
Dehydroabietic Acid
Isopimaric Acid
Pimaric Acid
Oleic Acid
Linoleic Acid
Linolenic Acid

The bleach plant derivatives include:

9, 10 - Epoxystearic Acid
9, 10 - Dichlorostearic Acid
Monochlorodehydroabietic Acid
Dichlorodehydroabietic Acid
3, 4, 5 - Trichloroguaiacol
3, 4, 5, 6 - Tetrachloroguaiacol

Other nonconventional pollutants evaluated include color, COD, ammonia, and xylene.

As outlined previously, the data development involved a literature review, a screening sampling program, and a verification sampling program.

Literature Review

As presented in Section II, project investigations have included a review of literature on toxic and nonconventional pollutants, supplemented by discussions with researchers. Potentially toxic pollutants in pulp, paper and paperboard mill effluents are derived primarily from the wood furnish. These are resin and fatty acids and, where pulp bleaching is practiced, their chlorinated analogs. Resin acids are present in many softwoods but are often absent in hardwoods. Toxic materials can originate from chemical additives, such as dyes containing heavy metals. Toxic pollutant and toxicity information for pulp, paper and paperboard wastewaters (as reported in the literature) is summarized below.

Measuring Acute Toxicity. Most studies of the toxicity of pulp, paper, and paperboard wastes are based on bio-assay procedures which indicate effluent concentrations at which fish survival is threatened. Toxic compounds which are diluted in large quantities of wastewater will have less toxicity than those compounds which are present at higher concentrations. The concentration which results in a 50 percent fish survival rate after 96 hours of exposure is termed the 96-hr LC-50. This concentration can be expressed either as a percentage of dilution or in terms of milligrams/litre (mg/l).

Toxicity is substantially affected by pH, with higher toxicities generally occurring in the lower pH range. For this reason, 96-hr LC-50 values are usually reported for pH 7.5.

Raw Effluent Acute Toxicity. Many raw pulp, paper and paperboard mill effluents exhibit a limited degree of toxicity. The major concern over this toxicity originates from a generally high water use. Typical water usage by subcategory is presented in Section VIII.

A summary of the range of LC-50 concentrations (expressed as percent dilution of raw waste) for various wood pulping and bleaching processes is shown in

Table V-28. As shown, the 96-hr LC-50 of the various effluents can vary from 4 to 100 percent by volume, with mechanical pulping effluents being the most toxic. It should be noted, however, that the non-chlorinated resin and fatty acids contributing to mechanical pulping effluent toxicity are more amenable to biodegradation than chlorinated compounds in bleachery wastes.

TABLE V-28

REPORTED MEDIAN LETHAL CONCENTRATIONS OF VARIOUS RAW PULPING EFFLUENTS

Pulping Process	Raw Waste 96-Hr LC-50 (%v/v)	Raw Waste Reference
Unbleached Kraft	10-100	(40,41,42,43)
Bleached Kraft	10-100	(44)
Mechanical Pulping	4- 10	(45)
Sulfite	10-100	(46)
Deink	3- 20	(47)
Paperboard	20- 40	(47)
Woodroom	1- 50	(48)

Sublethal Toxicity. As solutions approach lethal concentrations, adverse sublethal effects have been observed for aquatic organisms. A summary of reported sublethal concentrations of kraft and sulfite effluents for various organisms is indicated in Table V-29.

Mutagenic and Carcinogenic Effects. In a recent study, Ander (49) has observed chlorination stage effluents from kraft bleaching to cause mutations in two strains of Salmonella bacteria. A weak mutagenic effect was also observed for hypochlorite stage bleaching effluent. The addition of human liver microsomes to the chlorination stage effluent decreased the mutagenic effect. This suggests that the mutagenic compounds would be partly degraded in the liver.

Chloroform also has been shown to induce carcinogenic effects in laboratory animals.(50)

Identification and Origin Of Specific Toxic Compounds Contributing to Raw Effluent Toxicity. Specific toxic pollutant concentrations have been reported for various pulp, paper, and wood products industry effluents. In most cases, the data which has been reported relates to specific mill effluents, rather than industry-wide surveys.

Walden has summarized the pollutants shown to be contributing the great majority of the observed toxicity in major pulping effluents.(51) His findings are presented in Table V-30. Resin acids reportedly contribute substantially to the toxicity in all the pulping processes indicated.

TABLE V-29

THRESHOLD OF SUBLETHAL CONCENTRATIONS OF KRAFT MILL AND SULFITE MILL EFFLUENTS(51)

Specie	Sublethal Effects	Kraft Mill Effluents[a]
Spring and coho	Growth, distress	0.12-0.14
Coho	Swimming	0.1 -0.2
Spring	Growth	0.12
	Growth	10% v/v
Coho	Growth	> 0.25
Rainbow	Respiration	0.08-0.18
Sockeye	Respiration	0.2
Sockeye	Arterial tension	< 0.33
Sparus macrocephalus	Various histochemical changes	3.6% v/v
Coho	Histochemical	> 0.25
Coho	Biochemical	< 0.33
Coho	Plasma glucose	0.1 -0.3
Coho	Biochemical (200 days)	< 0.1
Spring	Fish biomass	0.08-0.14
Fish food	Abundance	> 0.03
Spring	Fish biomass	> 0.03
Aquatic plants	Abundance	> 0.05
Insects, fish	Diversity	> 0.05
food	Abundance	> 0.05
Spring	Fish biomass	> 0.05
Coho	Swimming	0.15
Lobsters	Avoidance	> 20% v/v
Atlantic Salmon	Avoidance	50% v/v
Oysters	Embryo deformity	0.6% v/v
		Sulfite Mill Effluents[a]
Freshwater shrimp	Growth	< 1.6% v/v
Oysters	Pumping	55
Oysters	Embryonic development	6-12

[a] Concentrations expressed as % v/v or as fraction of 96 hr LC50 static bioassay value, unless otherwise noted.

TABLE V-30

RELATIVE TOXICITY CONTRIBUTION OF COMPOUNDS IN PULP MILL EFFLUENT (51)

Type of Chemical Compound	Specific Examples	Kraft Effluents			Debarking Effluent	Mechanical Pulping Effluent	Sulfite Pulping Effluent
		Pulping	Bleachery Chlorination	Bleachery Caustic			
Naturally occurring resin acids	Abietic, dehydroabietic, isopimaric, levopimaric, palustric, pimaric, sandaracopimaric, neoabietic.	Major	Minor	Major	Major	Major	Major
Chlorinated lignins	-	-	Major	-	-	-	-
Chlorinated resin acids	Mono- and dichlorodehydroabietic	-	-	Intermediate	-	-	-
Unsaturated fatty acids	Oleic, linoleic, linolenic, palmitoleic	Intermediate	-	-	Minor	-	-
Chlorinated phenolics	Tri- and tetraclorioguaiacol	-	-	Intermediate	-	-	-
Diterpene alcohols	Pimarol, isopimarol, dehydroabietal, abietal	-	-	-	Minor	Intermediate	
Juvabiones	Juvabione, juvabiol 1'-dehydroajuvabione, 1'-dehydrojuvabiol, dehydrojuvabione	-	-	-	-	Minor	-
Other acidics	Epoxystearic acid Dichlorostearic acid, Pitch dispersant	-	-	Intermediate	-	-	-
Other neutrals	Abienol, 12E-abienol, 13-epimanool	-	-	-	Minor	-	-
Lignin degradation products	Eugenol, isoeugenol $3,3^{1}$ dimethoxy, $4,4^{1}$ dihydroxystilbene	-	-	-	-	-	Intermediate

Swan has summarized the resin acid contents of major wood species used in the pulp, paper, and paperboard industry.(52) His results, summarized in Table V-31, show that pines contain by far the highest resin acid content of the species studied.

TABLE V-31

TYPICAL RESIN AND FATTY ACID CONTENTS OF RAW WOOD TYPES(52)

Species	Total Resin Acids (percent Oven Dryed Wood)	Total Fatty Acids (percent o.d. wood)
Pines	1.5%	1.0%
Other Softwoods	0.1%	0.1%
Hardwoods	negligible	0.5%

Variance was observed within the major species groups indicated. One study showed substantial variance in resin acid content within the same species for differing tree ages. Specifically, pinus bansiana was evaluated for six resin acids in trees of differing diameters.(53) The relative percentage of individual resin acid content was almost always progressively higher with an increase in diameter. The total identified resin acid contents and respective tree diameters are summarized in Table V-32.

TABLE V-32

RESIN ACID CONTENT OF PINUS BANSIANA FOR VARIOUS TREE DIAMETERS(53)

Diameter (inches)	4	8	12	15	20
Total Identified Resin Acid Content (% o.d. wood)	1.55	1.59	2.38	2.91	6.0

These results illustrate some of the complexities of attempting to characterize the toxic pollutant content of various raw effluents. No meaningful correlation has been established to date among toxic pollutant loads, pulping process and wood source. This may be caused by general lack of data on this subject.

Other potentially toxic pollutants of concern in pulp, paper, and paperboard effluents are heavy metals which can originate from dyes or other chemicals used in papermaking. There is an apparent lack of published literature with respect to specific effluent toxicity originating from additives used in various papers. Heavy metals originate largely from pigments added in paper coating and glazing operations. A summary of heavy metal content in these effluents is shown in Table V-33.

TABLE V-33

SUMMARY OF HEAVY METAL CONTENT OF WASTEWATER FROM PAPER COATING AND GLAZING (54)

Plant	Coating	Source of Pigment	Water Use (gal/ton of Product)	Concentration of Toxic Substances (mg/l): Pb	Cr	Cu	Zn	Cd	Hg[(a)]
1	Black	Carbon Black	80	0.05-0.61	0.01-0.04	0.11-2.9	0.06-1.1	0.005	8-16
	Orange	Organic Pigment	30	0.14-3.5	0.03-1.01	0.2 -130	5.6 -73	0.003-0.01	0.2-18
	Red	Precipitated Dyestuff	140	0.06-0.58	0.06-0.37	0.12-1.5	0.34-7.2	0.0002-0.27	0.2
	Yellow	Lead Chromate	290	420-1,100	130-1,400	0.25-2.8	5.7 -13	0.005 -0.034	0.2-0.7
2	Total Washup	N.D.	N.D.	0.64-0.83	0.42-0.83	0.68-1.4	8.7 -19	0.015 -0.027	0.2-0.6
3	Laminator Washup	N.D.	N.D.	0.26-0.29	0.04-0.09	0.3 -0.71	1.4 -2.1	0.13 -0.31	0.2-0.5

(a) The concentrations in ug/l.
N.D. No Data

Detergents used for deinking can also contribute to toxicity. Martin (55) determined that the detergents Nalco 808 and Sterox MS-b which are used in deinking were lethal to fish at a concentration of 4.0 mg/l. PCB's which were formerly used in carbonless copy paper are still present in some waste paper mill effluents by virtue of the waste paper cycle.

The New York State Department of Conservation has conducted a study concerning PCB's in wastepaper mill effluents.(56) Of the 40 mills in New York State using some waste paper, 18 were selected as potential direct dischargers of PCB's. Final effluent samples were analyzed for each month from October 1976 to September 1978. Sample types ranged from grab samples to flow-proportioned 24-hour composite samples taken at the 18 mills. At most mills secondary treatment was employed prior to discharge.

The results are summarized as follows:

- 81 percent of all samples showed PCB concentrations of less than 1 microgram/litre.
- The average of all reported median mill PCB concentrations was 0.76 micrograms/litre.
- The average of all median mill PCB levels, excluding mills without effluent treatment, was 0.61 micrograms/litre.
- The discharge of PCB's for any given mill was variable, with several reported values above 10 micrograms/litre. The highest value was 18 micrograms/litre.

These results imply that PCB concentrations from waste paper mills are generally below 1 microgram/litre and that the concentration is reduced by secondary treatment. Occasional periods of higher concentrations have occurred, although their cause is not precisely known.

Heavy metals generally originate from pigments added in paper dyeing, coating and glazing operations. The sampling conducted during this program should provide more specific information concerning the effect of these processes on whole mill effluents.

96-Hr-LC-50's for Specific Compounds. Selected pollutants in pulp and paper wastes and reported 96-hr LC-50 values are shown in Table V-34.

Reported Raw Wastewater Concentrations of Potentially Toxic Compounds

The toxicity of various raw pulp, paper, and paperboard wastewaters and relative toxicity contribution of specific compounds in those wastes has been discussed. Also, the reported toxicity of specific toxic compounds has been

TABLE V-34

MEDIAN LETHAL CONCENTRATIONS OF CERTAIN TOXICANTS KNOWN TO BE PRESENT IN VARIOUS PULP AND PAPER MILL EFFLUENTS(69)

Substance	96-hr LC-50, mg/l (Rainbow Trout)
Resin Acids	
Isopimaric	0.4
Palustric	0.5
Abietic	0.7
Pimaric	0.8
Dehydroabietic	1.1
Diterpene Alcohols	
Isopimarol	0.3
Pimarol	0.3
Dehydroabietol	0.8
Abietol	1.8
Chlorinated Resin Acids	
Monochlorodehydroabietic acid	0.6
Dichlorodehydroabietic acid	0.6
Chlorinated Phenolics	
Trichloroguaiacol	0.72
Tetrachloroguaiacol	0.32
Fatty Acids	
C18-Unsatuated fatty acid	9
Other Acids	
Epoxystearic acid	1.5
Juvabiones	
Iso-Dehydrojuvabione	0.8
Juvabione	1.5
Dihydrojuvabiones	1.8
Juvabiols	2.0
Heavy Metals	
Zinc	1.0
Volatiles	
Hydrogen sulfide	0.3-0.7
Methyl mercaptan	0.5-0.9
Sodium sulfide	1.0-1.8

summarized. Investigations concerning the specific concentrations of toxic and potentially toxic compounds found in raw pulp and paper effluents have been published. No attempt will be made here to summarize these results, however, the following are some of the more relevant studies on this topic: (57) (58) (59) (60) (61) (62) (63) (64) (65) (66) (67) (68).

Screening Program

As part of the overall project investigations, the screening program was undertaken to provide information on the presence or absence and the relative levels of toxic and non-conventional pollutants discharged by the pulp, paper and paperboard industry. Screening surveys were undertaken by the Jordan Company and by EPA regional surveillance and analysis (S & A) teams. As outlined previously, the Jordan Company undertook 11 screening surveys. Table V-35 presents a summary of the screening program analysis results. The EPA regional surveillance and analysis teams undertook 47 surveys which have or will develop screening survey analysis results. Table V-36 presents a summary of the results from 17 of the EPA S & A surveys.

Verification Program

As described previously, the screening survey results, industry survey responses, and available literature were reviewed to develop a list of parameters to be studied in verification sampling. The verification program was developed to provide data on the toxic compounds and nonconventional pollutants present in pulp, paper and paperboard mill effluents. Analysis results are summarized by subcategory in Appendix A. Only those compounds which were detected at the raw water, aeration influent (or equivalent) and final effluent have been summarized. The analysis results listed are preliminary. Confirmation of the results is currently in progress.

The procedure used to develop this summary is similar to that used in summarizing the screening program results. Each compound and sample point was examined individually and the analysis results are reported in concentration ranges of: less than 10 ug/l; 10 to 100 ug/l; and more than 100 ug/l. Also included in the summary is the total of all samples analyzed for which toxic or nonconventional pollutants were not detected and the average concentration for each compound at each sample point.

SUMMARY

This section has presented waste characteristics by subcategory for the pulp, paper, and paperboard industry. Data developed through these and continuing project investigations will be analyzed in further detail to provide the basis for establishment of effluent limitation guidelines and standards for the pulp, paper and paperboard industry.

TABLE V-35

SUMMARY OF SCREENING PROGRAM ANALYSIS RESULTS

Toxic Pollutant	Raw Water (ug/l)					Raw Wastewater (ug/l)					Final Effluent (ug/l)				
	Not Detected	< 10	10-100	> 100	Ave	Not Detected	< 10	10-100	> 100	Ave	Not Detected	< 10	10-100	> 100	Ave
1. acenaphthene	11					12					11				
2. acrolein	11					12					11				
3. acrylonitrile	11					12					11				
4. benzene	11					4	6	2		3	6	5			1
5. benzidine	11					12					11				
6. carbon tetrachloride (tetrachloromethane)	11					12					11				
7. chlorobenezene	11					10	1	1		8	11				
8. 1,2,4-trichlorobenzene	11					12					11				
9. hexachlorobenzene	11					12					11				
10. 1,2-dichloroethane	11					11	1			1	10	1			1
11. 1,1,1-trichloroethane	11					7	2	3		6	11				
12. hexachloroethane	11					12					11				
13. 1,1-dichloroethane	11					11	1			1	10	1			1
14. 1,1,2-trichloroethane	11					12					11				
15. 1,1,2,2-tetrachloroethane	11					11	1			1	11				
16. chloroethane	11					12					11				
17. bis(chloromethyl) ether	11					12					11				
18. bis(2-chloroethly) ether	11					12					11				
19. 2-chloroethyl vinyl ether (mixed)		11					12					11			
20. 2-chloronaphthalene	11					12					11				
21. 2,4,6-trichlorophenol	11					11		1		2	11				
22. parachlorometa cresol	11					12					11				
23. chloroform (trichloremethane)	9	2			1	2	2	2	6	269	3	5	3		16
24. 2-chlorophenol	11					12					11				
25. 1,2-dichlorobenzene	11					12					11				
26. 1,3-dichlorobenzene	11					12					11				
27. 1,4-dichlorobenzene	11					12					11				
28. 3,3'-dichlorobenzidine	11					12					11				
29. 1,1-dichloroethylene	11					12					11				

TABLE V-35 (continued)

Toxic Pollutant	Raw Water (ug/l) Not Detected	< 10	10-100	> 100	Avg	Raw Wastewater (ug/l) Not Detected	< 10	10-100	> 100	Avg	Final Effluent (ug/l) Not Detected	< 10	10-100	> 100	Avg
30. 1,2-trans-dichloroethylene	11					12					11				
31. 2,4-dichlorophenol	11					11		1		1	9	2			1
32. 1,2-dichloropropane	11					12					11				
33. 1,3-dichloropropylene (1,3 dichloropropene)	11					12					11				
34. 2,4-dimenthylphenol	11					12					11				
35. 2,4-dinitrotoluene	11					12					11				
36. 2,6-dinitrotoluene	11					12					11				
37. 1,2-diphenylhydrazine	11					12					11				
38. ethylbenzene	11					6	5		1	9	9	2			1
39. *fluoranthene	11					10	2			1	10	1			1
40. 4-chlorophenyl phenyl ether	11					12					11				
41. 4-bromophenyl phenyl ether	11					12					11				
42. bis(2-chloroisopropyl) ether	11					12					11				
43. bis(2-chloroethoxy) methane	11					12					11				
44. methylene chloride (dichloromethane)	3	2	3	3	72	1	1	6	4	81	1	2	4	4	55
45. methyl chloride (chloromethane)	11					12					11				
46. methyl bromide (bromomethane)	11					12					11				
47. bromoform (tribromomethane)	11					12					11				
48. dichlorobromomethane	11					11	1			1	11				
49. trichlorofluoromethane	11					11			1	23	10			1	19
50. dichlorodifluoromethane	11					12					11				
51. chlorodibromomethane	11					11	1			1	11				
52. hexachlorobutadiene	11					12					11				
53. hexachlorocyclopentadiene	11					12					11				
54. isophorone	11					11		1		5	11				
55. naphthalene	11					10		1	1	13	11				
56. nitrobenzene	11					12					11				
57. 2-nitrophenol	11					12					11				
58. 4-nitrophenol	11					12					11				
59. 2,4-dinitrophenol	11					12					11				

TABLE V-35 (continued)

Toxic Pollutant	Raw Water (ug/l) Not Detected	<10	10-100	>100	Avg	Raw Wastewater (ug/l) Not Detected	<10	10-100	>100	Avg	Final Effluent (ug/l) Not Detected	<10	10-100	>100	Avg
60. 4,6-dinitro-o-cresol	11					12					11				
61. N-nitrosodimethylamine	11					12					11				
62. N-nitrosodiphenylamine	11					12					11				
63. N-nitrosodi-n-propylamine	11					12					11				
64. pentachlorophenol	11					12					11				
65. phenol	0	9	2		6	0	2	6	4	624	0	5	5	1	89
66. bis(2-ethylhexyl) phthalate	7	1	3		5	2	1	6	3	66	5	0	5	1	22
67. butyl benzyl phthalate	11					12					11				
68. di-n-butyl phthalate	4	3	3	1	16	3	1	3	5	85	5	3	2	1	16
69. di-n-octyl phthalate	10	1			1	12					11				
70. diethyl phthalate	10	1			1	7	1	4		7	7	4			1
71. dimethyl phthalate	11					12					11				
72. benzo (a)anthracene (1,2-benzanthracene)	11					12					11				
73. benzo(a)pyrene (3,4-benzopyrene)		11					12					11			
74. 3,4-benzo fluoranthene	11					12					11				
75. benzo(k)fluoranthene (11,12-benzo fluoranthene)	11					12					11				
76. chrysene	11					11	1			1	11				
77. acenaphthlene	11					12					11				
78. anthracene	11					8	2	2		9	10	1			1
79. benzo(ghi)perylene (1,12-benzoperylene)	11					12					11				
80. fluroene	11					12					11				
81. phenathrene	11					12					11				
82. dibenzo (a,h) anthracene (1,2,5,6-dibenzanthracene)	11					12					11				
83. indeno (1,2,3-cd) pyrene (2,3-o-phenylenepyrene)	11					12					11				
84. pyrene	11					12					11				
85. tetrachloroethylene	11					10	2			1	10		1		7
86. toluene	10	1			1	2	8	2		4	4	6	1		4

TABLE V-35 (continued)

Toxic Pollutant	Raw Water (ug/l)					Raw Wastewater (ug/l)					Final Effluent (ug/l)				
	Not Detected	< 10	10-100	> 100	Avg	Not Detected	< 10	10-100	> 100	Avg	Not Detected	< 10	10-100	> 100	Avg
87. trichloroethylene	11					10	2			1	11				
88. vinyl chloride (chloroethylene)	11					12					11				
89. aldrin	11					12					11				
90. dieldrin	11					12					11				
91. chlordane (technical mixture & metabolites)	11					12					11				
92. 4,4'-DDT	11					12					11				
93. 4,4'-DDE (p,p'-DDX)	11					12					11				
94. 4,4'-DDD (p,p'-TDE)	11					12					11				
95. a-endosulfan-Alpha	11					12					11				
96. b-endosulfan-Beta	11					12					11				
97. endosulfan sulfate	11					12					11				
98. endrin	11					12					11				
99. endrin aldehyde	11					12					11				
100.heptachlor	11					12					11				
101.heptachlor epoxide	11					12					11				
102.a-BHC-Alpha	11					12					11				
103.b-BHC-Beta	11					12					11				
104.r-BHC (lindane)-Gamma	11					12					11				
105.g-BHC-Delta	11					12					11				
106.PCB-1242 (Arochlor 1242)	11					12					11				
107.PCB-1254 (Arochlor 1254)	11					11	1			1	10	1			1
108.PCB-1221 (Arochlor 1221)	11					12					11				
109.PCB-1232 (Arochlor 1232)	11					12					11				
110.PCB-1248 (Arochlor 1248)	11					12					11				
111.PCB-1260 (Arochlor 1260)	11					12					11				
112.PCB-1016 (Arochlor 1016)	11					12					11				
113.Toxaphene	11					12					11				
114.Antimony (Total)	0	11			1	0	10	2		7	0	10	1		4
115.Arsenic (Total)	0	11			3	0	11	1		5	0	10	1		3
116.Asbestos (Fibrous)	11					12					11				
117.Beryllium (Total)	0	11			1	0	12			1	0	11			1

TABLE V-35 (continued)

Toxic Pollutant	Raw Water (ug/l) Not Detected	< 10	10-100	> 100	Avg	Raw Wastewater (ug/l) Not Detected	< 10	10-100	> 100	Avg	Final Effluent (ug/l) Not Detected	< 10	10-100	> 100	Avg
118. Cadmium (Total)	0	11			1	0	12			2	0	11			2
119. Chromium (Total)**	0	6	5		8	0	3	8	1	42	0	7	4		12
120. Copper (Total)**	0	1	10		27	0	0	8	4	80	0	0	11		53
121. Cyanide (Total)	0	11			10	0	11		1	27	0	11			10
122. Lead (Total)**	0	6	5		10	0	4	7	1	36	0	5	6		16
123. Mercury (Total)	0	11			1.2	0	12			1.5	0	11			1.5
124. Nickel (Total)**	0	6	5		13	0	2	10		35	0	3	7	1	38
125. Selenium (Total)	0	11			2	0	12			2.4	0	11			2
126. Silver (Total)	0	10	1		5	0	12			2	0	10	1		6
127. Thallium (Total)	0	11			2	0	12			2	0	11			2
128. Zinc (Total)**	0	0	9	2	55	0	0	6	6	555	0	0	7	4	124
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	11					12					11				
130. Abietic Acid	11					1		4	7	365	7	0	3	1	94
131. Dehydroabietic Acid	11					1	0	1	10	700	5	1	3	2	89
132. Isopimaric Acid	11					11			1	9	11				
133. Primaric Acid	11					2	0	5	5	87	8	1	2		12
134. Oleic Acid	11					3	2	4	3	99	6	2	3		16
135. Linoleic Acid	11					6	1	2	3	192	10		1		6
136. Linolenic Acid	11					11			1	18	11				
137. 9,10-Epoxystearic Acid	11					11		1		5	11				
138. 9,10-Dichlorostearic Acid	11					12					11				
139. Monochlorodehydroabietic Acid	11					8	1	2	1	41	11				
140. Dichlorodehydroabietic Acid	11					11		1		5	11				
141. 3,4,5-Trichloroguaiacol	11					11		1		1	10	1			1
142. Tetrachloroguaiacol	11					11		1		1	10	1			1
143. Xylene	11					11			1	44	11				

**Consistent discrepancies existed between split sample results for this compound.

TABLE V-36

ORGANIC ANALYSIS RESULTS
SUMMARY OF SCREENING PROGRAM
RESULTS FOR EPA REGIONAL SURVEYS

Priority Pollutant	Raw Wastewater (ug/l)				Final Effluent (ug/l)			
	ND	< 10	10-100	> 100	ND	< 10	100-100	> 100
carbon tetrachloride	34	3	0	0	30	1	0	0
chlorobenzene	34	3	0	0	31	0	0	0
1,2,4-trichlorobenzene	36	0	1	0	31	0	0	0
1,2-dichloroethane	36	1	0	0	31	0	0	0
1,1,1-trichloroethane	30	6	1	0	27	4	0	0
bis(2-chloroethyl)ether	36	0	1	0	31	0	0	0
2,4,6-trichlorophenol	18	11	7	1	20	10	1	0
chloroform	13	1	5	18	12	3	8	8
2-chlorophenol	35	2	0	0	31	0	0	0
1,2-dichlorobenzene	36	1	0	0	30	1	0	0
1,4-dichlorbenzene	36	1	0	0	31	0	0	0
2,4-dichlorophenol	26	8	3	0	24	7	0	0
2,4-dimethylphenol	31	2	3	1	30	1	0	0
2,6-dinitrotoluene	36	1	0	0	31	0	0	0
1,2-diphenylhydrazine	36	0	1	0	31	0	0	0
ethylbenzene	35	2	0	0	31	0	0	0
fluoranthene	37	0	0	0	30	1	0	0
bis(2-chloroisopropyl)ether	36	0	1	0	30	1	0	0
bis(2-chloroethoxy)methane	36	0	1	0	30	1	0	0
methyl bromide	36	1	0	0	31	0	0	0
bromoform	35	2	0	0	31	0	0	0
trichlorfluoromethane	36	1	0	0	31	0	0	0
dichlorobromomethane	37	0	0	0	30	1	0	0
isophorone	35	1	1	0	31	0	0	0
naphthalene	33	1	3	0	29	2	0	0
nitrobenzene	32	2	2	1	30	1	0	0
2-nitrophenol	36	1	0	0	31	0	0	0
4-nitrophenol	36	0	1	0	30	1	0	0
N-nitrosodiphenylamine	34	2	1	0	30	1	0	0
pentachlorophenol	31	2	4	0	27	4	0	0
phenol	16	5	12	4	25	5	1	0
bis(2-ethylhexyl)phthalate	33	1	2	1	28	1	2	0
butyl benzyl phthalate	34	0	1	2	29	2	0	0
di-n-butyl phthalate	34	0	3	0	29	2	0	0
di-n-octyl phthalate	34	2	1	0	27	4	0	0
diethyl phthalate	31	2	4	0	30	1	0	0
dimethyl phthalate	34	2	1	0	31	0	0	0
benzo (a) anthracene	35	2	0	0	31	0	0	0
benzo (a) pyrene	36	1	0	0	31	0	0	0

TABLE V-36 (continued)

Priority Pollutant	Raw Wastewater (ug/l)				Final Effluent (ug/l)			
	ND	< 10	10-100	> 100	ND	< 10	100-100	> 100
chrysene	34	3	0	0	31	0	0	0
acenaphthylene	36	1	0	0	30	1	0	0
anthracene/phenanthrene	30	6	1	0	31	0	0	0
fluorene	35	2	0	0	31	0	0	0
dibenzo (a,h) anthracene	36	1	0	0	31	0	0	0
ideno (1,2,3-cd) pyrene	37	0	0	0	30	1	0	0
pyrene	37	0	0	0	29	2	0	0
tetrachloroethylene	34	2	1	0	28	3	0	0
toluene	33	2	1	1	26	3	2	0
trichloroethylene	36	1	0	0	30	0	1	0
aldrin	37	0	0	0	29	2	0	0
dieldrin	36	1	0	0	31	0	0	0
4,4'-DDT	37	0	0	0	30	1	0	0
4,4'-DDD	36	1	0	0	31	0	0	0
a-endosulfan-alpha	36	1	0	0	30	1	0	0
b-endosulfan-beta	36	1	0	0	31	0	0	0
endrin	37	0	0	0	30	1	0	0
heptachlor epoxide	35	2	0	0	30	1	0	0
a-BHC-alpha	36	1	0	0	29	2	0	0
b-BHC-beta	36	1	0	0	28	3	0	[illegible]
c-BHC-gamma	37	0	0	0	28	3	0	[illegible]
PCB - 1242	34	2	1	0	31	0	0	0
PCB - 1260	36	1	0	0	31	0	0	0

SECTION VI

PRODUCTION PROCESS CONTROLS

INTRODUCTION

Many mills within the pulp, paper and paperboard industry have made significant progress in implementing process controls to reduce effluent volume and loading. Mills have developed many alternative approaches for their diverse production processes. The implementation of appropriate production process controls at a given mill can reduce effluent loads, alter energy consumption and affect production costs.

Earlier effluent limitations guidelines development documents have identified technologies commonly employed by the industry to control pulping, bleaching, washing, liquor recovery and papermaking processes.(2)(37) These technologies are not employed solely to reduce raw waste loads. Of greater concern to the industry is the consistent production of high quality products with minimum loss of substrate. Production process controls have historically been part of an integrated pulp and papermaking operation concerned mostly with product characteristics and process economics.

As part of the data request program, production process control information was received from a total of 644 mills. Review of this information indicated that the control items generally fall into nine specific mill areas:

1. woodyard/woodroom;
2. pulp mill;
3. washers/screen room;
4. bleachery;
5. evaporators and recovery;
6. liquor preparation area;
7. papermill;
8. steam plant and utilities; and
9. effluent recycle.

With the development of BCT effluent limitations guidelines, the BCT cost test can be applied to progressive levels of control technology. To apply the cost test, the various production process controls have been classified as Level 1 or Level 2 technologies for application within each subcategory of the pulp, paper and paperboard industry. Level 1 technologies offer the most effectiveness in terms of raw waste load reduction. Level 2 technologies are expected to have less impact in reducing raw waste load and are primarily for reducing TSS raw waste loading. Table VI-1 summarizes the production process

TABLE VI-1

LEVEL 1 AND 2 PRODUCTION PROCESS CONTROLS

Control	Subcategory																							
	011	012	013	014	015	016	017	019	021	022	032	033	034	101	102	111	112	113	114	201	202	204	205	211
1. Woodyard/Woodroom																								
a. Close-up or dry woodyard and barking operation									1				1											
b. Segregate cooling water	1	1	1	1	1	1	1	1	1	1	1	1	1											
2. Pulp Mill																								
a. Reuse relief and blow condensates	1	1	1	1	1			1																
b. Reduce groundwood thickener overflow													2											
c. Spill Collection	1	1	1	1				1	1	1		1	1	1										
3. Washers and Screen Room																								
a. Add 3rd or 4th stage washer or press	1	1	1	1	1	1	1	1		1					1									
b. Recycle more decker filtrate		1	1	1				1	1															
c. Cleaner rejects to landfill								2		2		2	2		2									
d. Replace sidehill screens with vibrating	1																							
4. Bleaching																								
a. Countercurrent or jump stage washing		2	2	2				2	1	1														
b. Evaporator caustic extract filtrate									1															
5. Evaporation and Recovery Areas																								
a. Recycle condensate			1			1		1																
b. Replace barometric condenser	2																							
c. Boil out tank	2	2																						
d. Neutralize spent sulfite liquor									1	1														
e. Segregate cooling water						1																		
f. Spill Collection	1	1	1				1	1																

TABLE VI-1 (Continued)

	011	012	013	014	015	016	017	019	021	022	032	033	034	101	102	111	112	113	114	201	202	204	205	211
6. Liquor Preparation Area																								
a. Green liquor dregs filter	2	2	2	2	2		2	2																
b. Lime mud pond				2	2			2																
c. Spill Collection	1		1	1				1	1	1														
d. Spare tank	1	1	1	1			1	1																
7. Paper Mill																								
a. Spill Collection																								
1. Paper machine and bleached pulp spill collection	1	1	1	1		2		1	1	1	1	1	1							1	1	1	1	
2. Color plant				1						1			1							1				
b. Improve saveall					1	2	1	1		1	1	1			1		1		1	1	1	1	1	
c. High pressure showers for wire and felt cleaning	1				1				2					1						1		1	1	
d. Whitewater use for vacuum pump sealing	1		1	1	1	2	1	1	2	1		1	2	1	1					1		1		1
e. Paper machine whitewater showers for wire cleaning					1	2									1				1				1	1
f. Whitewater storage for upsets and pulper dilution			1	1				1	2	1		1		1			1					1		
g. Recycle press water	1				1	2		1		1		1	2											1
h. Reuse of vacuum pump water				1	1	2	1		2	1		1	2							1				1
i. Broke storage																						1		
j. Wet lap machine				1						1			1	1										
k. Segregate cooling water																				1	1	1		
l. Cleaner rejects to land-fill	2	2	2	2	2			2		2		2	2	2	2	1				2	2	2		
8. Steam Plant and Utility Areas																								
a. Segregate cooling water	1							1	1	1			1	1									1	1
b. Lagoon for boiler blow-down & backwash waters	2	2	2	2				2		2				2				1		2	2	2		
9. Recycle of effluent																1		1	1			1	1	1

controls which would be considered Level 1 or 2 technologies applicable to each subcategory. These controls and their general effectiveness are described below.

SPECIFIC PRODUCTION PROCESS CONTROLS

Woodyard/Woodroom

Production process controls that reduce raw waste loading in the woodroom area include: 1) conversion to mechanical or dry systems or close-up of wet operations with variations in sources of make-up water and means of handling flume overflow and dumping; and 2) the segregation and reuse or direct discharge of uncontaminated cooling waters. These controls, their applicability to the various subcategories, and their general effectiveness are described below.

Close-Up or Dry Operation. This production process control item is commonly practiced at most mills; however, it has not been commonly employed at mills in the Sulfite-Dissolving and Groundwood-Fine subcategories. For the Sulfite-Dissolving subcategory, hydraulic barking systems can be closed up by installing a collecton tank and cleaning system for recycled water and by using pulp mill wastewater as make-up. At mills in the Groundwood-Fine subcategory, conversion to dry barking and mechanical conveyors is possible. In colder climates it may be necessary to use steam in the barking drums. These control items are illustrated in Figures VI-1 and VI-2.

Application of these controls in the woodroom will result in reduced water use and a lower water content in the bark. With drier bark, combustion (and heat reclamation) is possible without further processing.

Close-up of the woodroom by conversion to dry debarking or a closed-cycle hydraulic system typically results in flow reductions of 8.3 to 12.5 kl/kkg (2 to 3 kgal/ton) and TSS reductions in the range of 5 to 10 kg/kkg (10 to 20 lb/ton).(70)(25)(71) Factors affecting the level of reduction are the source of water utilized in the woodroom, the type of operation, the type of wood, seasonal factors, and ultimate disposal. In all cases, these control items are designated as Level 1 technology.

Segregate Cooling Water. This control item involves the collection of water used for motor, chip blower, and bearing cooling. These noncontact cooling water can be returned to an existing water collection tank. At mills in some subcategories, this control could also include the return of condensate from the heating system to the steam plant through a separate line. The technology is illustrated in Figure VI-3.

Woodroom noncontact cooling water segregation has been neglected at most mills in the integrated subcategories. It is designated as an applicable Level 1 technology in the 13 integrated subcategories that employ woodrooms. Its implementation can result in a measurable flow reduction and significant energy savings. Segregation of cooling water via a separate discharge typically reduces effluent flow by approximately 2.0 kl/kkg (0.5 kgal/t). Flow

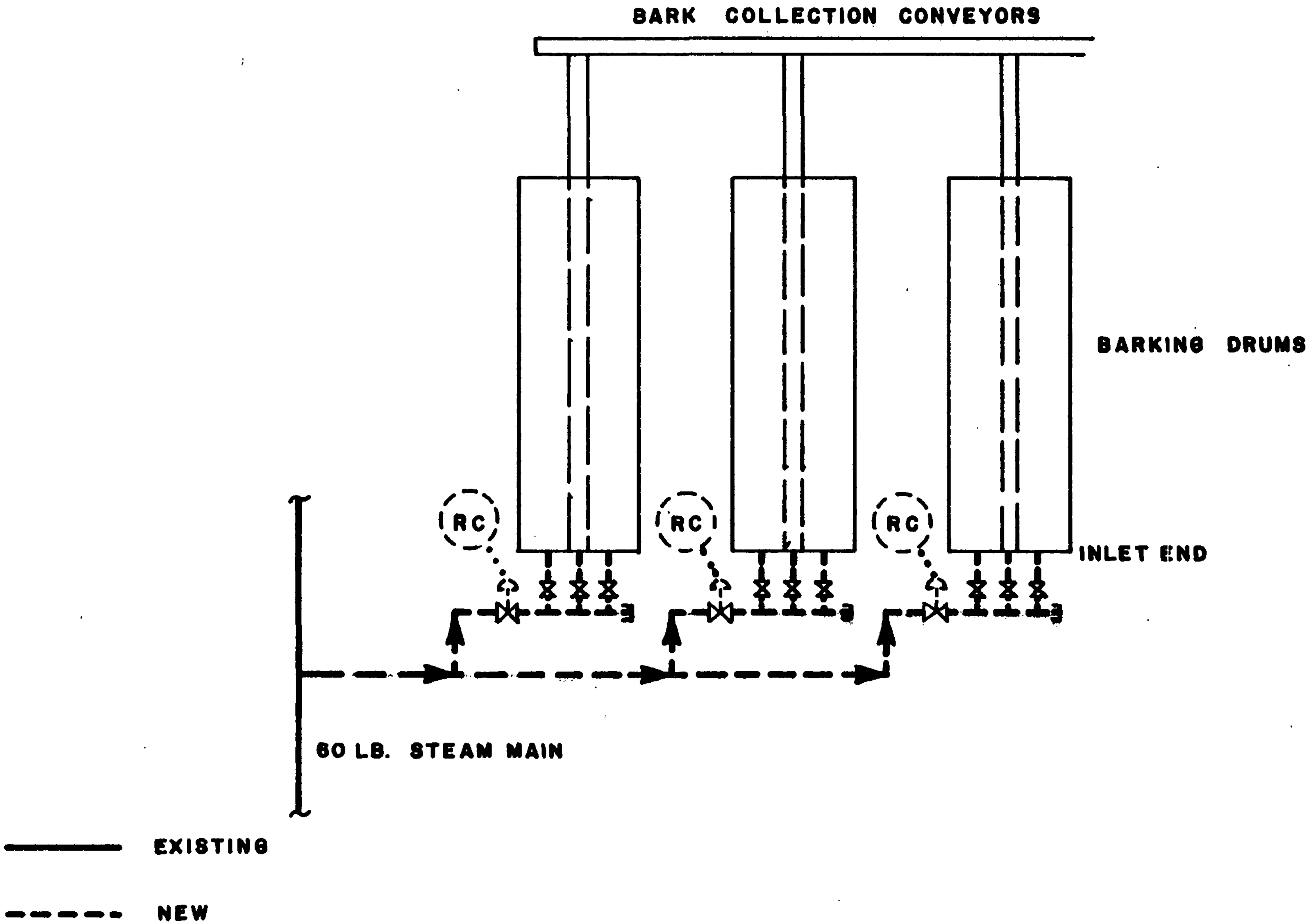
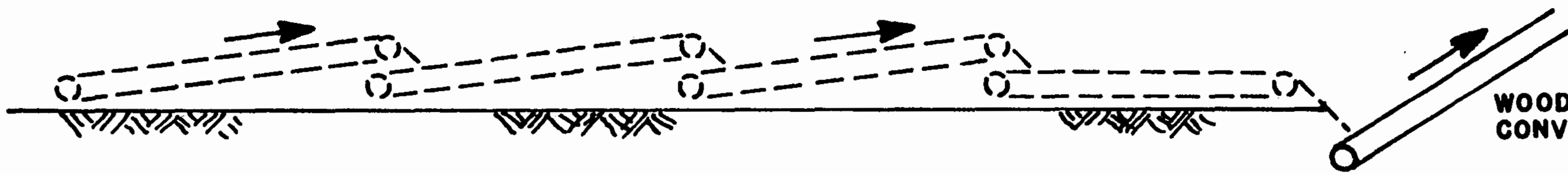
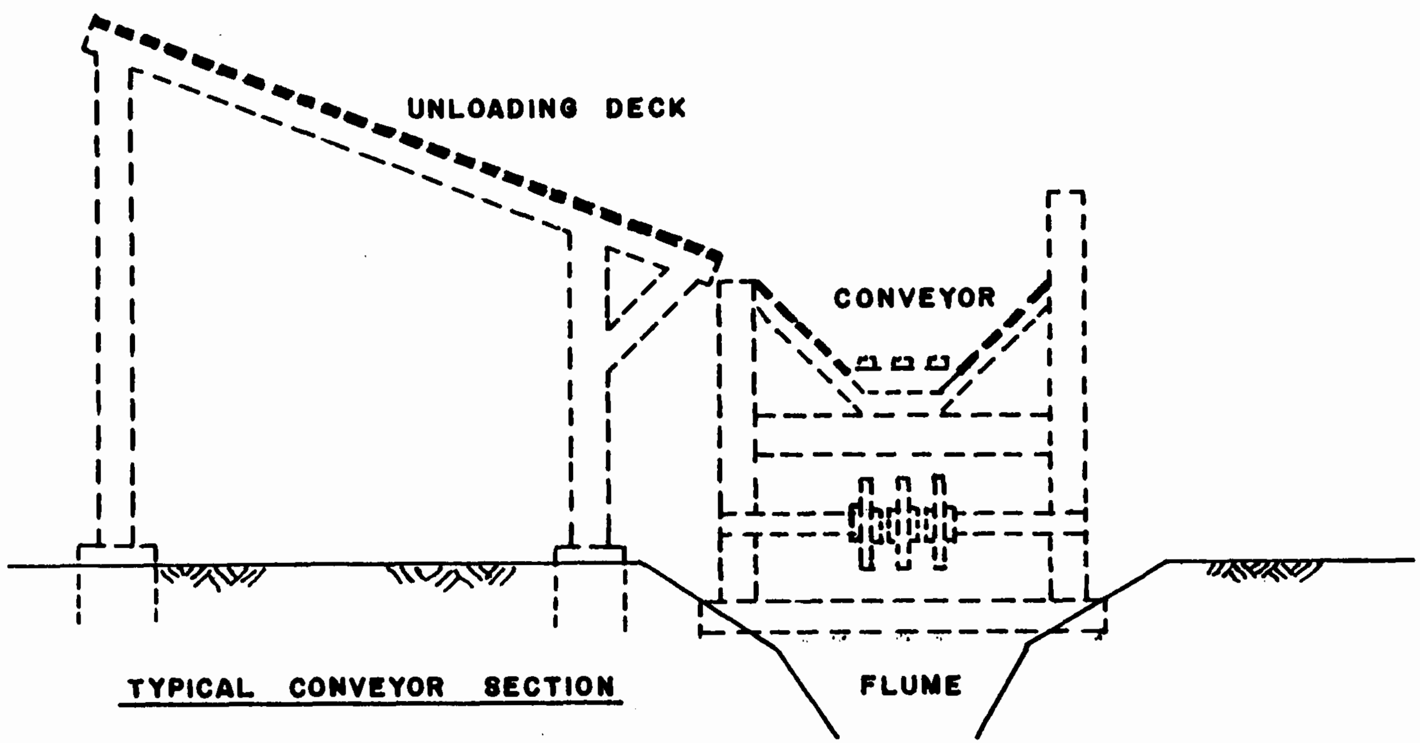


FIGURE VI - 1
CONVERT HYDRAULIC BARKING
SYSTEM TO DRY SYSTEM



OUTLINE ELEVATION OF CONVEYORS



TYPICAL CONVEYOR SECTION

FIGURE VI-2
FLUME REPLACED BY
MECHANICAL CONVEYOR

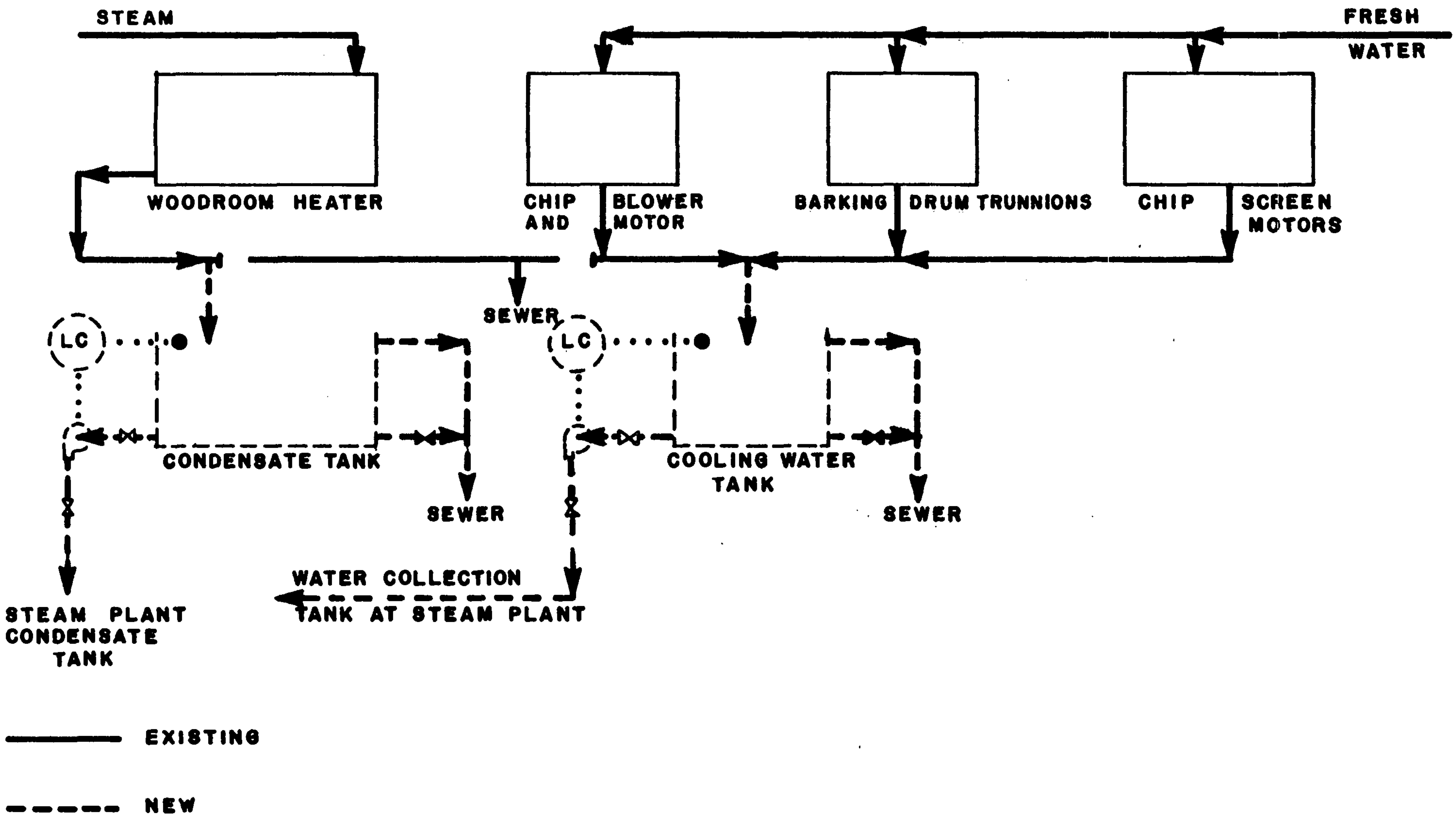


FIGURE VI-3
SEGREGATE COOLING WATER
AND CONDENSATE-WOODROOM

reduction ranges from about 1.25 to 4.17 kl/kkg (.3 to 1.0 kgal/t), depending upon the subcategory. Little reduction in BOD5 or TSS raw waste loads result from application of this technology.

Pulp Mill

Production process controls that reduce raw waste loading in the pulp mill area include: 1) reuse of digester relief and blow condensates; 2) reduction of groundwood thickener overflow; and 3) spill collection in the brown stock, digester and liquor storage areas. These controls and their applicability are described below.

Reuse Relief and Blow Condensates. Digester relief and blow condensates may be major contributors to the total BOD5 discharge from a mill. Particularly with continuous digesters, the relatively small flows are highly contaminated with foul smelling organic mercaptans and other organic compounds. Figure VI-4 illustrates a control system for relief and blow condensates. This control is designated as an applicable Level 1 technology for all of the alkaline subcategories. Digester condensate is collected in a tank and pumped to the area of greatest benefit, which could be in order of general preference:

1. first shower of last stage brown stock washer;
2. add at salt cake dissolving tank;
3. use for mud washing or smelt dissolving;
4. add directly to black liquor (extra evaporation costs); and
5. strip or use reverse osmosis to reduce BOD5.

A collection tank should be equipped with a conductivity alarm to alert the operator of unusually strong condensate.

Wastewater BOD5 reductions ranging from 0.9 kg to 3.0 kg/kkg (1.8 to 6 lb/t) can be achieved by incorporating digester relief and blow condensates back into the black liquor recovery cycle where possible.(72)(73)(74) However, at many mills with strict air emission standards, this may not be an easy task; this must be taken into account when estimating the cost of implementation of this technology. Possible alternatives would be steam stripping or reverse osmosis to remove 75-90 percent of the BOD5 before discharge or recycle.

Reduce Groundwood Thickener Overflow. At a typical mill in the Groundwood-Fine subcategory, excess thickener filtrate overflows to the sewer at a rate of up to 16.6 kl/kkg (4.0 kgal/t) of pulp produced.(75) This overflow represents a small source of fiber loss and contributes 5.0 kg/kkg (10 lb/ton) of TSS at a typical mill. Modifications shown in Figure VI-5 can be imple-

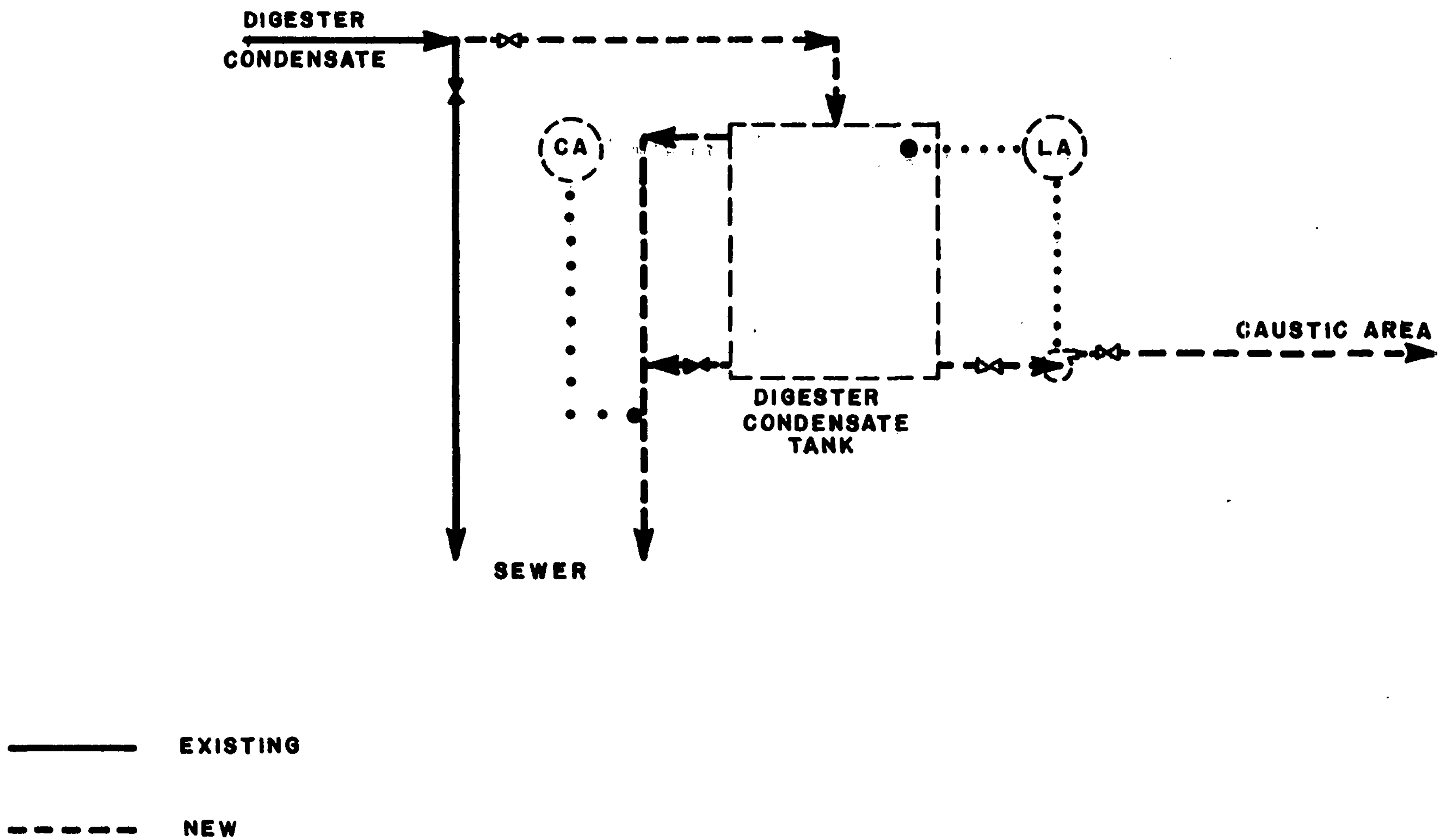


FIGURE VI - 4
REUSE OF DIGESTER CONDENSATE

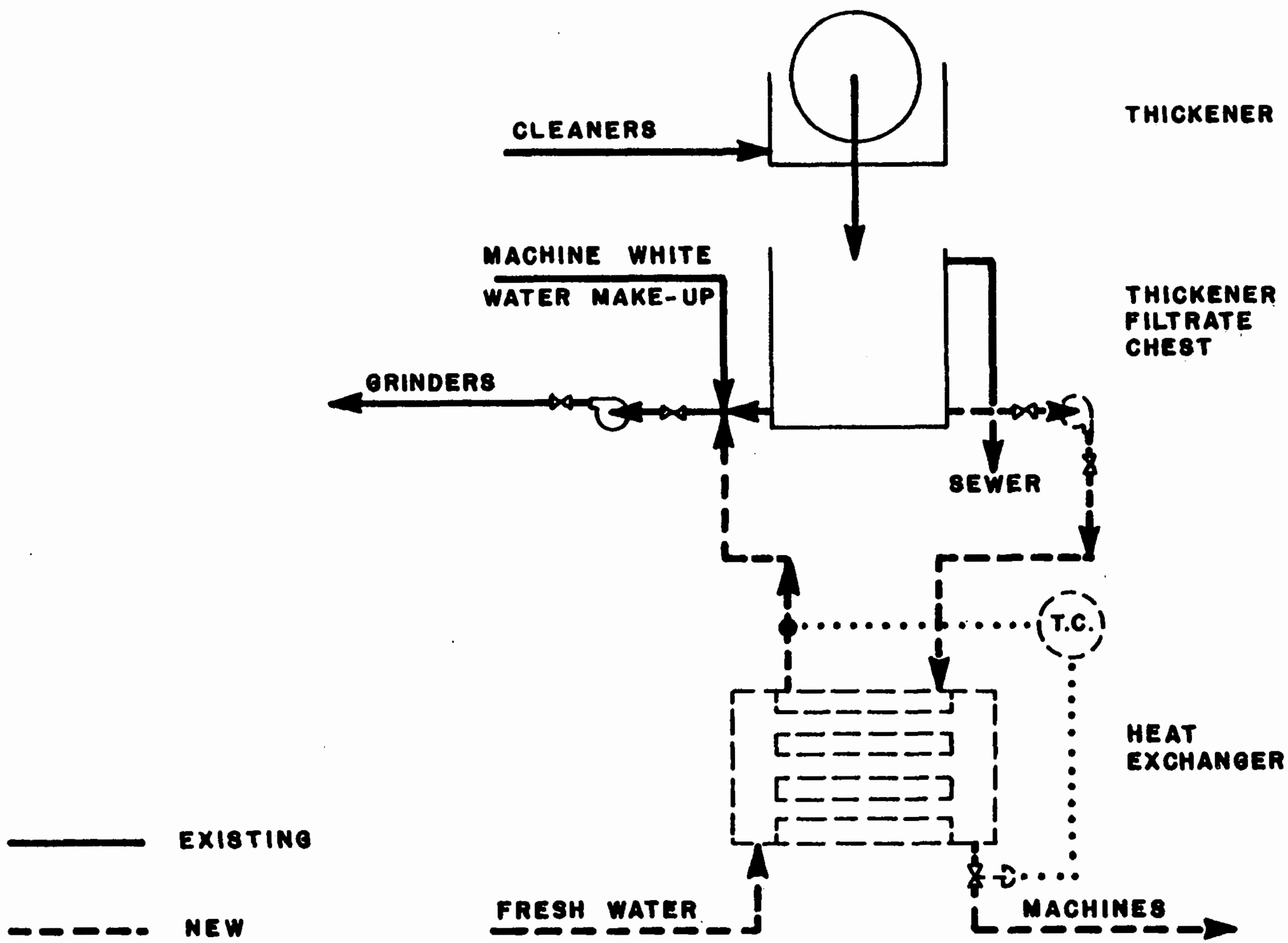


FIGURE VI - 5
REDUCE GROUNDWOOD
THICKENER FILTRATE OVERFLOW

mented to close up the whitewater system, essentially eliminating thickener filtrate overflow to the sewer. A small bleed would be maintained to control the build-up of pulp fines in the final accepted groundwood. Water make-up to the groundwood system would be excess papermachine whitewater. A heat exchanger would be required to control heat build-up in the filtrate, at least during the warmer months of the year. Fresh water used as cooling water in the heat exchanger would subsequently be returned as make-up to the papermachine systems. This closeup would be considered as Level 2 because of the insignificant effect on BOD5.

Spill Collection. Improved spill collection systems can be employed in the digester, liquor storage, and brown stock areas. A system designed to recover leaks, spills, dumps, and weak liquor overflows would result in a recovery of approximately 1.5 to 3.5 kg/kkg (3 to 7 lb/ton) of BOD5.(76) In the brown stock area, the combination of stock and liquor spills would generally be pumped with the brown stock entering the first-stage washer vat. This control is designated as an applicable Level 1 technology in 10 subcategories. A pulp mill liquor spill system is illustrated in Figure VI-6.

A separate spill collection system can be employed using a sump in conjunction with conductivity measurements to detect and pickup any leaks, spills, or overflows from the pulp mill digester and liquor storage tanks. Any liquor recovered would be diverted to its appropriate tank or to a spare liquor tank. This is considered a Level 1 technology for the Alkaline-Dissolving, Market, BCT, Fine and Newsprint subcategories.

Brown Stock Washers and Screen Room

Production process controls that reduce raw waste loading in the washer and screen room areas include: 1) addition of a third or fourth-stage washer; 2) recycle of more decker filtrate; 3) discharge of cleaner rejects to landfill; and 4.) replacement of sidehill screens with vibrating screens (in dissolving pulp mills). These controls are discussed below.

Add Third or Fourth-Stage Washer or Press. This control is applicable to mills in the Alkaline, Semi-Chemical, Sulfite-Papergrade, and Deink-Newsprint subcategories. The control includes a fourth-stage washer to be added to all alkaline washing lines, a third-stage washer to be added to all Semi-Chemical and Sulfite-Papergrade washing lines, and a press to be added following the last stage of washing in the Deink-Newsprint subcategory. The systems requiring an additional washer stage are shown in Figure VI-7. For these systems, this control is primarily a BOD5 reduction measure, as dissolved solids losses from the pulping operation are reduced. For the Deink-Newsprint subcategory, three-stage countercurrent washing and reuse of papermachine whitewater is typical. However, by adding a press after the final washer to bring the pulp to 15 percent consistency, the washing is improved. By reusing the press effluent on the washers, this system reduces the effluent flow as well as BOD5 and TSS.

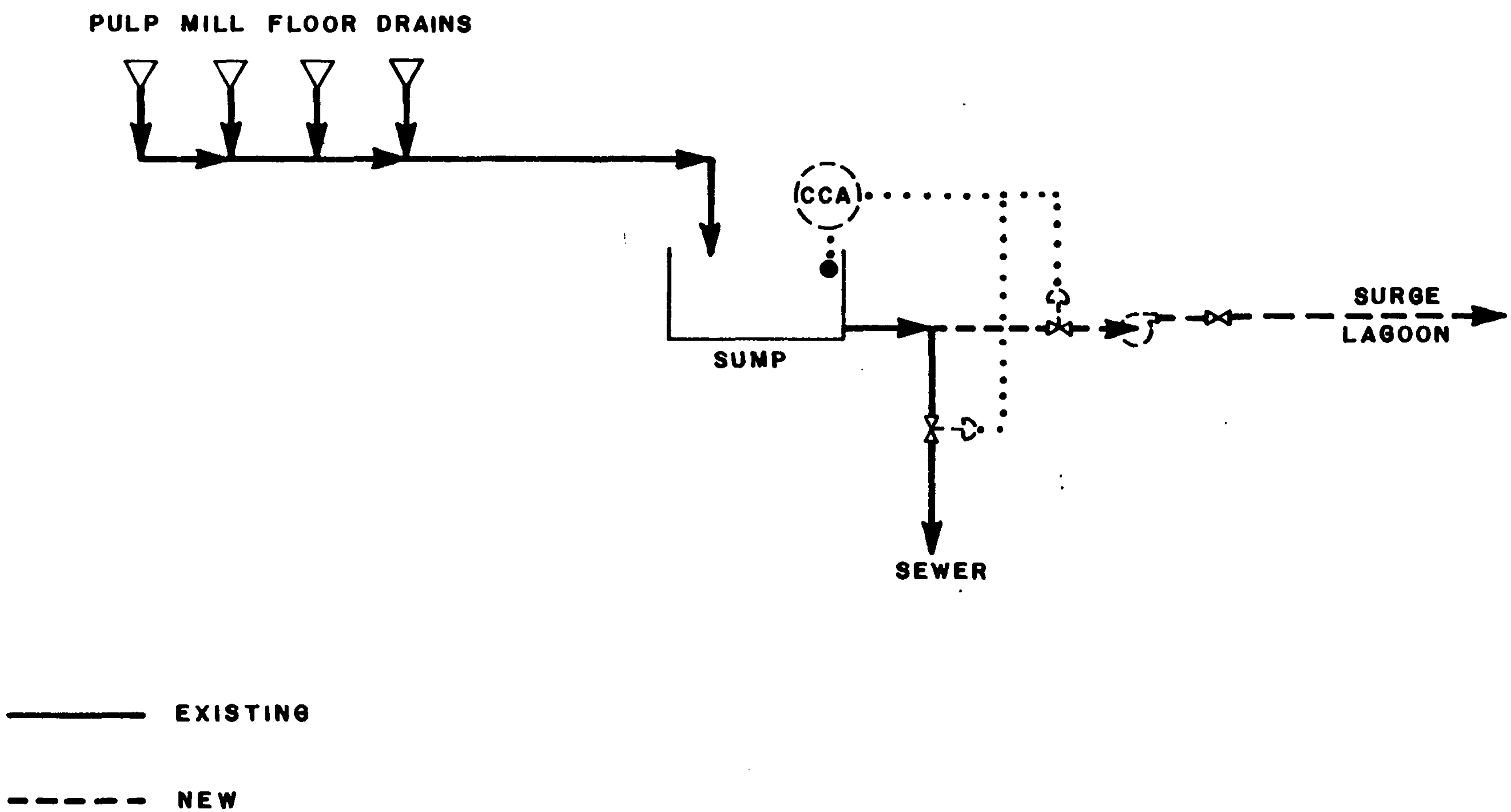


FIGURE VI -6
PULP MILL SPILL COLLECTION
DIGESTER AREA

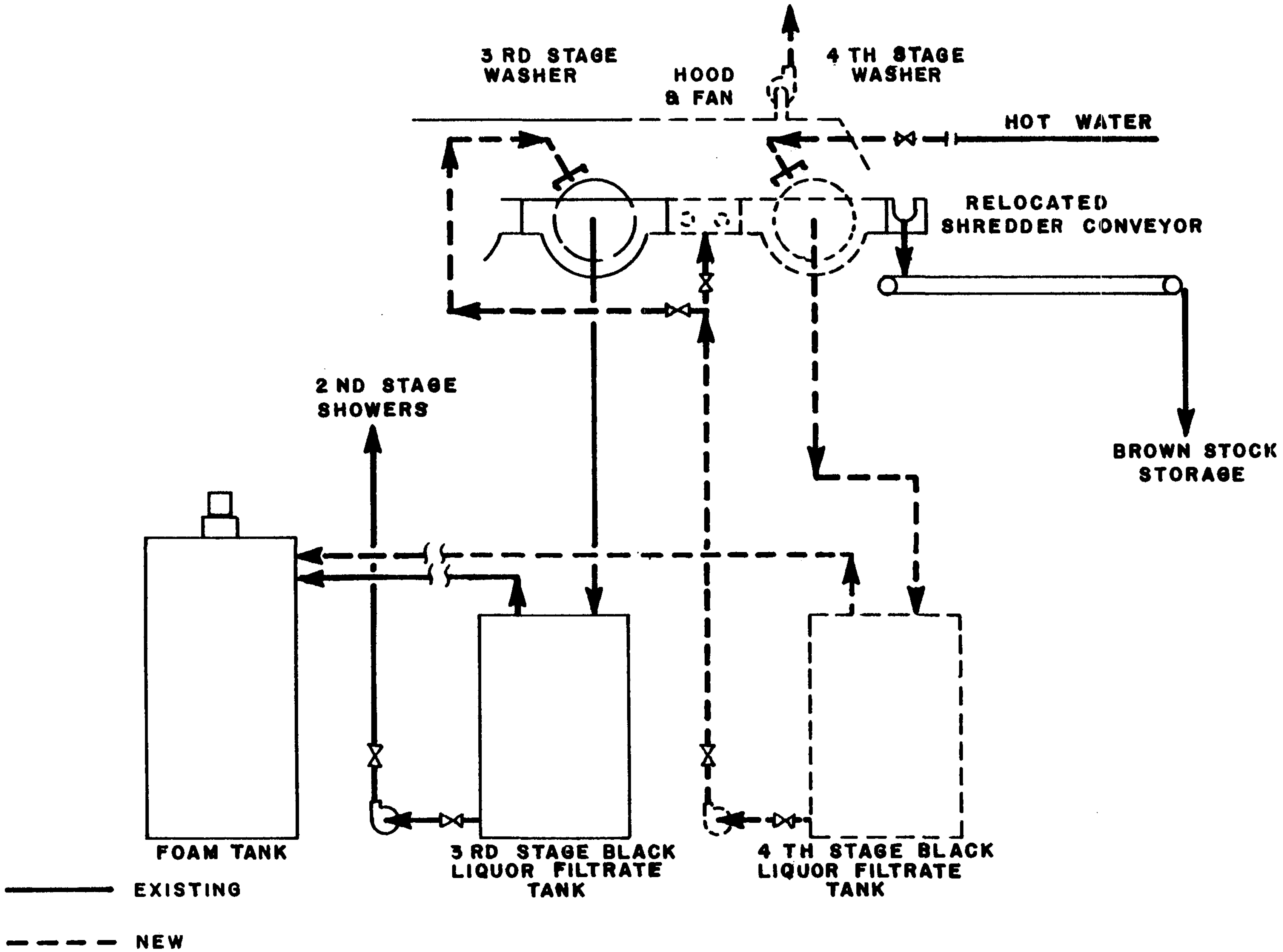


FIGURE VI-7
ADDITION OF THIRD OR
FOURTH STAGE PULP WASHER

In all bleached subcategories, improved washing facilitates better bleaching and lower bleach chemical costs. In terms of raw waste load, the main effect is a reduction in BOD5, ranging from about 2.5 kg/kkg (5 lb/ton) for Alkaline-Dissolving mills to as much as 4 kg/kkg (8 lb/ton) for the Alkaline-BCT subcategory. In the Alkaline-Newsprint subcategory (with generally newer, more modern mills, and more properly sized washers), such losses are estimated at 1 kg/kkg (2 lb/t).(77)(78)(79)

Recycle More Decker Filtrate. This Level 1 control item is generally applicable to the Sulfite-Dissolving subcategory and to all the alkaline subcategories except Alkaline-Dissolving. The unique quality demands of the dissolving pulps preclude the practicality of such complete closeup; few mills have a closed-up decker filtrate system. Tightening up by using decker filtrate for brown stock washer showers can substantially reduce decker filtrate overflow to the sewer, thus reducing effluent flow and BOD5. Efficient washing on the decker is required to reduce liquor carry-over to bleaching. A schematic of this control is shown in Figure VI-8.

Typically, reductions of about 4.2 kl/kkg (1.0 kgal/t) of flow and 0.5 to 1.0 kg/kkg (1 to 2 lb/ton) of BOD5 can be realized by such a close-up.(80)(81) Implementation of this technology requires a detailed study at each mill; the efficiency of the existing washing and screening systems should be taken into account, prior to further modification.

Cleaner Rejects to Landfill. Centricleaner rejects and continuous-screen rejects from the screen room are generally sewered directly and processed in the wastewater treatment facility. Most of such rejects are removed in the primary clarifier and handled in the solids dewatering system, or often mixed with solids from the secondary clarifier. Dry collection of screen and cleaner rejects, as shown on Figure VI-9, with separate discharge to landfill (in effect bypassing the wastewater treatment facility) will reduce TSS raw waste loads. This technology is considered to be a Level 2 technology applicable to the Alkaline-Newsprint, Sulfite-Papergrade, Groundwood-CMN and Fine, and Deink-Newsprint subcategories.

Typically 2 to 3 kg/kkg (4 to 6 lb/ton) of TSS would be removed from the raw waste in most of the integrated subcategories. This may or may not be a significant factor in final effluent characteristics, depending on the existing balance of the primary clarifier. If the clarifier is overloaded, TSS reduction can have an appreciable effect on overall treatment facility performance. If the clarifier can readily accommodate this loading, it may be advantageous to continue sewering these wastes in that the accompanying fibrous material, when mixed with secondary solids, can aid in dewatering of the combined solids.

Replace Sidehill Screens. For the Alkaline-Dissolving subcategory, sidehill screens used to fractionate the pulp can be replaced with a continuous screening system. Dry discharge to landfill can then be employed to significantly reduce raw waste load, both in terms of BOD5 and TSS. A reduction of approx-

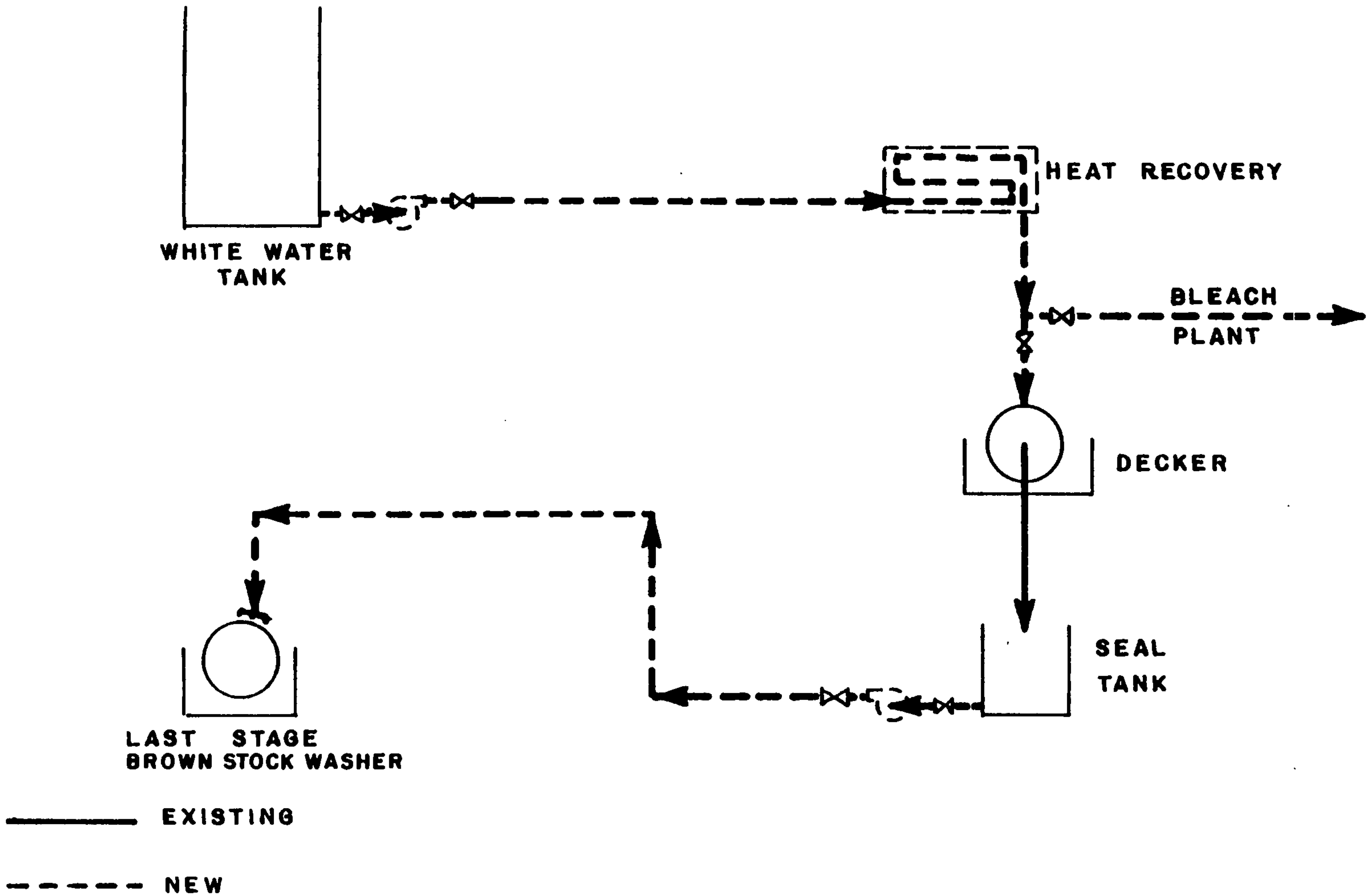


FIGURE VI-8
RECYCLE DECKER FILTRATE

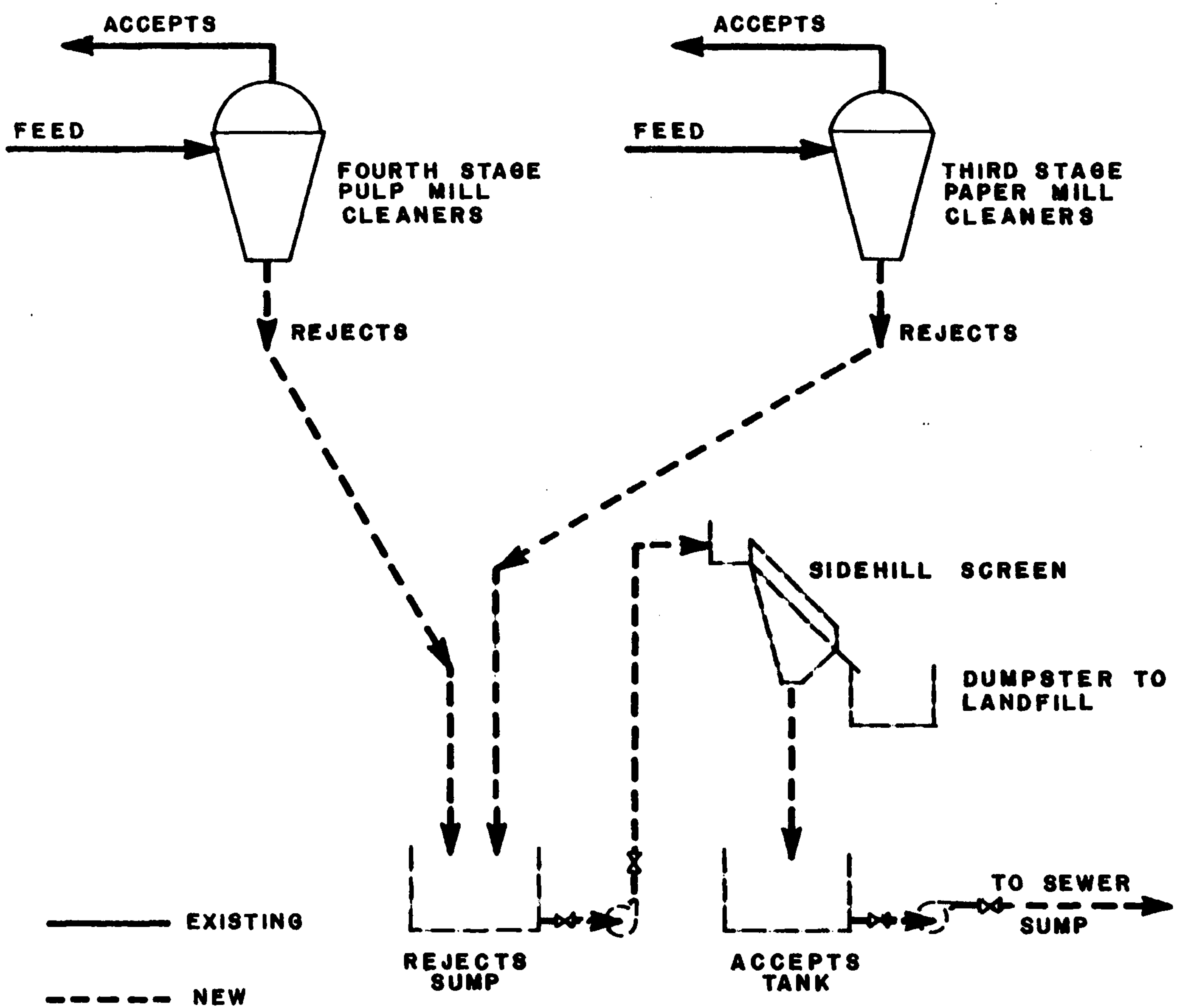


FIGURE VI-9
CLEANER REJECTS TO LANDFILL

imately 7.5 kg/kkg (15 lb/ton) each of BOD_5 and TSS is estimated. To obtain the necessary dissolving pulp purity, additional vibrating slotted screens and extra bleach plant purification can be employed. The pulp on the sidehill screens is handled at very low consistency and the resulting large effluent flow cannot generally be recycled or screened to remove solid material. The rejects from the vibrating slotted screens, however, can be removed and thickened and subsequently separately discharged. Figure VI-10 shows this control technology, which is considered to be a Level 1 technology applicable to the Alakaline-Dissolving subcategory.

Bleaching Systems

Bleaching systems vary widely from single stage operations in groundwood and deinked mills, to three (CEH) stages in sulfite and semi-bleached alkaline mills. In fully bleached alkaline mills a common sequence is CEDED. Generally effluent from the first two stages is mostly sewered, although some of the first-stage chlorination filtrate may be used to dilute incoming washed brown stock. The following technologies address further steps which may be implemented to reduce effluent flow from multi-stage bleacheries - a major source of process effluent in bleached alkaline pulp mills.

Countercurrent or Jump-stage Wash. This control is applicable to all alkaline mills and many sulfite mills. In jump-stage washing, the filtrate from the second chlorine dioxide washer is used on the showers of the first chlorine dioxide washer, and the filtrate from the first chlorine dioxide washer is used on the showers of the chlorine washer. The filtrate from the second caustic washer will be used on the first caustic washer. Jump-stage, instead of straight countercurrent washing, is necessary if the first and second caustic washers are constructed of materials that are not sufficiently corrosion resistant (i.e., either 304 stainless steel (ss) or rubber covered, rather than the more resistant 317 ss). Water savings equivalent to that previously used on three stages may be obtained.

In newer mills where all bleach plant washers, pumps, pipelines, repulpers, etc. are constructed of 317 ss or equivalent, full countercurrent washing may be implemented. Fresh water, or preferably pulp machine or papermachine whitewater, is used for the last stage washer showers and for dilution after high density bleached pulp storage. All washer filtrate would be used for showers and dilution for the preceding stage. Compared to a bleach plant with all fresh water showers, the conversion of full countercurrent washing can reduce bleach plant effluent volume by up to 80 percent. See Figures VI-11 and VI-12 for typical flow diagrams.

Full countercurrent bleaching utilizing chlorine dioxide necessitates the use of 317 ss or titanium materials of construction for all washers, pumps, and pipelines in the system. If not already in place, such equipment is extremely expensive, whereas jump-stage washing sequences can often be readily implemented utilizing the existing major items of equipment with relatively minor alterations, such as the addition of pumps and pipelines to service additional showers.

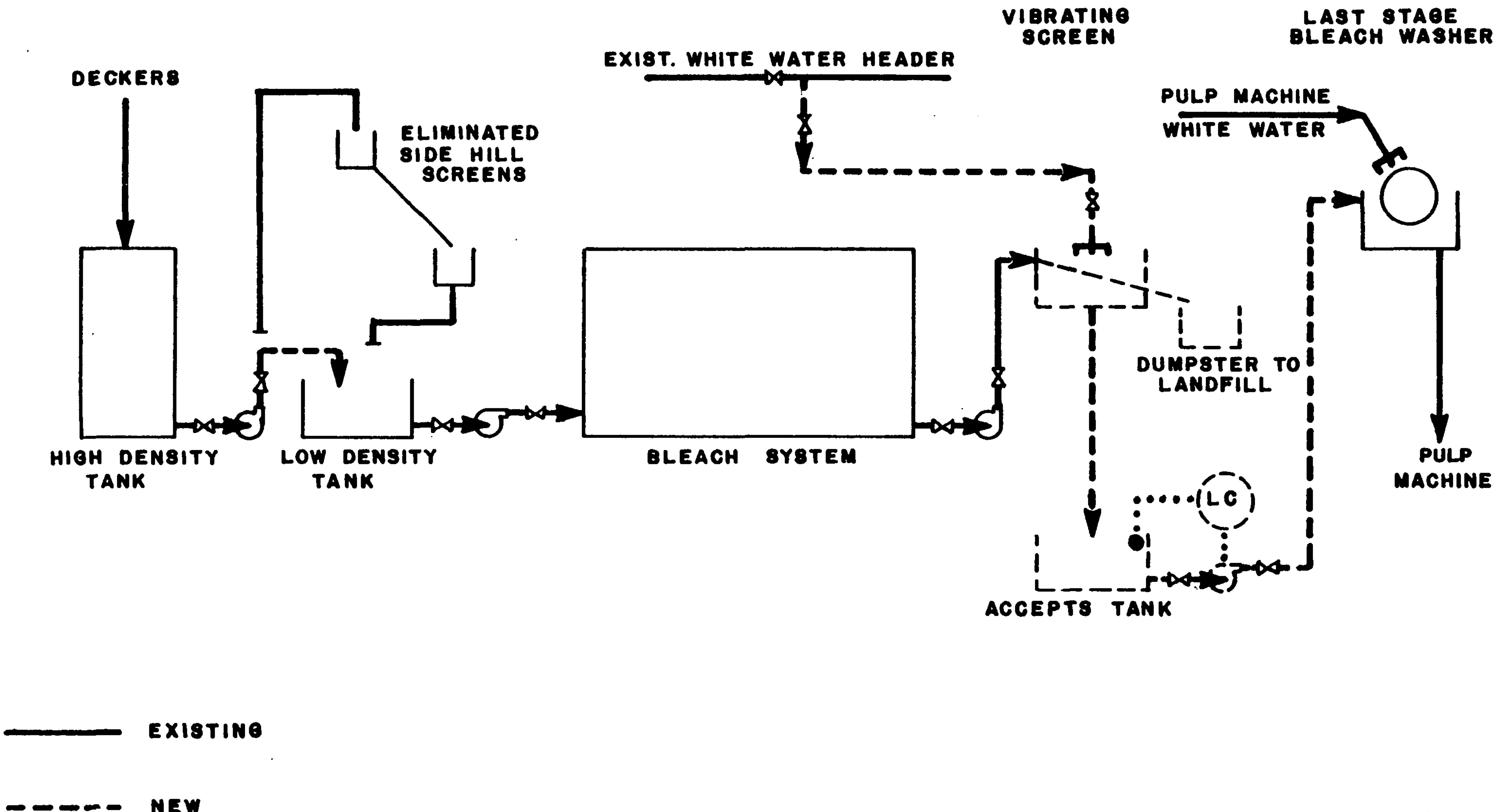


FIGURE VI- 10
ELIMINATE SIDE HILL SCREENS
ALKALINE - DISSOLVING

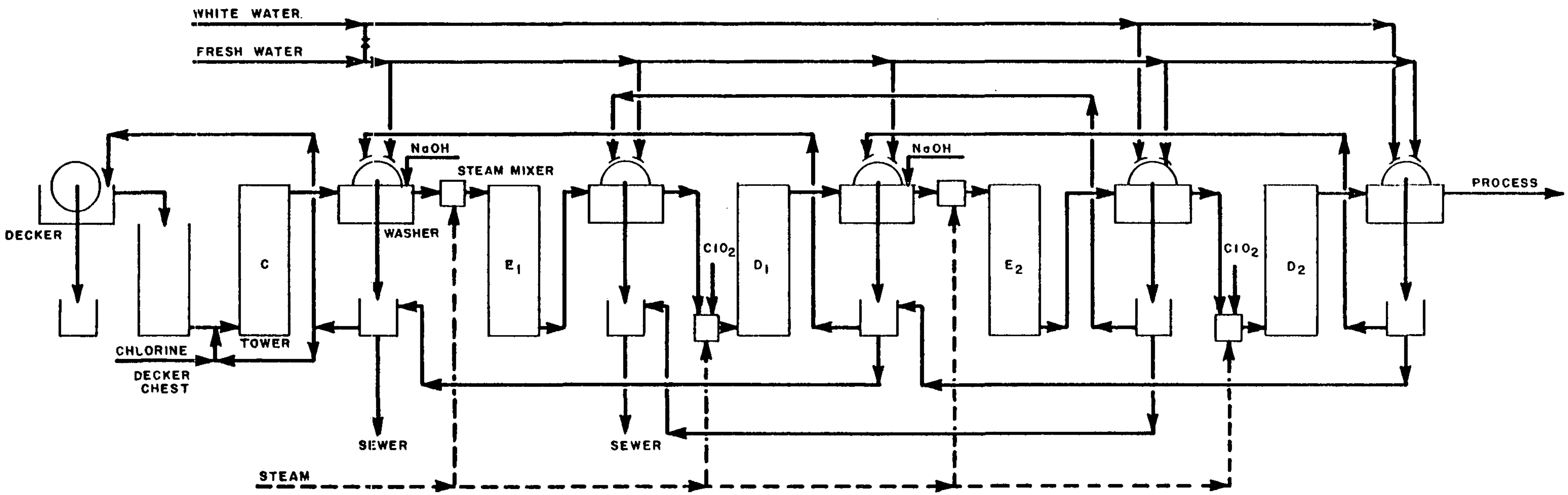


FIGURE VI - 11
JUMP STAGE WASHING IN BLEACH PLANT

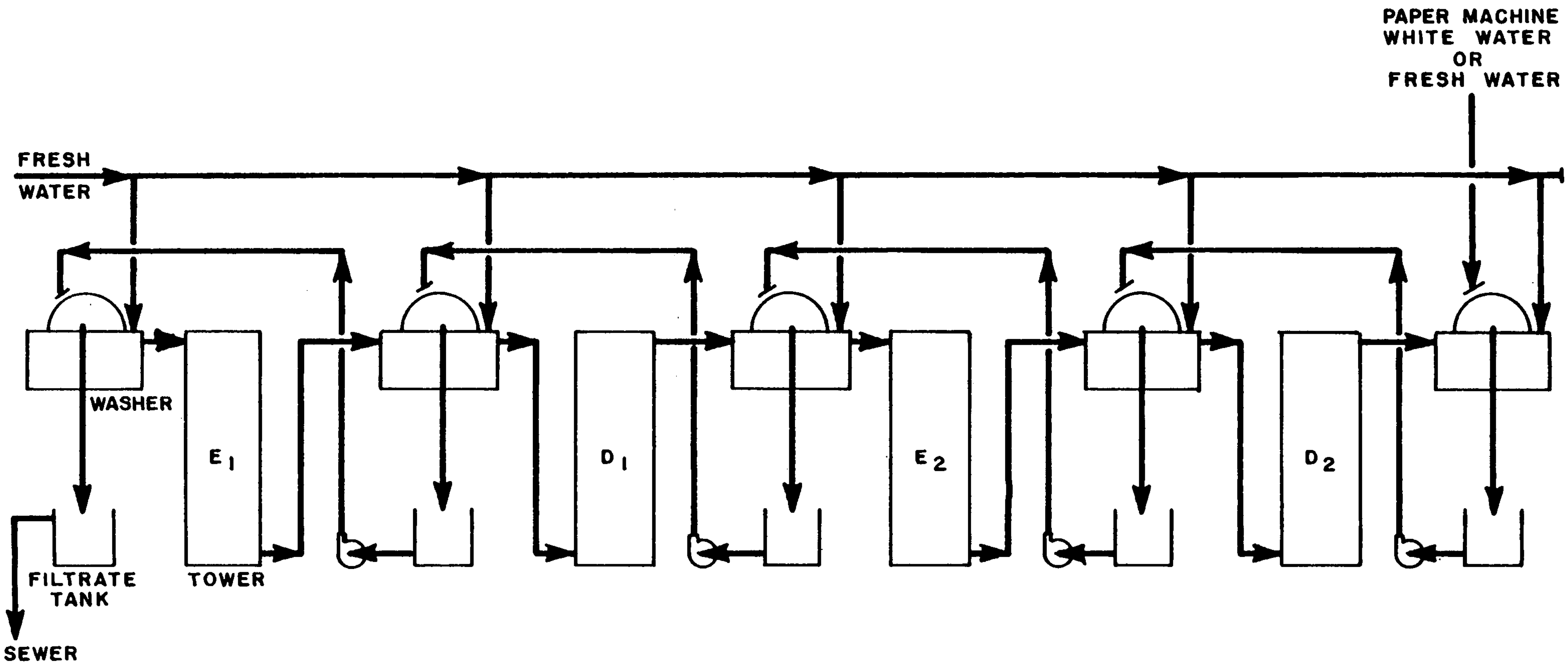


FIGURE VI - 12
FULL COUNTER - CURRENT
WASHING IN BLEACH PLANT

Earlier studies have proposed full countercurrent washing or jump-stage washing in multi-stage alkaline pulp mill bleach plants. Jump-stage washing or modifications of such a system are utilized at many mills. Bleach plant water use has declined sharply as a result of these changes. Greater water reuse on preceding stages would be effective in reducing raw waste flows from the Alkaline-Market, BCT, Fine, Newsprint, and Sulfite-Dissolving and Papergrade subcategories. For the alkaline subcategories, this modification is designated as Level 2 technology because of the high cost and essentially only a resulting flow reduction. Flow reductions of 9 to 25 kl/kkg (2 to 6 kgal/t) are possible through improved countercurrent reuse of filtrates in the bleaching sequence at mills in the alkaline and sulfite subcategories. For the two sulfite subcategories this technology is designated as Level 1. For the simpler Sulfite-Papergrade bleach plants, savings would be about 29 kl/kkg (7 kgal/ t).(82)(83)(74)

Evaporate Caustic Extraction Stage Filtrate. This control item is designated as an applicable Level 1 technology for the Sulfite-Dissolving subcategory. The hot caustic extraction stage would have a three-stage washing system similar to a red stock washer with carefully controlled hot showers. The effluent from this stage would be evaporated and incinerated separately from the rest of the bleaching effluent; therefore, flow would be kept to a minimum. Implementation of this control will greatly reduce the BOD_5 loadings 25 kg/kkg (50 lb/ton) and substantially reduce the TSS loading.(37) A flow diagram for this system is shown in Figure VI-13.

Evaporation and Recovery

Production process controls that reduce raw waste loading in the evaporator and recovery areas include: 1) recycle of condensates; 2) replacement of the barometric condenser with a surface condenser; 3) addition of a boil-out tank; 4) neutralization of spent sulfite liquor; 5) segregation of cooling water; and 6) various spill collection measures. These controls are discussed below.

Recycle of Condensates. In the evaporator and recovery area, the analysis of mill responses indicates that considerable progress has been made in utilizing essentially all condensates. Only in the Alkaline-BCT, Semi-Chemical, and Alkaline-Newsprint subcategories does extensive increased recycle of condensate appear feasible when compared to present modes of operation. At Alkaline-BCT mills, improved use of condensate is projected to eliminate up to 7.5 kg/kkg (15 lb/ton) of BOD_5 from the raw waste. In the Alkaline-Semi-Chemical operations, where lower levels of substrate are dissolved, the reuse of condensate represents a far lower BOD_5 saving, generally less than 0.25 kg/kkg (0.5 lb/ton).(78)(84)(90)(81) For mills in the Alkaline-Newsprint subcategory, reductions of approximately 1.5 kg/kkg (3 lb/ton) of BOD_5 can be achieved. As BOD_5 reductions are significant such steps are designated as Level 1. A flow diagram for this system is shown in Figure VI-14.

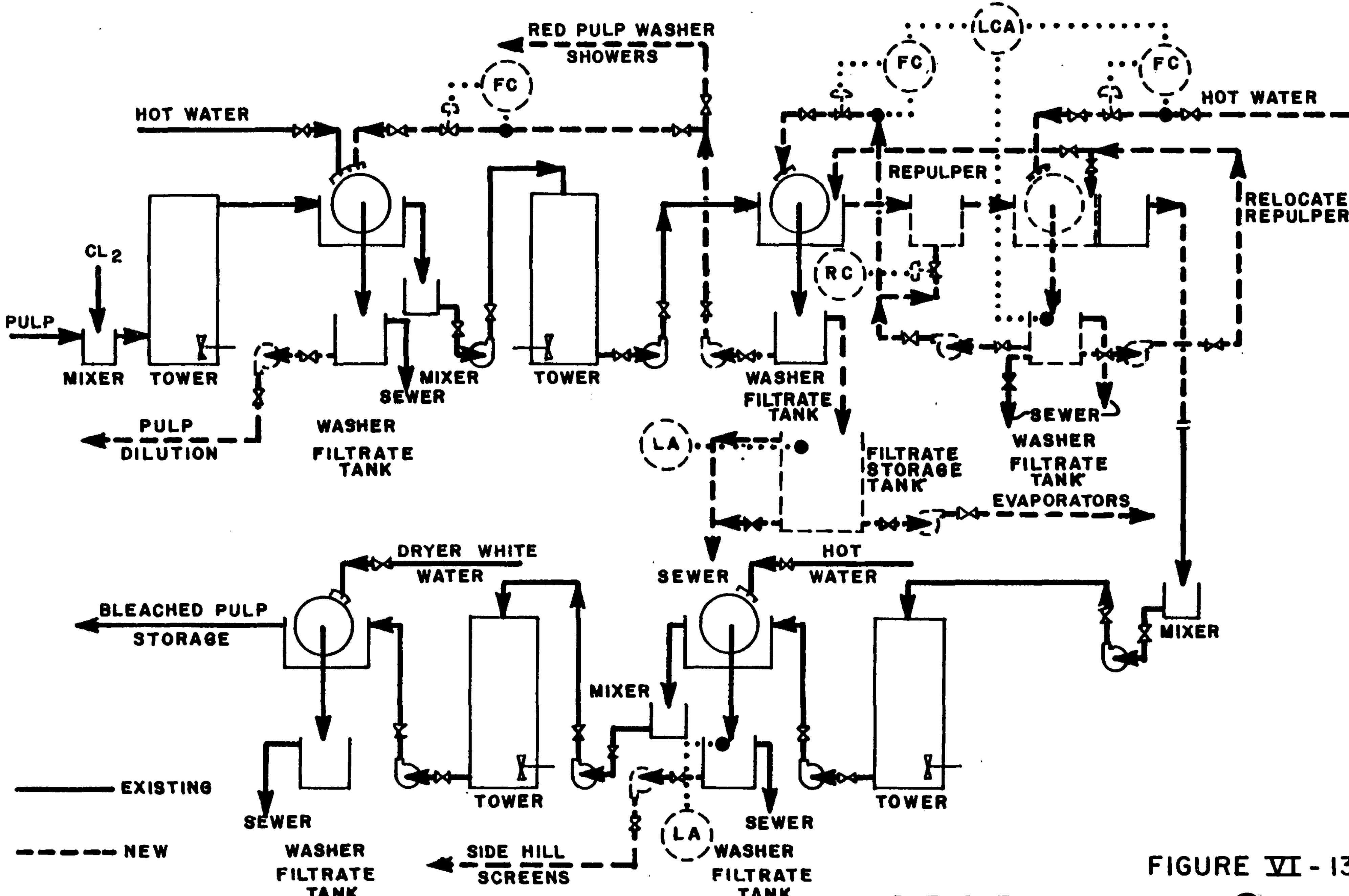


FIGURE VI - 13

BLEACHERY - JUMP STAGE WASHING

SULFITE-DISSOLVING

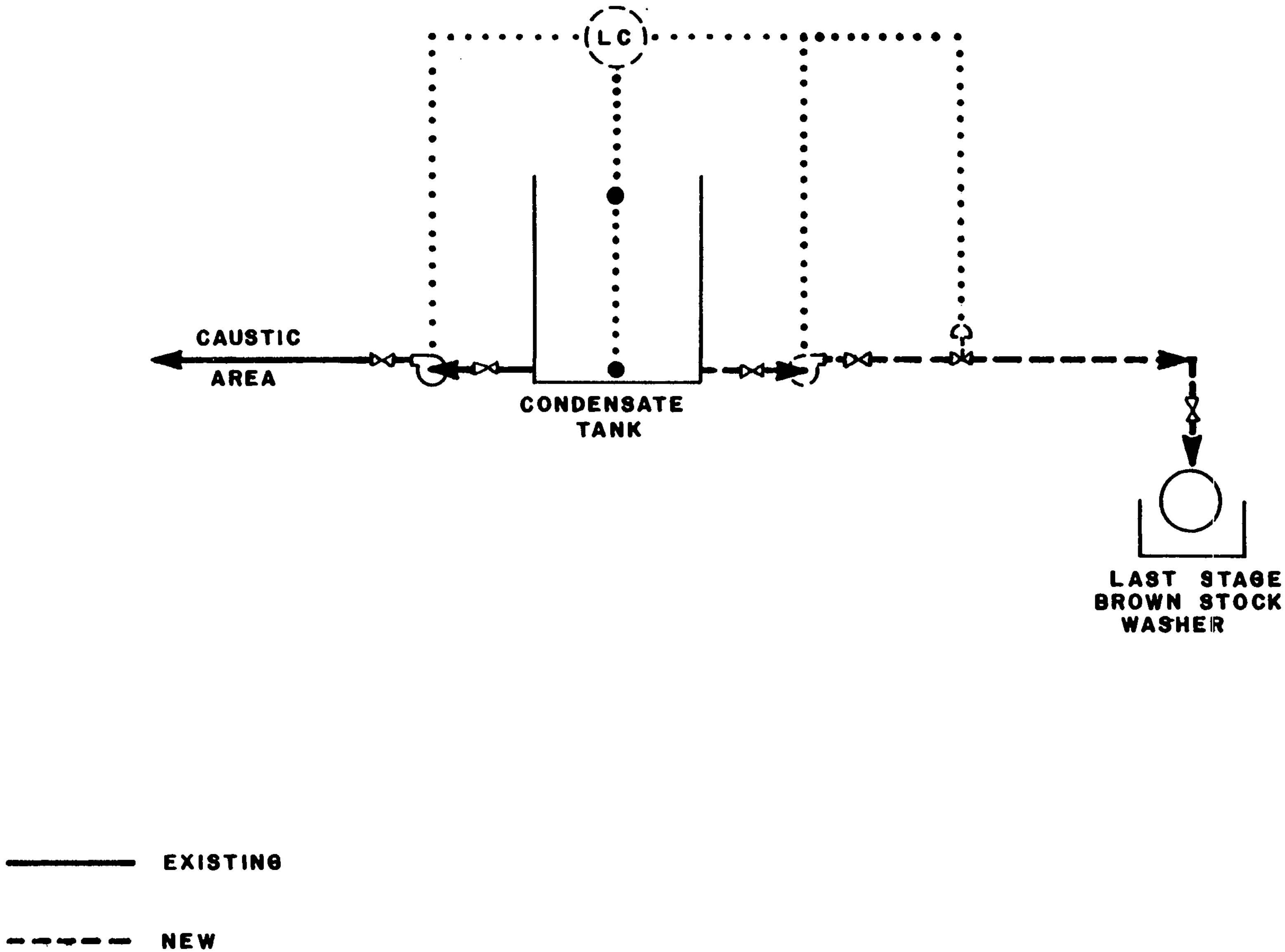


FIGURE VI - 14
COMPLETE REUSE OF EVAPORATOR CONDENSATE
ALKALINE PULP MILLS

Replace Barometric Condenser. Most mills in all integrated subcategories, except for Alkaline-Dissolving, use surface condensers. For this subcategory, the barometric condenser can be replaced with a surface condenser, thus assuring a clean, warm condenser water stream usable in most applications. This also results in a smaller concentrated stream of condensate that may be reused in the causticizing area or in the brown stock washer area. The existing barometric condenser seal tank would be reused as a seal tank for the new surface condenser. The air ejectors would be retained as standby, for system startup.

A cooling water pump would be provided to pump mill process water through the condenser and return it to the process water main. In summer the cooling water may be too hot to return entirely to process. Automatic temperature control could be implemented to divert excess water to a noncontact water thermal sewer and return only the acceptable amount to the process water line. A new condensate pump would be provided to pump to the required discharge point or to washers for reuse if possible. This production process control is shown schematically in Figure VI-15. This high cost item would result in less than 0.5 kg/kkg (1.0 lb/ton) BOD5 reduction, and less than 4.2 kl/kkg (1.0 kgal/t), flow reduction, and is therefore considered as a Level 2 technology item.(74)(85)

Boilout Tank. This control item is designated as an applicable Level 2 technology for mills in the Alkaline-Dissolving and Alkaline-Market subcategories. Water for the boilout would be pumped to the evaporators from the boilout tank, which would be full at the start of the process. When the concentration of the black liquor coming out of the evaporators starts to decrease, the flow would be diverted to the weak black liquor tank. When the concentration decreases further to a predetermined value, the flow is diverted (evaporator discharge) to the boilout tank. Overflow from the condensate tank, which occurs during boilout because of an increased rate of evaporation, would also be put into the boilout tank. After the boilout is complete and weak black liquor is again being fed to the evaporator causing the concentration from the evaporators to rise, weak black liquor flow would be diverted to the weak black liquor tank and eventually to the strong black liquor tank. This system is shown in Figure VI-16.

Neutralize Spent Sulfite Liquor. In both the Sulfite-Dissolving and Papergrade subcategories, some mills (particularly those with MgO systems) can benefit from neutralization of spent sulfite liquor before evaporation. Neutralization gives a significant reduction in the carry-over of organic compounds to the condensate. Depending on the mode of operation, this can range from 1 to 1.5 kg/kkg (2 to 3 lb/ton) of BOD5 at Sulfite-Papergrade mills and up to 25 kg/kkg (50 lb/ton) of BOD5 at Sulfite-Dissolving mills. Figure VI-17 shows the modifications. This item is a Level 1 control because of the significant BOD5 reduction. Mills other than MgO or Na base would have to use an organics removal system and evaporator condensate recycle. The reduction in BOD5 load to the effluent in the evaporator condensate is of the same order of magnitude as with spent sulfite liquor neutralization. The capital cost can be more. Organics removal is essential to prevent buildup in the system when recycled.

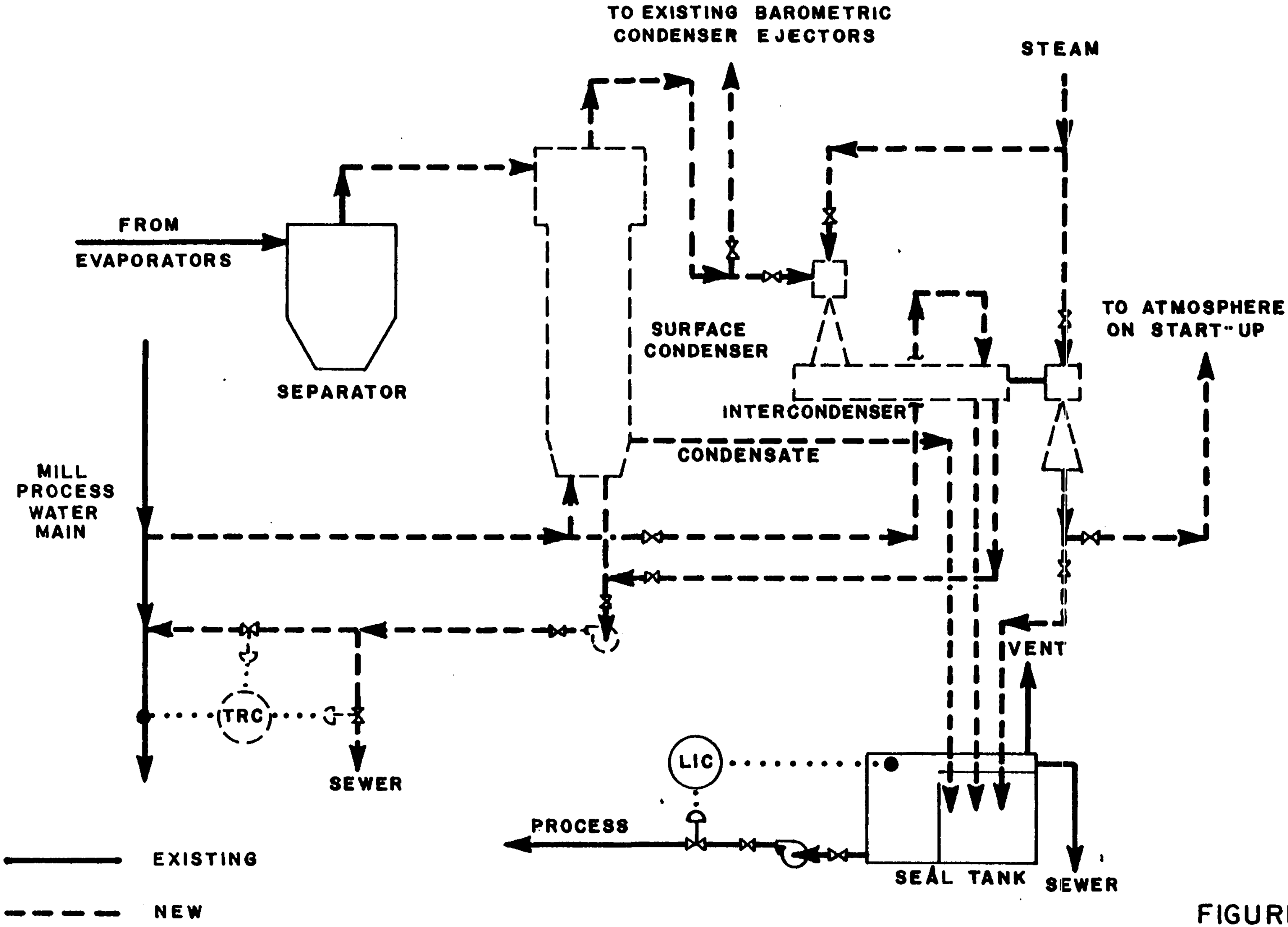


FIGURE VI - 15
REPLACE BAROMETRIC CONDENSER
WITH SURFACE CONDENSER

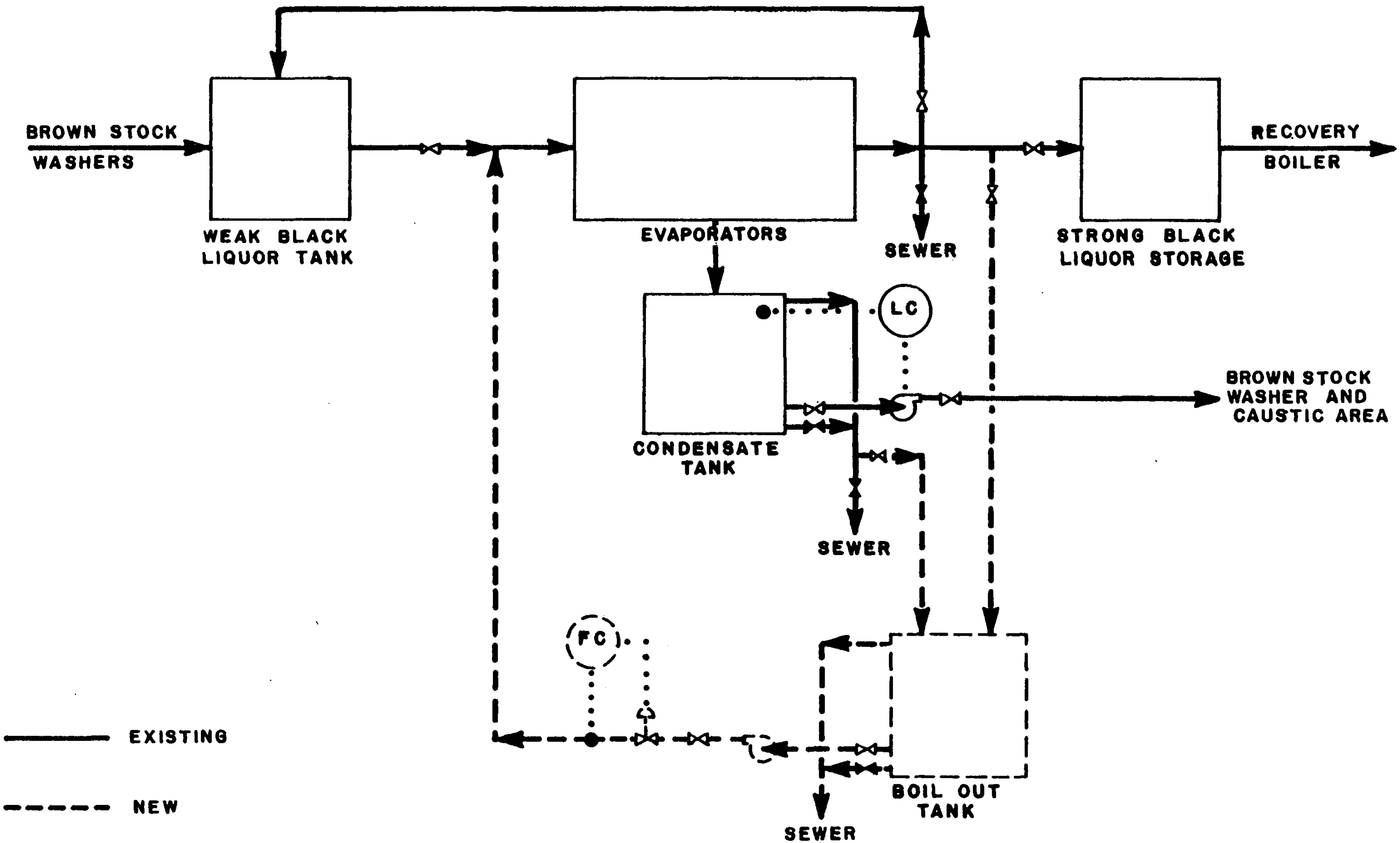


FIGURE VI - 16
EVAPORATOR BOIL OUT TANK

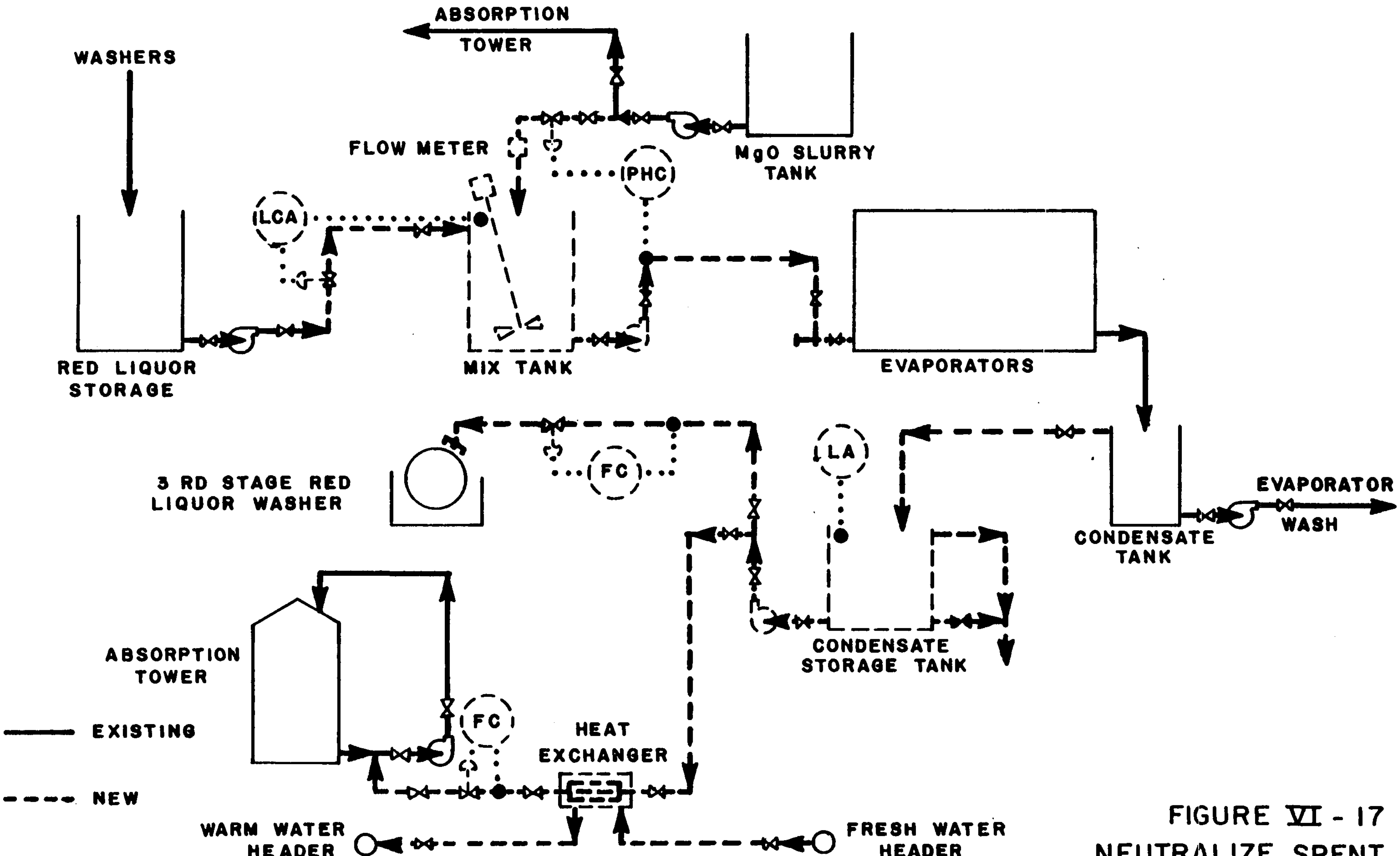


FIGURE VI - 17
NEUTRALIZE SPENT
SULFITE LIQUOR

Segregate Cooling Water. Segregation and reuse of cooling water in the evaporator and recovery area of semi-chemical mills can result in substantial flow reductions. At some of these mills, extensive reuse of cooling water is practiced; however, smaller streams are typically discharged to the sewer. Elimination of the discharge of these sewered streams would reduce the flow to the treatment facility. The equipment requirements are similar to those shown earlier in Figure VI-3 for application in the woodroom area.

Cooling water segregation in the evaporator and recovery area is a viable production process control for semi-chemical pulp mills. Estimated flow reductions of approximately 1.7 kl/kkg (0.4 kgal/t) result.(74)(75) This is considered as a Level 1 technology.

Spill Collection. Spill collection in the evaporator, recovery, causticizing and liquor storage areas could be implemented to varying degrees at mills in the Alkaline Unbleached subcategories. The spill collection system applicable to mills in each subcategory varies widely, depending on the existing level of implementation. This technology involves the use of the following techniques, all of which are being used at some mills in certain subcategories:

- spill collection in the evaporator and recovery boiler area;
- spill collection in the liquor storage area;
- spill collection in the causticizing area; and
- addition of a spare liquor tank to accept spills from any of these three areas, and a pump to return a spill to its point of origin.

All spill collection systems involve the use of a sump and a pump to divert the spill to the spill tank. If the tank were full, spills would be diverted to a surge lagoon. The spill collection sump for the liquor storage area would be equipped with a conductivity controller which allows surface runoff and low conductivity spills to be diverted to the surge lagoon, while high conductivity spills would be sent to the spill tank to be recovered. A flow diagram for a typical system is shown in Figure VI-18. These modifications are considered as Level 1 because of the effective reduction of both BOD_5 and TSS.(78)(86)(87)

Liquor Preparation Area

Production process controls that reduce raw waste loads in the liquor preparation area include installation of a green liquor dregs filter and lime mud pond, as described below.

Installation of Green Liquor Dregs Filter. At an alkaline pulp mill with a modern recovery furnace, green liquor dregs contribute approximately 5 kg/kkg (10 lb/ton) of TSS.(25) Diversion of this material from the primary clarifier can have a beneficial effect, as the dregs are usually pumped from a gravity-

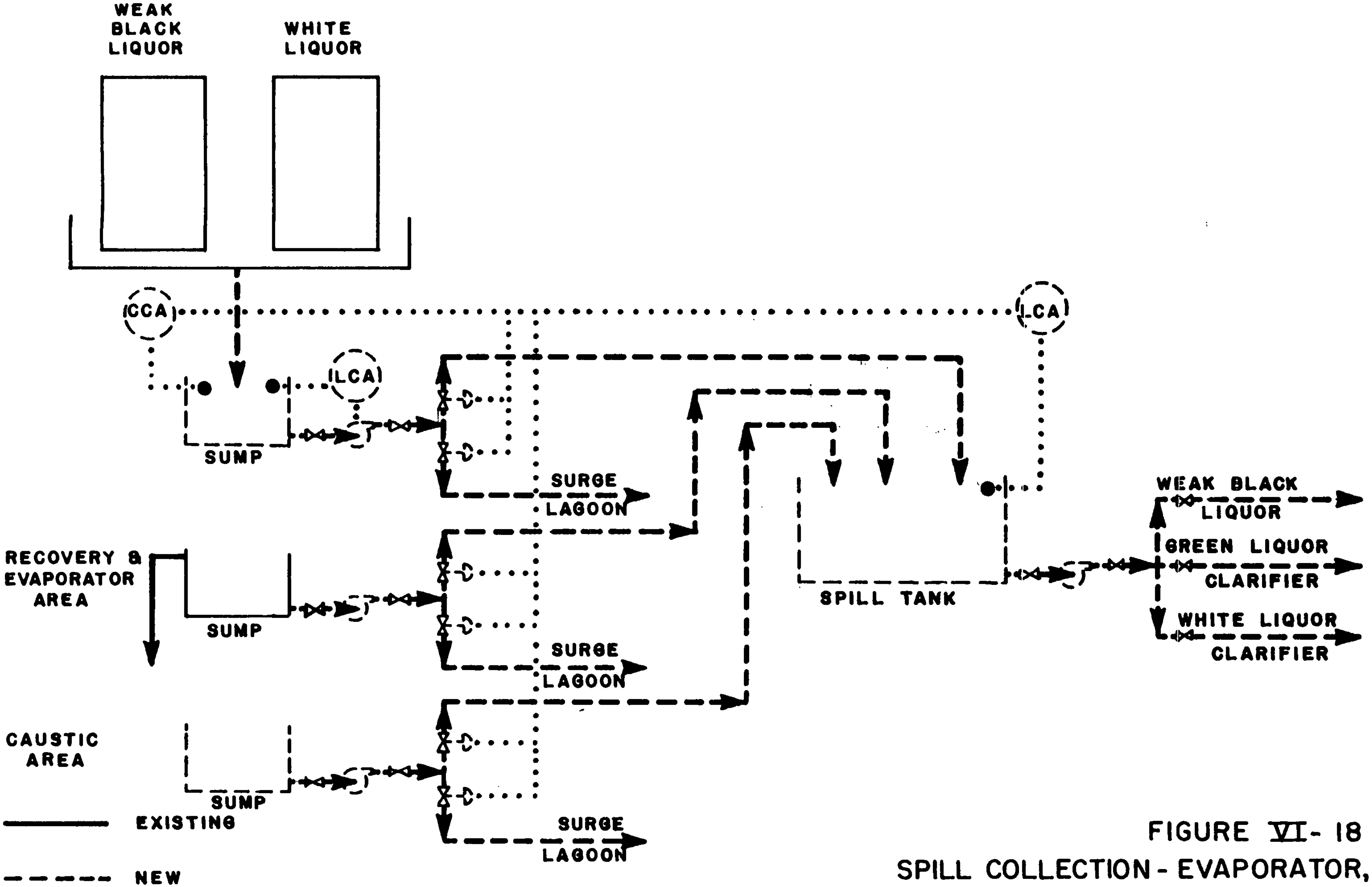


FIGURE VI-18
SPILL COLLECTION - EVAPORATOR, RECOVERY, CAUSTICIZING AND LIQUOR STORAGE AREAS

type dregs washer or clarifier at very low consistencies with accompanying high strength alkaline liquor entrainment. This may have an appreciable effect on pH at the clarifier. In addition, the material tends to be of a fine colloidal nature and can be difficult to settle.

At many modern mills belt-type filters have been installed to improve washing and sodium recovery from the dregs. This results in a drier material that can readily be disposed of at a landfill site. For mills having only a gravity-type unit, a small vacuum filter can be employed. Condensate can be applied for washing the cake on the filter with subsequent use of the filtrate in the dregs washer itself. This creates a countercurrent system that is effective in the recovery of sodium and for dry dregs disposal. Generally, such projects are justified on the basis of alkali saving. This decision depends on the capability of the existing primary clarifier and sludge thickening operations. Figure VI-19 presents a schematic of this Level 2 control technology. Such devices are generally applicable to all alkaline subcategories.

Lime Mud Pond. At alkaline pulp mills, the use of a lime mud pond can also reduce TSS caused by upsets, startups, and shutdowns in the white liquor clarification and mud washing area. Use of a lime mud pond can also aid in operation of the entire lime system by maintaining high lime availability for minimum requirements during processing and in avoiding a dead recycled load of lime. This minimizes potential overloading problems in the white liquor recovery area, and reduced operating costs at the lime kiln.

A spill collection diversion system, incorporating a pond for liquors containing high quantities of lime mud, enables the reuse of this mud. It also assures minimum upsets to the primary clarifier in the case of a dump of a unit containing high concentrations of lime for an extended period of outage or repair. Typical long-term savings average 1.5 to 2.5 kg/kkg (3 to 5 lb/ton) of TSS in alkaline pulp mills.(79) This Level 2 item is applicable to the Alkaline-Fine, Unbleached, and Newsprint subcategories. It has been commonly applied to other alkaline subcategories. Figure VI-20 presents a schematic of this control technology.

Papermill

Production process controls that reduce raw waste loading in the papermill area include: 1) papermachine, bleached pulp and color plant spill collection; 2) saveall improvement; 3.) high-pressure showers for wire and felt cleaning; 4) whitewater use for vacuum pump sealing; 5) whitewater showers for wire cleaning; 6) whitewater storage for upsets and pulper dilution; 7) recycle of press effluent; 8) reuse of vacuum pump water; 9) provision for additional broke storage; 10) installation of wet lap machines; 11) segregation of cooling water; and 12) collection of cleaner rejects for landfill disposal and/or fourth-stage cleaners. These specific controls, their applicability to the various subcategories, and their general effectiveness are described individually in the following paragraphs.

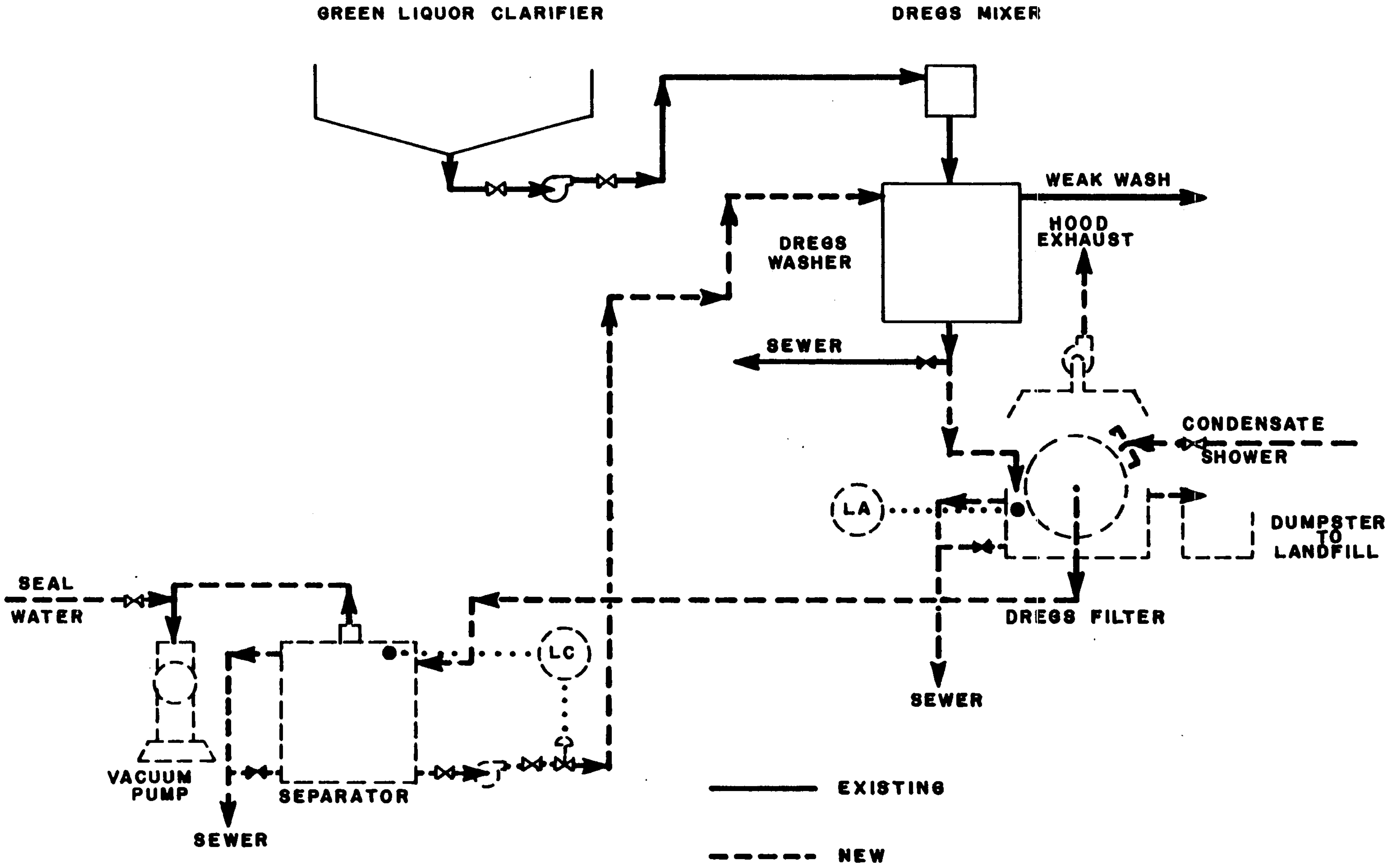


FIGURE VI - 19
GREEN LIQUOR DREGS FILTER

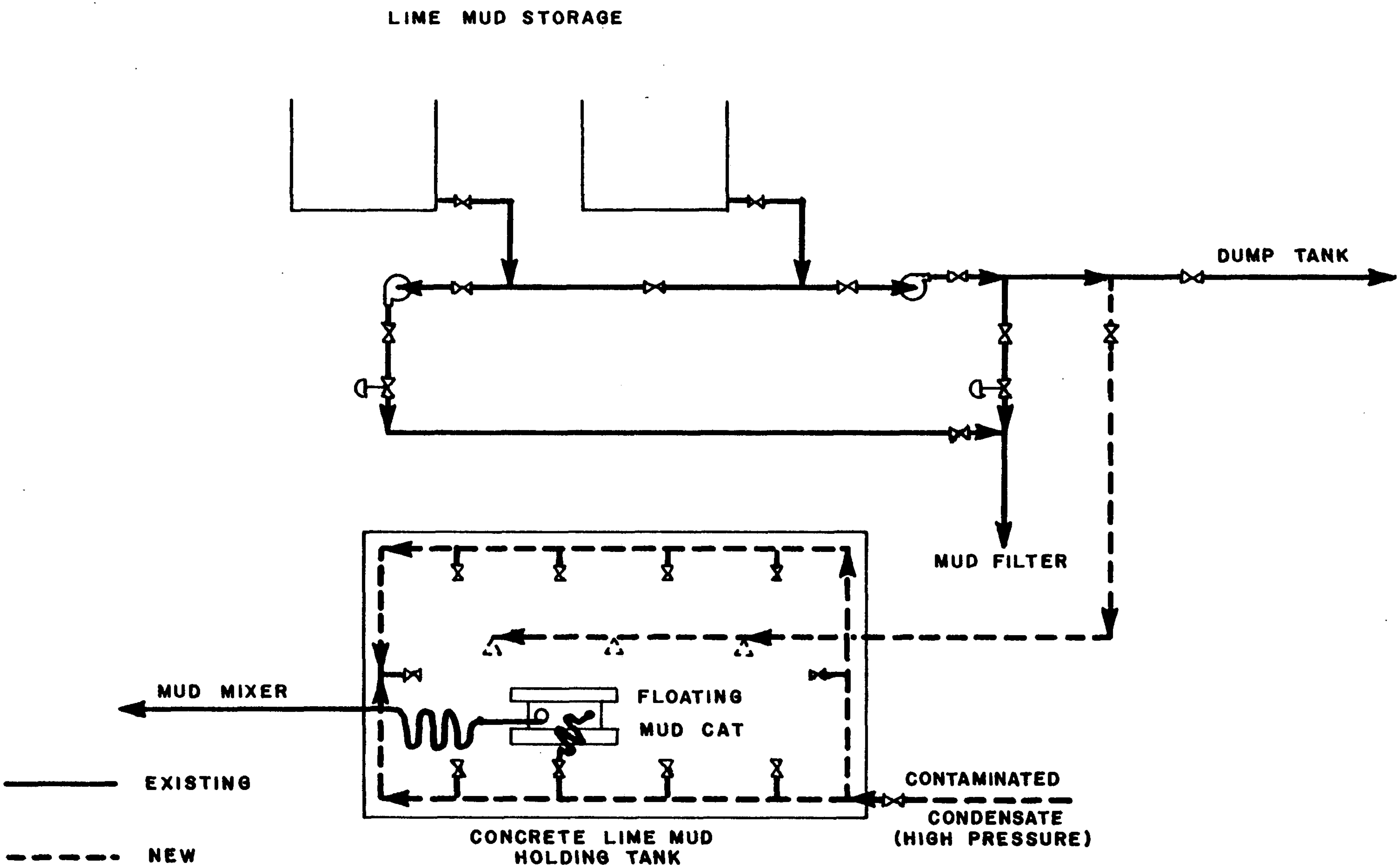


FIGURE VI - 20
LIME MUD STORAGE POND

Spill Collection. Papermachine and bleached pulp storage area spill collection is applicable to mills in all the bleached alkaline, sulfite, groundwood, and nonintegrated subcategories. The extensiveness of the control varies by subcategory, depending on factors such as the number of machines and the extent to which spill collection already exists at typical mills. For the bleached alkaline and sulfite subcategories, spill collection systems would handle overflows and equipment drains along with spills from the bleached stock storage area, the stock preparation areas, and the papermachine or pulp machine wet ends. As shown in Figures VI-21 through VI-23, these systems would generally require installation of a new sump, a new stock tank and a pump to return the spills to a point where they could be blended back into the process. This Level 1 control should result in substantial stock savings, and a reduction in TSS load. Savings estimates vary widely, but may typically be 2-2.5 kg/kkg, (4-5 lb/ton) for both BOD_5 and TSS.

Color plant spill collection is applicable to mills in all subcategories manufacturing fine papers. One spill collection system would be applied for each machine which has a coater or size press. With this system, a spill would be collected in a sump and stored for reuse. The system provides for control of spills in all the storage and mix tank areas of the color plant, and at the coater, tanks, and screens. Implementation of this Level 1 control would result in a saving of expensive coating pigments and adhesives, as well as a reduction in the TSS load. A flow diagram is shown in Figure VI-24.

Improvement of Savealls. Mills in the majority of subcategories will benefit from saveall improvements such as new vacuum disc saveall installations or reworking of existing savealls with addition of some new equipment. Savealls can be employed on all types of machines, producing all types of production including: fine paper, board, tissue, molded products and newsprint. This technology is general practice in the Alkaline-Fine and BCT, Groundwood-Fine, and Deink-Fine subcategories. Most of the savealls being installed today are of the vacuum disc filter type. They are flexible in handling various types of stock and shock loadings and exhibit high separation efficiencies. As a control item, their usefulness results mostly from flow and solids reductions. Nearly all stock saved is stored or reused immediately. The clear whitewater can be readily reused within the mill, replacing some fresh water uses. If not reused, it becomes a relatively clear overflow to the sewer. Thus significant flow reductions, as well as TSS and BOD_5 are permitted when an effective saveall is used. Extensive filtrate recycle then becomes possible. Such modifications are considered as Level 1 technology.

Mills with existing savealls may not require entire installations. In these cases a new saveall could replace the existing saveall on the largest machine, making use of existing pumps, tanks, and piping. The existing saveall could be repiped for the next smaller machine, and so on down the line, so that each machine may have a larger, more effective saveall. Figures VI-25 through VI-27 illustrate typical saveall installations. The resulting overall whitewater balance determines the net saving, but saveall flow reductions of from about 0.8 kl/kkg (0.2 kgal/t) to 41.7 kl/kkg (10 kgal/t) are possible depending on the type of mill.(81)

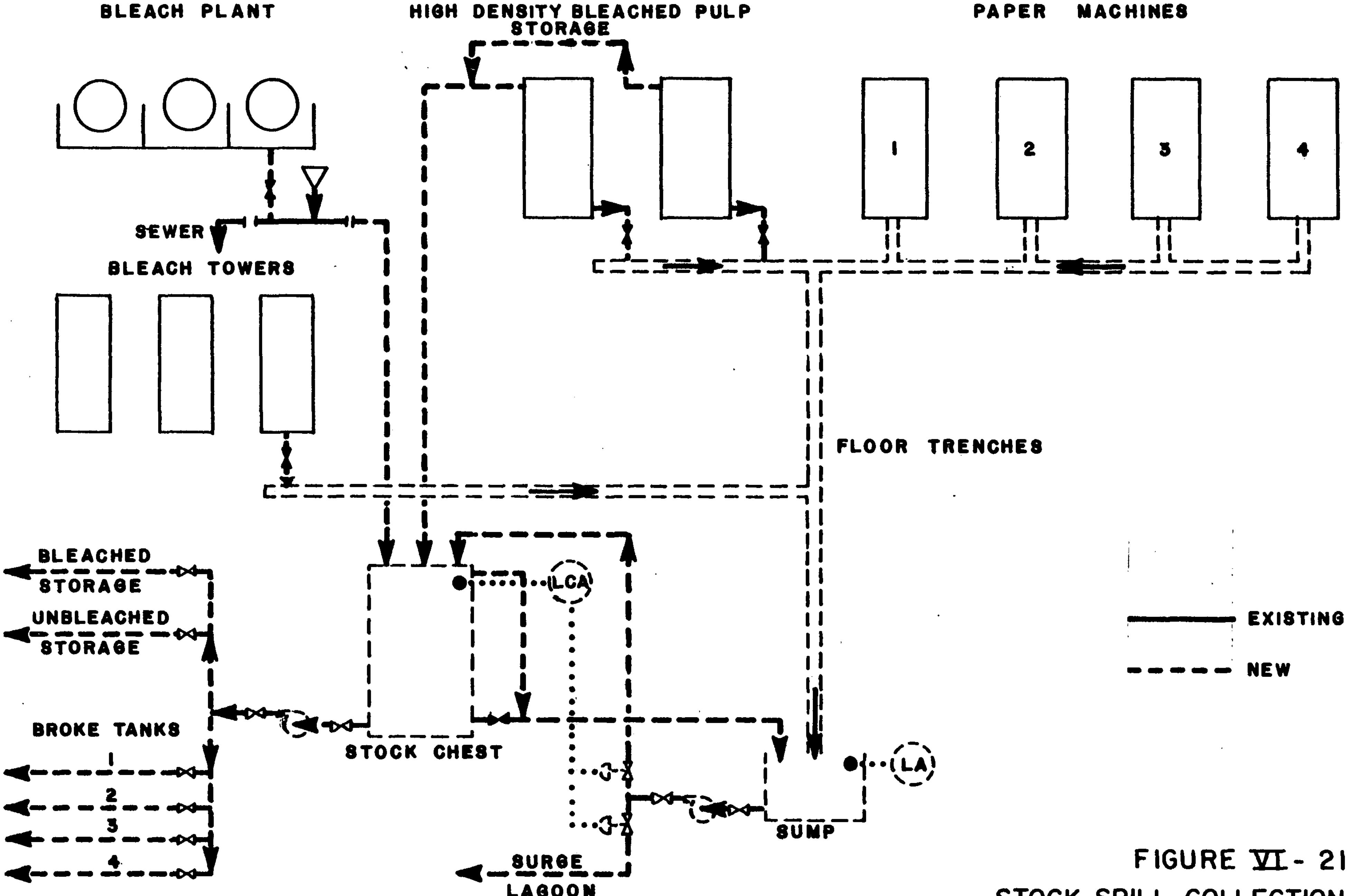


FIGURE VI - 21
STOCK SPILL COLLECTION
PULP BLEACHING & PAPER MACHINE AREAS
SULFITE - PAPER GRADE

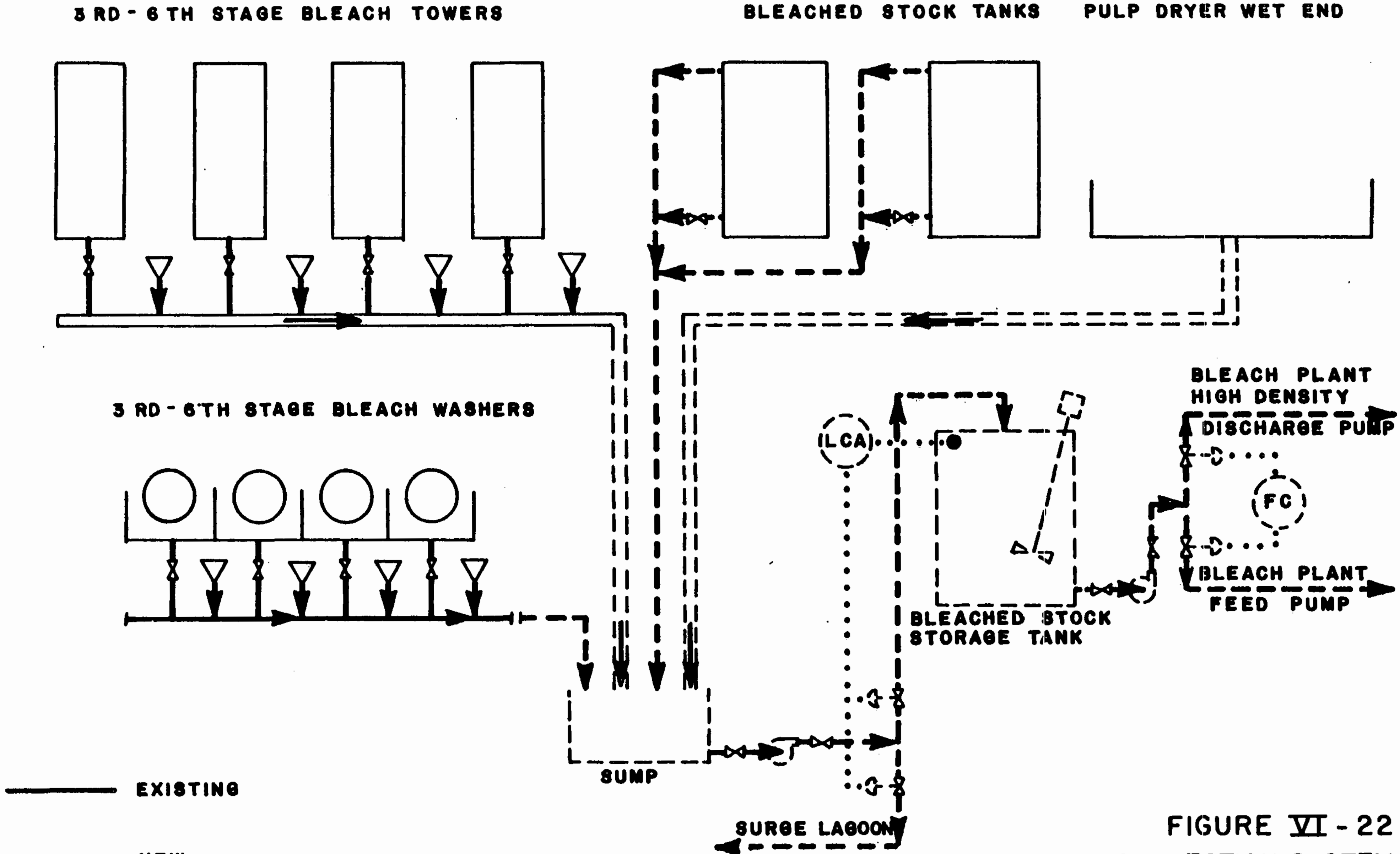


FIGURE VI - 22
STOCK SPILL COLLECTION SYSTEM
PULP BLEACHING AND DRYER AREAS
ALKALINE PULP MILLS

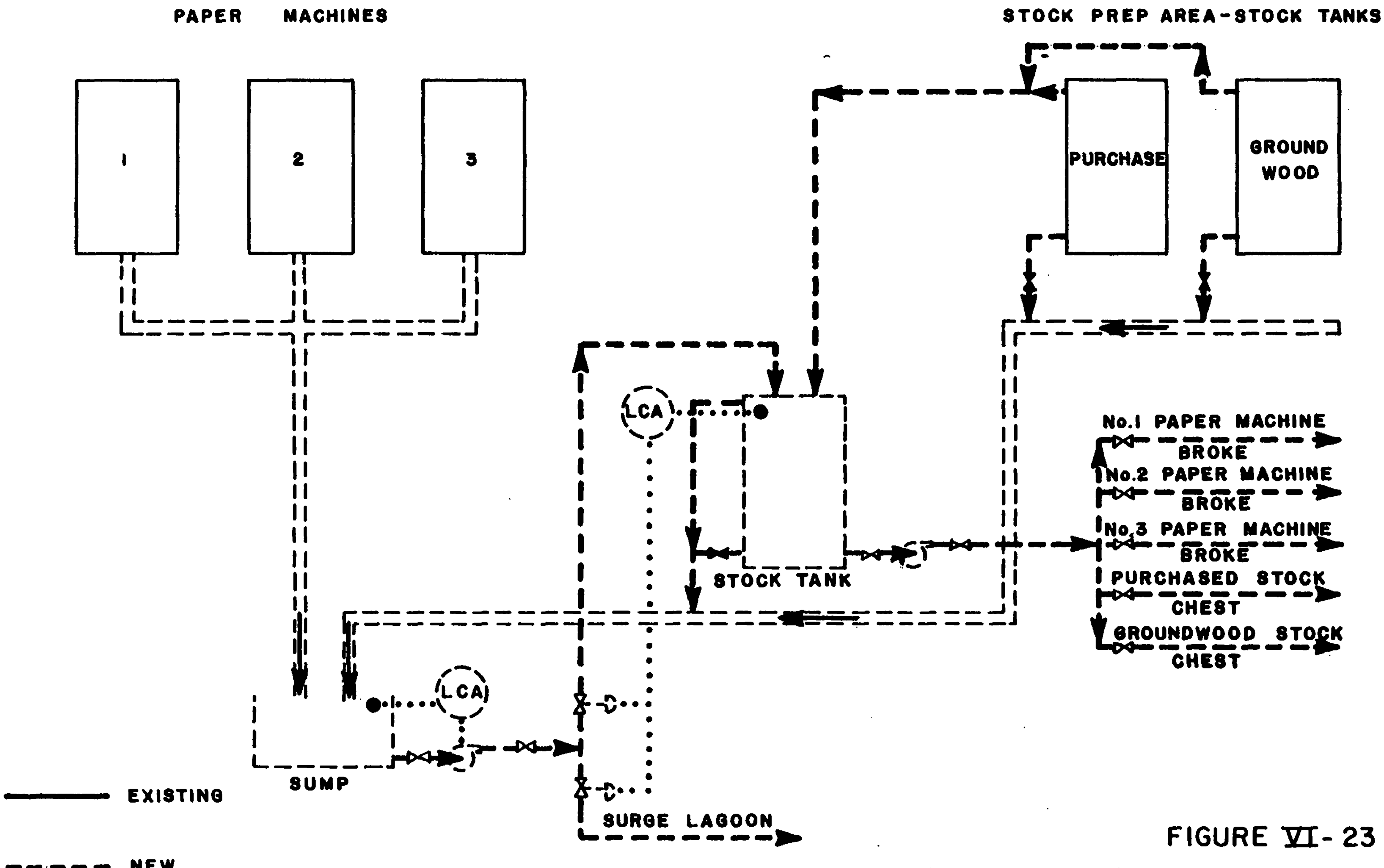


FIGURE VI- 23
STOCK SPILL COLLECTION SYSTEM
PAPER MILL AREA
GROUNDWOOD - CMN OR FINE

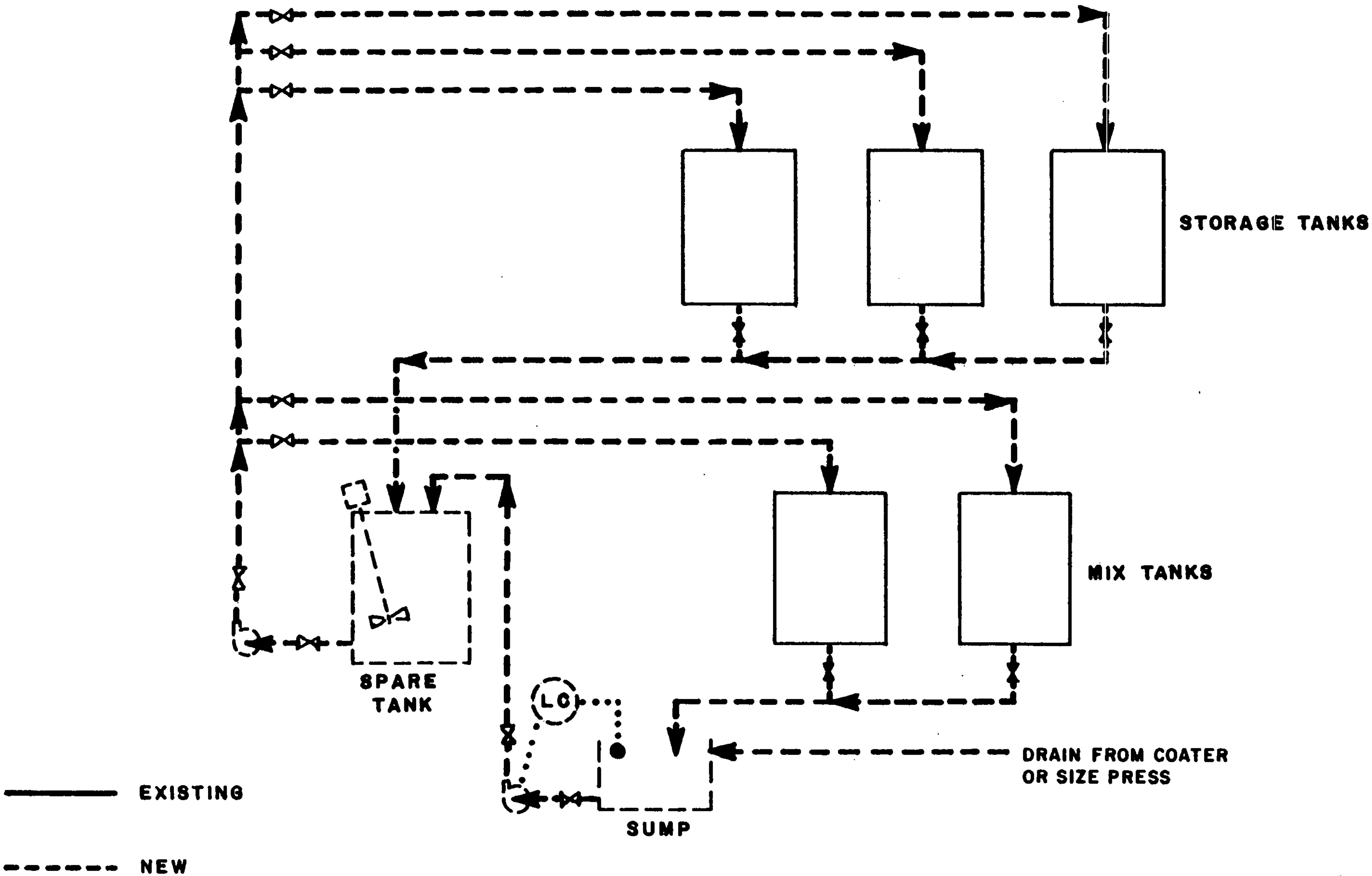


FIGURE VI - 24
SPILL COLLECTION SYSTEM
COLOR PLANT ALKALINE-FINE

color

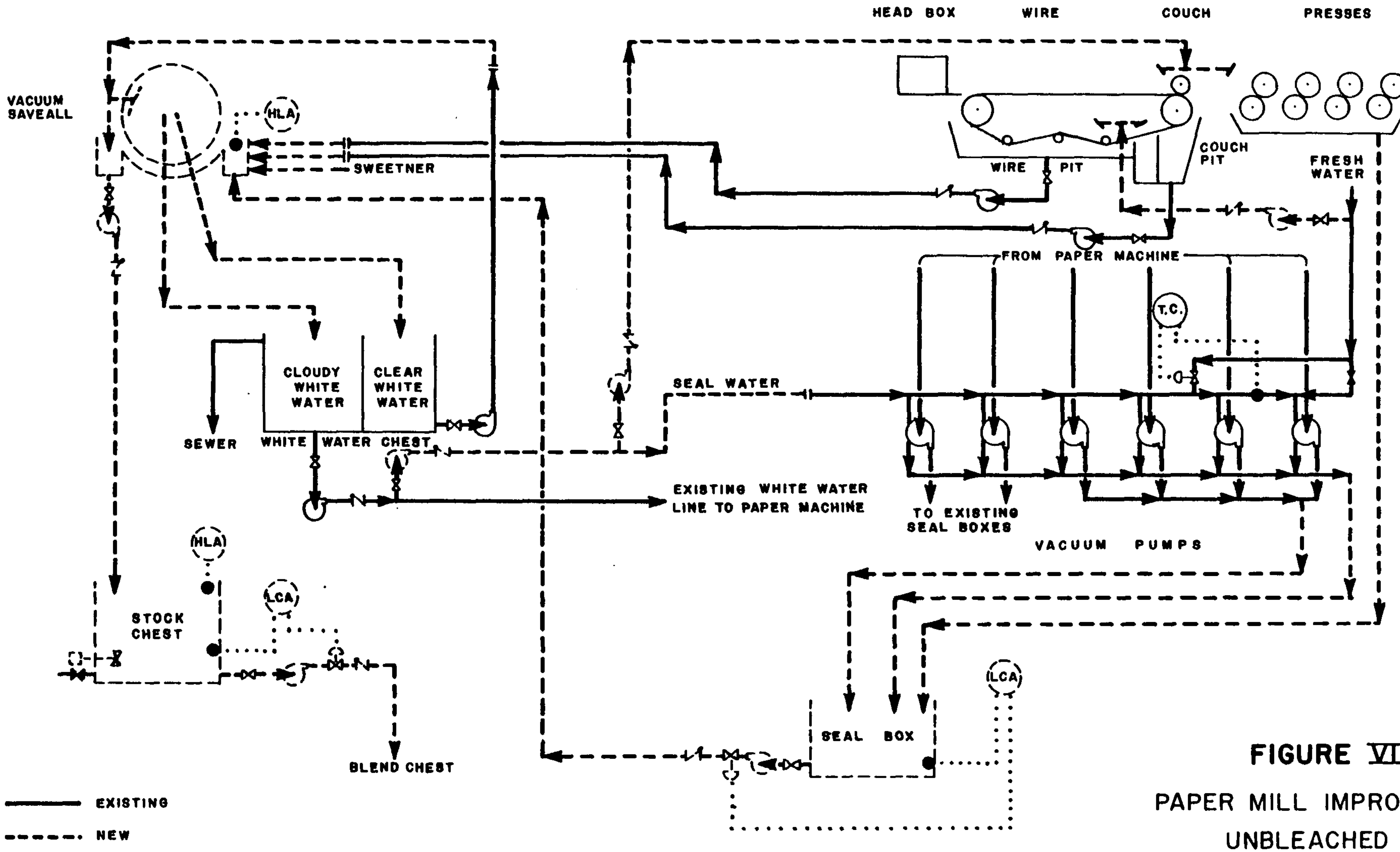


FIGURE VI-25
PAPER MILL IMPROVEMENTS
UNBLEACHED KRAFT

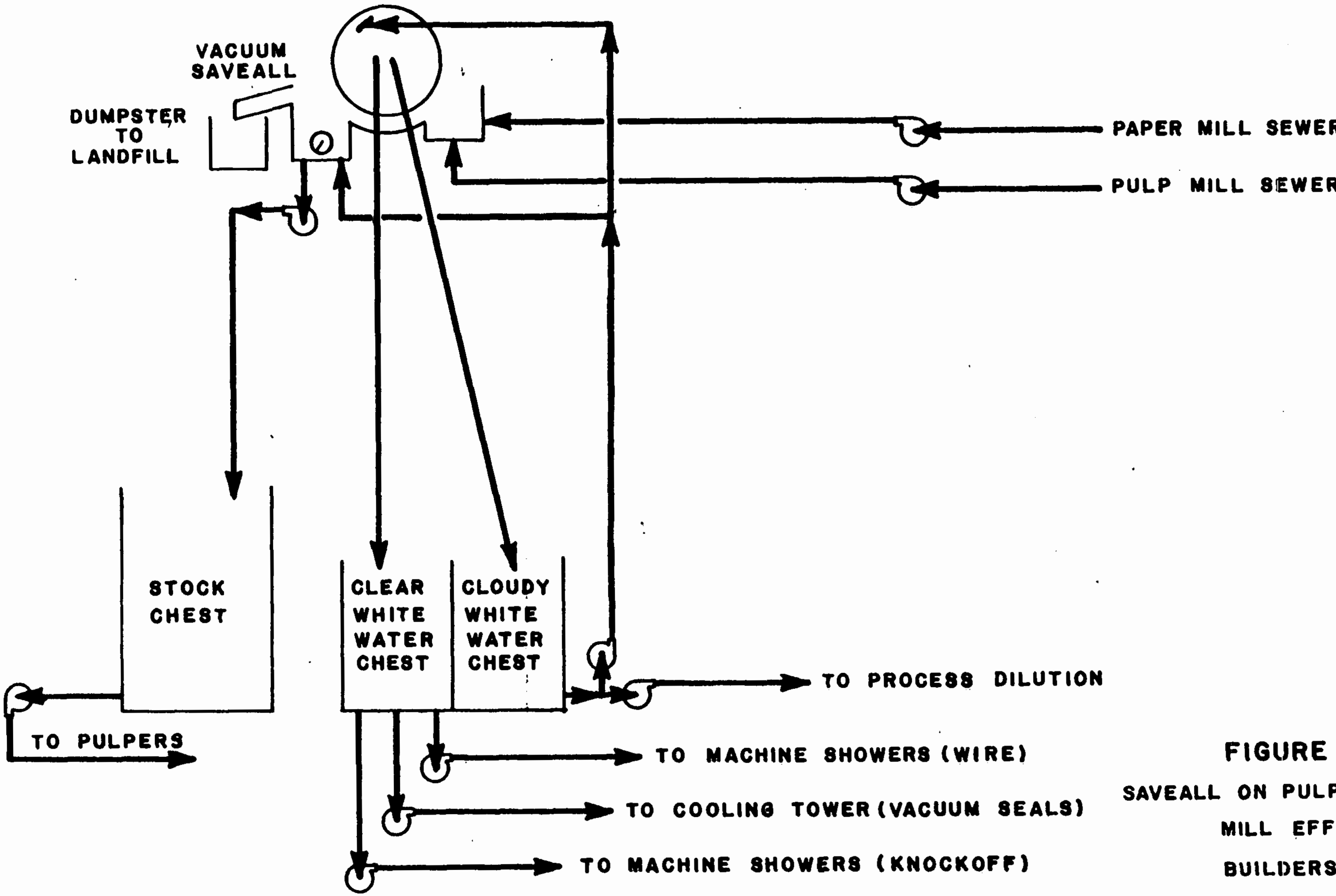


FIGURE VI-26
SAVEALL ON PULP AND PAPER MILL EFFLUENTS
BUILDERS PAPER

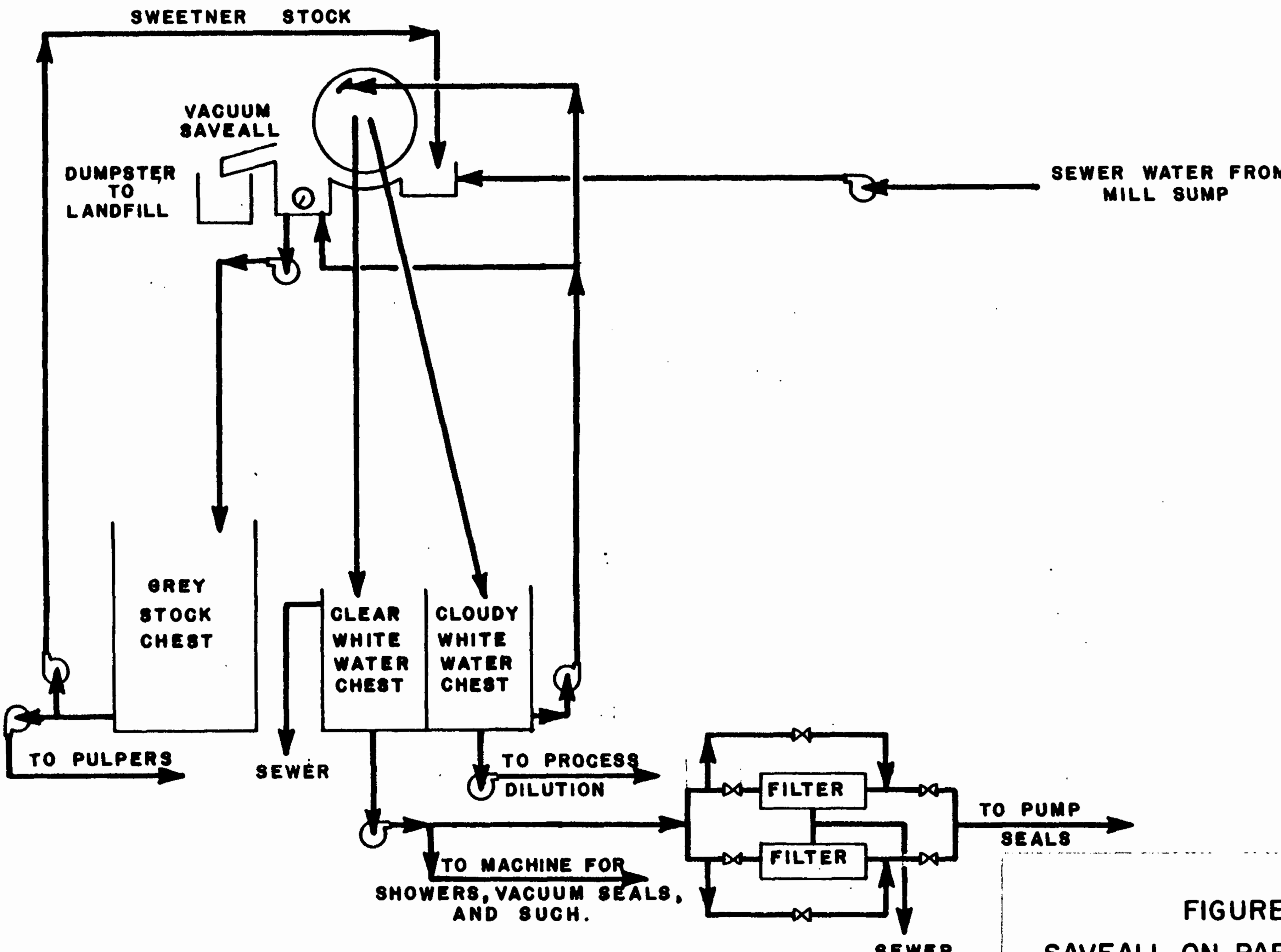


FIGURE VI- 27

SAVEALL ON PAPER MILL EFFLUENT - MOLDED PULP

Use of High-Pressure Showers for Wire and Felt Cleaning. High-pressure showers to replace low-pressure, high-volume showers (i.e., those used for felt cleaning, return wire cleaning, and couch roll cleaning) may save up to 90 percent of the water used in conventional shower applications and may be more effective. It is generally considered that felt cleaning showers are operated at 35.2 kg/sq cm (500 psi), and fourdrinier showers at 21.1 kg/sq cm (300 psi). A typical installation is shown in Figure VI-25. High-pressure showers are identified as Level 1 technology for the Alkaline-Dissolving, Alkaline-Unbleached, Nonintegrated-Filter and Nonwoven subcategories. They are designated as Level 2 technology applicable to the Sulfite-Dissolving subcategory.(81)(88)(89)(90)(91)

Whitewater Use for Vacuum Pump Sealing. Excess clarified whitewater has been successfully used to replace fresh water on mill vacuum pumps. The vacuum pump seal water is then recycled or discharged. At the least, the equivalent quantity of fresh water use is directly displaced. Corrosion and abrasion may be deterrents to implementation of this system, particularly at low pH or high filler levels. As shown in Figure VI-28, fresh water addition may be required and can be provided to maintain temperatures below 32°C. This technology can be applied at mills in all subcategories. It is generally considered Level 1 because of the flow reduction obtained. The result again is part of the overall balance, but flows of 6.6-26.4 litres/minute (25-100 gpm) per pump are common.(88)(89)(90)(92)(93)

Papermachine Whitewater Use on Wire Cleaning Showers. Clarified whitewater from the papermachine saveall, containing low levels of additives and fillers, allows installation of self-cleaning whitewater showers. In this system, the whitewater would be used for fourdrinier showers and knock-off showers as shown earlier in Figures VI-25 through VI-27. The system includes a whitewater supply pump, supply piping, and showers. A fresh water backup supply header is provided, with controls for introduction of fresh water to the whitewater chest in event of low volume in the chest. This Level 1 technology can be applied to mills in the Alkaline-Unbleached, Semi-Chemical, Deink-Newsprint, Wastepaper-Contruction Products, and Nonintegrated-Filter and Nonwoven subcategores. The effect varies widely by machine and type of mill.

Whitewater Storage for Upsets and Pulper Dilution. As illustrated in Figure VI-29, this system consists of an additional storage tank to store excess whitewater that would overflow from the existing clear whitewater tank. Where possible, the tank could be adjacent to or added onto the existing tank to eliminate pumping costs.

The whitewater from this tank can be used in the pulper or bleach plant. The tank would be sized to hold adequate whitewater needed for pulper dilution after pulping, bleach plant washing, or continuous washing requirements. A fresh water header is provided to the tank for make-up.

A system may be needed for each machine, depending on the variability of furnish. Each machine may have its own pulper, and require a completely separate whitewater system.

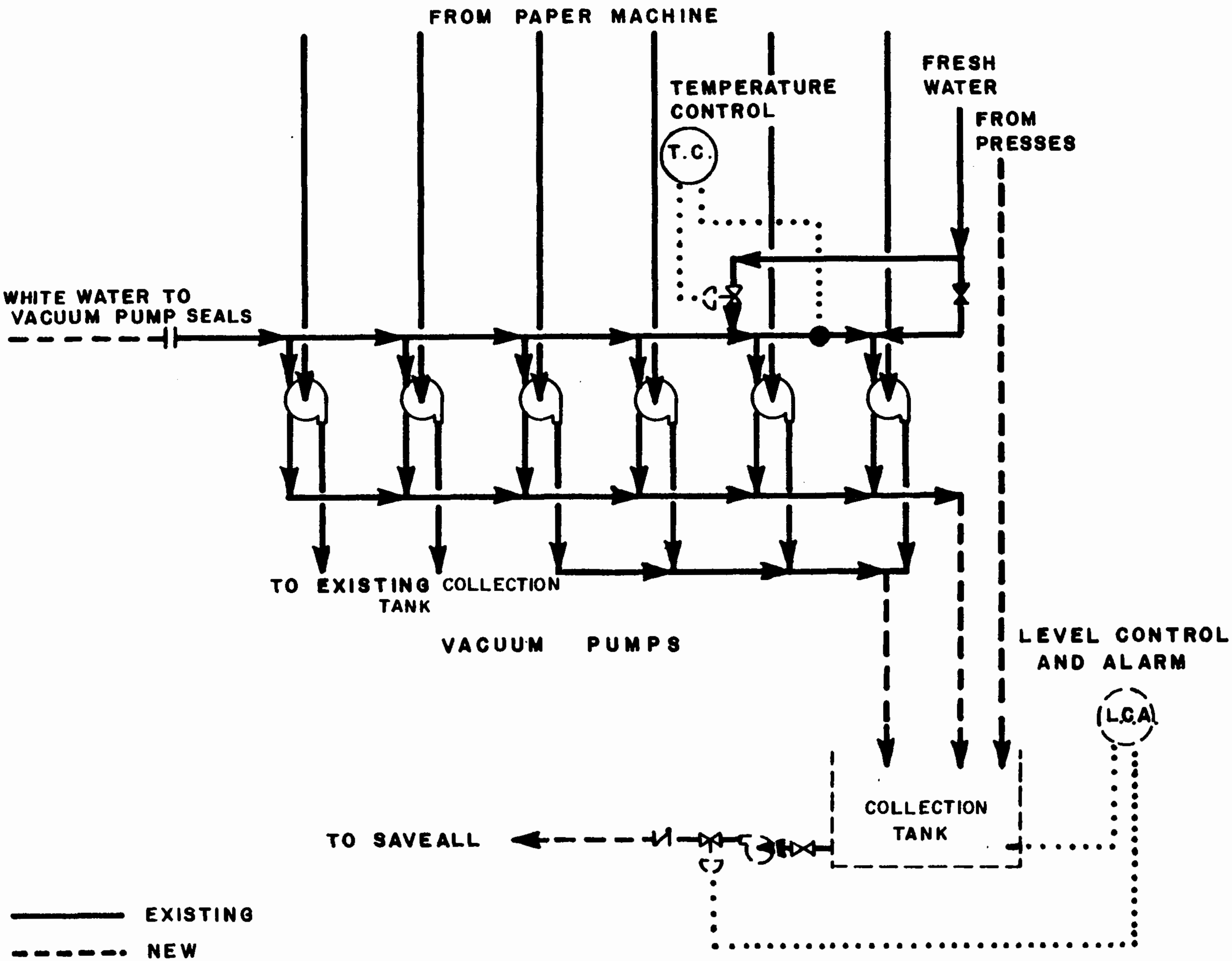


FIGURE VI-28
WHITE WATER TO VACUUM PUMPS AND COLLECTION TANK
FOR PUMP SEAL WATER AND PRESS EFFLUENT

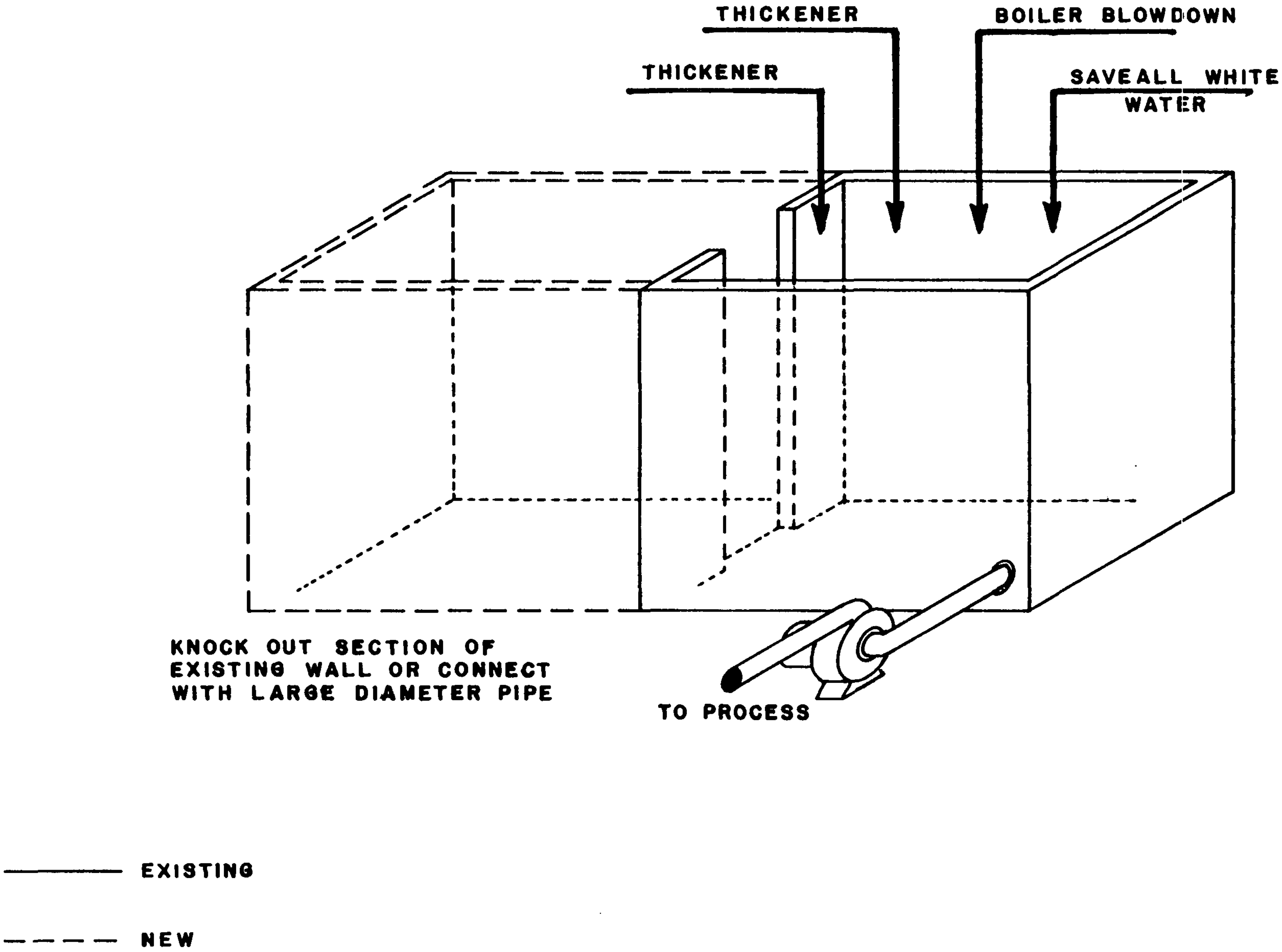


FIGURE VI-29
INCREASED WHITE WATER STORAGE CAPACITY

For model mills in the Alkaline-BCT, Fine and Newsprint, Sulfite-Dissolving and Papergrade, Groundwood-CMN, Deink-Fine and Tissue, Wastepaper-Board, and Nonintegrated Lightweight subcategories, increased storage facilities can be provided, resulting in significant flow reductions. This is Level 1 if needed, as significant BOD_5 and TSS reduction may result.(81)

Recycle of Press Water. Effluent from the press section of a papermachine contains fibrous fines and fillers that can be reintroduced into the whitewater system and recovered. Water from the vacuum presses, as well as pressure rolls, can be piped to a collection tank (or wire pit) often without use of pumps. From the tank the water can be pumped to the saveall system to reclaim the fiber and fillers and to make the water available for use in the whitewater systems. This would reduce solids and may reduce flow to the wastewater treatment plant. Generally, a separate system would be required for each machine.

Felt hairs, previously a deterrent in some systems, have been largely eliminated with the advent of synthetic felts. Thus, no provision for the removal of felt hairs has been included in the system, although such provision may be required on top-of-the-line printing or specialty grades.

This system could be installed at mills in the Alkaline-Dissolving and Alkaline-Newsprint subcategories and would result in significant flow and TSS reductions. When BOD_5 reduction is significant, this control is considered as Level 1; otherwise it is considered Level 2 for a TSS reduction.

Reuse of Vacuum Pump Water. Recycle of vacuum pump water (most of which is seal water) and use of whitewater as seal water (see Figure VI-28), will nearly eliminate fresh water additions for this purpose. Installation of the system would require piping, a collection tank, and a pump to return the water to storage for reuse. One system is needed for each machine.

This system is not used at the majority of mills in four subcategories: Sulfite-Dissolving; Alkaline-Unbleached and Semi-Chemical; Alkaline-Fine; and Nonintegrated-Fine. Most of the mills in another six subcategories do not have specific collection systems for press effluent and vacuum pump seal water. By combining the two systems, cost reductions could be realized in the Alkaline-Unbleached, Semi-Chemical, Sulfite-Papergrade, Groundwood-CMN and Fine, and Nonintegrated-Paperboard subcategories. Based on flow, TSS, and BOD_5 reductions, these items are generally considered as Level 1. Up to 21.0 kl/kkg or (5.0 kgal/t) may be saved.(70)

Additional Broke Storage. An additional broke storage chest could be installed at most mills in the Nonintegrated-Lightweight subcategory. The system consists of a central broke storage chest and pumps and piping to bring excess broke to the chest; it can be returned to the proper machine once the upset is over. At some other mills, more than one chest would be required, depending on the number of machines and product mix. Generally, the tank is sized to hold 30 minutes of broke from the couch pit. It would allow for breaks or grade changes to occur with a minimum of overflow to the sewers. Up to 10 kg/kkg (20 lb/ton) TSS might be saved. The effectiveness of such a control in terms of reducing impact on wastewater treatment and as a stock saving for the mill would preclude a Level 1 designation.

Installation of Wet Lap Machines. Wet lap machines can be installed at mills in several subcategories as part of an overall stock spill collection system. The wet lap machine would be preceded by a screen for removal of rejects and dirt from spilled stock. Rejects would be hauled to landfill. The accepts would be fed to the wet lap machine, allowing recovered stock to be stored in a convenient form for later reintroduction to the system or sale to another plant. The significant effectiveness as an effluent reduction tool would suggest a Level 1 classification for this approach.

Mills in the Alkaline-Fine, Groundwood-Fine, Deink-Fine and Tissue, and Sulfite-Papergrade subcategories could employ one or more wet lap machines to reduce stock losses. In some mills devices such as sidehill or inclined screens may be effective at lower cost. The wet lap is however, very useful as a way to create excess broke storage.

Segregate Cooling Water. Improvements in cooling water segregation in the papermill could be employed at mills in three of the nonintegrated subcategories (Fine, Tissue and Lightweight) resulting in reductions in water usage. Implementation of this control requires modifications to eliminate pump seal, calender stack, and bearing and other cooling waters from the sewer. These waters would be collected in a sump and, depending on the mill's warm water requirements, either pumped to the mill water system or discharged via a separate thermal sewer. Such modifications are considered as Level 1 because of the significant impact on raw waste flow. At least 4 kl/kkg (1.0 kgal/t) would be expected to be reduced in most of the above types of mills.

Cleaner Rejects to Landfill. Collection and screening of rejects from sources such as pulp cleaners, papermill cleaners, pressure screens, and centriscreens will eliminate up to 40 percent of the solids to the treatment plant from these sources.(73)(81) The system would consist of piping from the reject sources to a collection tank, pump and piping to the screen headbox, a sidehill type screen, and rejects dumpster. In the case of remote cleaner reject sources, an accept tank and pump and piping from the accepts tank to the source for sluice water would be required. Figure VI-9 presented earlier, shows this Level 2 modification.

This type of system could generally be applied at alkaline pulp and paper mills, nonintegrated mills, and mills in the Deink-Fine and Tissue subcategory. For mills with ample primary clarifier capacity, implementation of this technology may not be deemed necessary, depending on the adequacy of existing equipment. These fiber losses have been reported to aid in the dewatering of combined primary-secondary sludges. Savings of 1.5 to 5.0 kg/kkg (3 to 10 lb/ton) are possible.

Fourth-Stage Cleaners. The addition of a fourth cleaner stage reduces by 80 to 90 percent the flow and solids being discharged from a three stage system. The pulp stock saving alone usually is ample justification for implementing such a system, which is shown in Figure VI-30. This Level 2 item may be an alternative to the above depending on relative mill operating parameters.

Steam Plant and Utility Areas

Production process controls that reduce raw waste loads in the steam plant and utility areas include: 1) segregation of cooling waters; and 2) installation of lagoons for boiler blowdown and backwash waters. These controls are discussed below.

Segregate Cooling Water. At mills in many subcategories, as noted in Table VI-1 this Level 1 control technology has been adequately implemented; however, this technology is not widely practiced at mills in eight subcategories. This control requires modifications to sewers and floor drains to keep cooling water out of the sewer, plus installation of a warm water storage tank. The sources of cooling water that are to be handled by this system differ at mills in the various subcategories. Generally, they are limited to miscellaneous items such as pump and bearing cooling water, air compressors, and major sources in the steam plant area, such as turbine and condensor cooling waters. This control is a flow reduction measure, but should also result in considerable energy savings.

Lagoon for Boiler Blowdown and Backwash Waters. This control could be effective at mills in about half of the subcategories. Mills in the remaining subcategories already have a separate discharge for these sources or reuse these waters in their process. The boiler blowdown water and the backwash would be pumped to a new lagoon, from which they are discharged to receiving waters. This keeps these sources out of the treatment plant, and provides enough settling time to remove most of the suspended solids. By mixing the blowdown water and the backwash water in the same lagoon, the thermal discharge limit, in most cases, should be no problem. Facilities for pH adjustment (usually alum) may be required in some cases. Implementation of this Level 2 control will reduce the flow to the treatment plant. While universally applicable, only a few subcategories now use such segregation.(74)

Recycle of Effluent

Mills in three subcategories can reduce fresh water usage by recycling clarified effluent to the mill for use as hose and pump seal water. These mills are in the Deink-Fine and Tissue, Nonintegrated-Fine, and Nonintegrated Filter and Non-Woven subcategories. The industrial tissue mills may also reduce purchased waste paper requirements through recycle of the clarifier solids to the system. Benefits from clarifier effluent recycle are effluent flow reductions corresponding to the amount recycled. Recycle of clarifier solids yields expected cost savings in the purchased furnish, and in handling and disposal of the remaining solids.

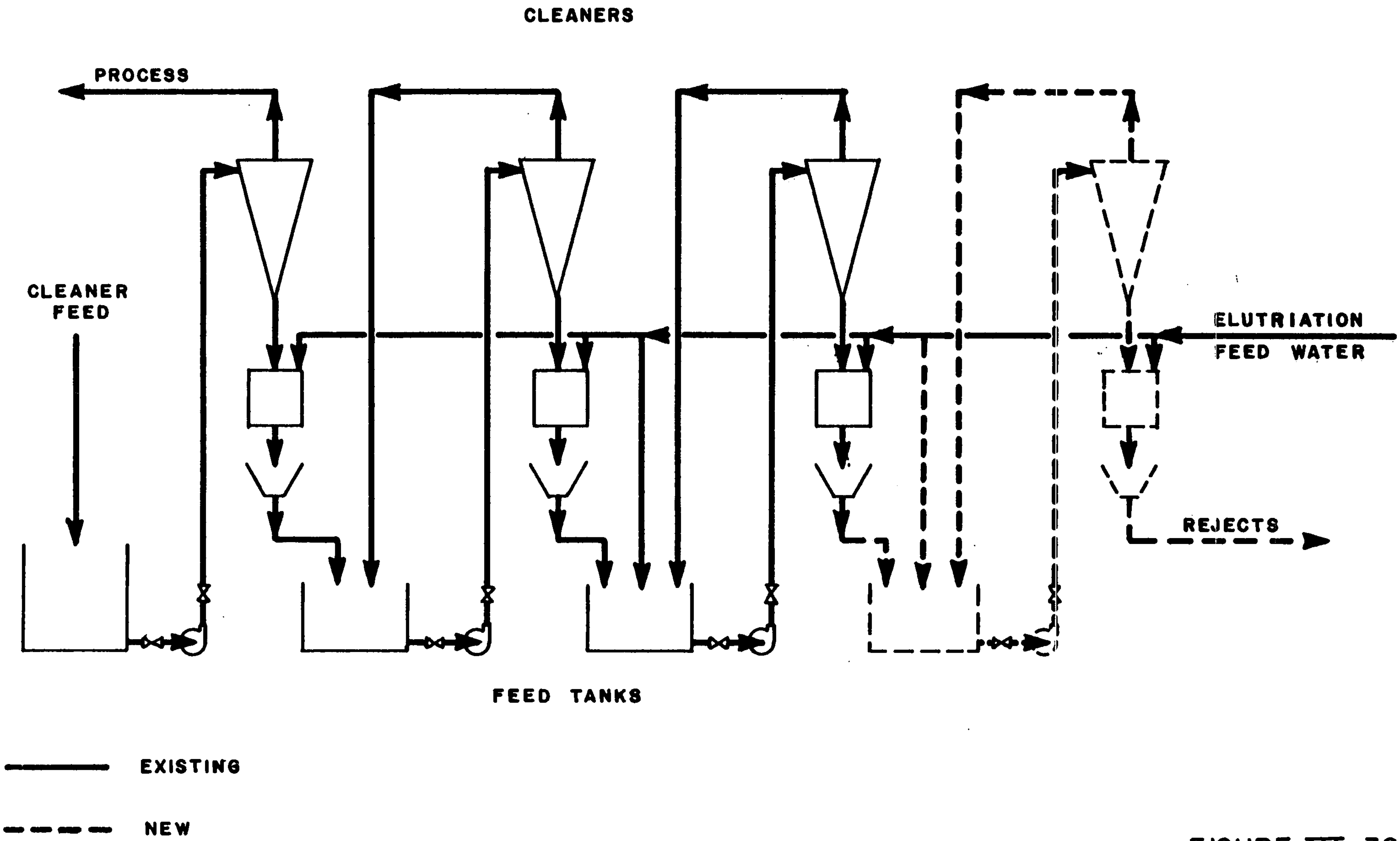


FIGURE VI-30
4-STAGE CENTRICLEANER
SYSTEM WITH ELUTRIATION

A system to recycle the clarified effluent would consist of a holding tank, piping from the clarifier to the holding tank, and a pump and piping from the holding tank to existing headers. The solids recycle system, as shown in Figure VI-31 would consist of a pump drawing from the existing sludge discharge line and piping to the pulpers. This Level 1 technology would be difficult to implement at mills with severe product quality constraints.

Some waste paper mills use effluent recycle now; however, the water clarity is not as good as it could be. Improved savealls permit use of more effluent for machine showers and eliminate the use of fresh water on the machine. Such recycle schemes are now commonly practiced in the Wastepaper-Board Molded Products, and Construction Products subcategories. Savealls may serve as means of recycling both effluent and reclaimed stock in these latter subcategories. Nonintegrated-Tissue and Nonintegrated-Lightweight paper mills can use a settling basin to handle cleaner floor drains and reuse this water for hoses and seal water instead of fresh water. Deink mills and Nonintegrated-Fine paper mills can also use this system. Higher grade product mills such as fine paper do not recycle solids; this is used primarily by waste paper mills.(88) A total of nine subcategories, including Nonintegrated-Paperboard, have some form of effluent recycle systems for the model mill.

EFFECTIVENESS OF LEVEL 1 AND 2 PRODUCTION PROCESS CONTROLS BY SUBCATEGORY

As noted earlier in Table VI-1, two ranges of production process control technology have been designated for application in the pulp, paper and paperboard industry. Level 1 technologies are those which would, if implemented, result in the most effective reduction of a mill's raw waste loading, particularly in terms of flow and BOD_5. Additional reductions in raw waste load can be achieved through implementation of the Level 2 technologies; these are identified primarily for TSS reductions and result in lesser reductions of BOD_5 and flow.

Individual production process controls have been described, along with their general application and effectiveness within the industry. The combined effect of Level 1 and 2 controls will now be presented for each subcategory. Table VI-2 summarizes the effectiveness of Level 1 and 2 technologies by listing the following for each subcategory:

1. the raw waste load for the model mill;

2. anticipated raw waste load reduction which can be achieved by implementing Level 1 technology;

3. resultant raw waste load, termed Level 1 Raw Waste Load (RWL);

4. further raw waste load reduction which can be achieved by implementing Level 2 technology; and

5. resultant raw waste load, termed Level 2 RWL.

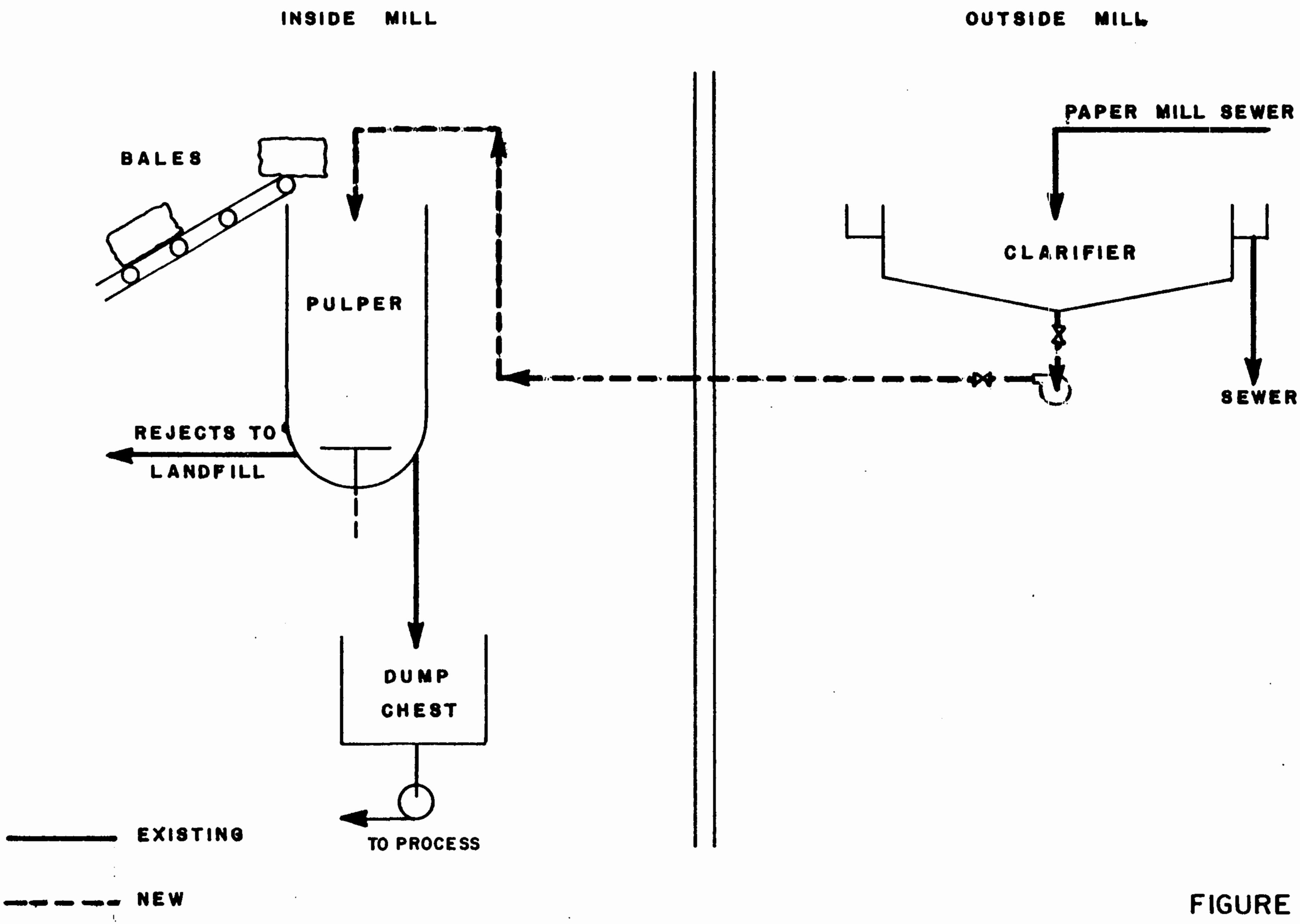


FIGURE VI - 31
IMPROVED EFFLUENT REUSE
CLARIFIER SLUDGE

TABLE VI-2

MODEL MILL RAW WASTE LOADS RESULTING FROM LEVEL 1 AND 2
PRODUCTION PROCESS CONTROL MODIFICATIONS

Subcategory		Raw Waste Load (RWL)					
		Flow		BOD5		TSS	
No.	Name	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
011	Alkaline-Dissolving						
	Model Mill RWL	198.1	(47.5)	53.8	(107.6)	76.8	(153.7)
	Level 1 Reduction	12.9	(3.1)	21.2	(42.3)	12.3	(24.5)
	Level 1 RWL	185.2	(44.4)	32.6	(65.3)	64.5	(129.2)
	Level 2 Reduction	8.0	(1.9)	0.6	(1.3)	4.3	(8.6)
	Level 2 RWL	177.2	(42.5)	32.0	(64.0)	60.2	(120.6)
012	Alkaline-Market						
	Model Mill RWL	178.2	(42.8)	41.5	(83.0)	31.8	(63.6)
	Level 1 Reduction	29.1	(7.0)	13.2	(26.4)	1.5	(3.0)
	Level 1 RWL	149.1	(35.8)	28.3	(56.6)	30.3	(60.6)
	Level 2 Reduction	15.9	(3.8)	0.4	(0.8)	3.5	(7.0)
	Level 2 RWL	133.2	(32.0)	27.9	(55.8)	26.8	(53.6)
013	Alkaline-BCT						
	Model Mill RWL	152.2	(36.5)	45.7	(91.3)	42.5	(85.0)
	Level 1 Reduction	26.3	(6.3)	19.9	(39.7)	3.6	(7.3)
	Level 1 RWL	125.9	(30.2)	25.8	(51.6)	38.9	(77.7)
	Level 2 Reduction	23.7	(5.7)	-	-	2.6	(5.2)
	Level 2 RWL	102.2	(24.5)	25.8	(51.6)	36.3	(72.5)
014	Alkaline-Fine						
	Model Mill RWL	110.5	(26.5)	30.5	(61.0)	66.2	(132.3)
	Level 1 Reduction	20.0	(4.8)	13.8	(27.7)	14.0	(28.0)
	Level 1 RWL	90.5	(21.7)	16.7	(33.3)	52.2	(104.3)
	Level 2 Reduction	16.7	(4.0)	-	-	5.5	(11.0)
	Level 2 RWL	73.8	(17.7)	16.7	(33.3)	46.7	(93.3)
015	Alkaline-Unbleached						
	Model Mill RWL	46.6	(11.2)	14.2	(28.3)	16.3	(32.5)
	Level 1 Reduction	10.4	(2.5)	4.0	(8.0)	0.8	(1.5)
	Level 1 RWL	36.2	(8.7)	10.2	(20.3)	15.5	(31.0)
	Level 2 Reduction	0.9	(0.2)	-	-	3.6	(7.3)
	Level 2 RWL	35.3	(8.5)	10.2	(20.3)	11.9	(23.7)
016	Semi-Chemical						
	Model Mill RWL	32.5	(7.8)	18.5	(36.9)	21.6	(43.1)
	Level 1 Reduction	3.3	(0.8)	1.9	(3.8)	-	-
	Level 1 RWL	29.2	(7.0)	16.6	(33.1)	21.6	(43.1)
	Level 2 Reduction	7.5	(1.8)	1.0	(1.9)	7.1	([illegible].2)
	Level 2 RWL	21.7	(5.2)	15.6	(31.2)	14.5	(28.9)

TABLE VI-2 (Continued)

Subcategory No.	Name	Raw Waste Load (RWL) Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
017	Alkaline-Unbleached and Semi-Chemical						
	Model Mill RWL	55.8	(13.4)	18.7	(37.3)	23.5	(47.0)
	Level 1 Reduction	20.4	(4.9)	5.2	(10.4)	5.5	(11.0)
	Level 1 RWL	35.4	(8.5)	13.5	(26.9)	18.0	(36.0)
	Level 2 Reduction	-	-	-	-	1.0	(2.0)
	Level 2 RWL	35.4	(8.5)	13.5	(26.9)	17.0	(34.0)
019	Alkaline Newsprint						
	Model Mill RWL	93.8	(22.5)	21.1	(42.2)	56.7	(113.3)
	Level 1 Reduction	25.9	(6.2)	6.3	(12.7)	10.8	(21.5)
	Level 1 RWL	67.9	(16.3)	14.8	(29.5)	45.9	(91.8)
	Level 2 Reduction	10.4	(2.5)	-	-	7.0	(13.9)
	Level 2 RWL	57.5	(13.8)	14.8	(29.5)	38.9	(77.9)
021	Sulfite-Dissolving						
	Model Mill RWL	256.9	(61.6)	153.0	(306.0)	90.3	(180.6)
	Level 1 Reduction	59.7	(14.3)	59.3	(118.6)	6.6	(13.3)
	Level 1 RWL	197.2	(47.3)	93.7	(187.4)	83.7	(167.3)
	Level 2 Reduction	20.0	(4.8)	1.0	(2.0)	5.0	(10.0)
	Level 2 RWL	177.2	(42.5)	92.7	(185.4)	78.7	(157.3)
022	Sulfite-Papergrade						
	Model Mill RWL	152.6	(36.6)	48.7	(97.3)	33.1	(66.2)
	Level 1 Reduction	62.6	(15.0)	20.7	(41.4)	1.6	(3.2)
	Level 1 RWL	90.0	(21.6)	28.0	(55.9)	31.5	(63.0)
	Level 2 Reduction	2.4	(0.6)	-	-	2.2	(4.4)
	Level 2 RWL	87.6	(21.0)	28.0	(55.9)	29.3	(58.6)
032	Thermo-Mechanical Pulp						
	Model Mill RWL	60.0	(14.4)	18.3	(36.5)	38.7	(77.4)
	Level 1 Reduction	17.5	(4.2)	2.6	(5.2)	12.4	(24.8)
	Level 1 RWL	42.5	(10.2)	15.7	(31.3)	26.3	(52.6)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	42.5	(10.2)	15.7	(31.3)	26.3	(52.6)
033	Groundwood-CMN						
	Model Mill RWL	88.4	(21.2)	18.6	(37.1)	48.5	(97.0)
	Level 1 Reduction	33.8	(8.1)	7.0	(13.9)	13.0	(26.0)
	Level 1 RWL	54.6	(13.1)	11.6	(23.2)	35.5	(71.0)
	Level 2 Reduction	--	(--)	--	(--)	6.5	(13.0)
	Level 2 RWL	54.6	(13.1)	11.6	(23.2)	29.0	(58.0)
034	Groundwood-Fine						
	Model Mill RWL	68.4	(16.4)	17.6	(35.2)	53.9	(107.9)
	Level 1 Reduction	14.2	(3.4)	4.6	(9.3)	16.0	(32.1)

TABLE VI-2 (Continued)

Subcategory No.	Name	Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
	Level 1 RWL	54.2	(13.0)	13.0	(25.9)	37.9	(75.8)
	Level 2 Reduction	10.4	(2.5)	0.8	(1.5)	3.9	(7.8)
	Level 2 RWL	43.8	(10.5)	12.2	(24.4)	34.0	(68.0)
101	Deink-Fine and Tissue						
	Model Mill RWL	81.3	(19.5)	48.7	(97.4)	143.0	(286.0)
	Level 1 Reduction	22.9	(5.5)	8.0	(16.1)	12.8	(25.5)
	Level 1 RWL	58.4	(14.0)	40.7	(81.3)	130.2	(260.5)
	Level 2 Reduction	2.9	(0.7)	-	-	2.0	(4.0)
	Level 2 RWL	55.5	(13.3)	40.7	(81.3)	128.2	(256.5)
102	Deink-Newsprint						
	Model Mill RWL	67.6	(16.2)	15.9	(31.7)	123.0	(246.0)
	Level 1 Reducton	10.1	(2.4)	2.5	(5.0)	5.0	(10.0)
	Level 1 RWL	57.5	(13.8)	13.4	(26.7)	118.0	(236.0)
	Level 2 Reduction	2.0	(0.5)	-	-	15.0	(30.0)
	Level 2 RWL	55.5	(13.3)	13.4	(26.7)	103.0	(206.0)
111	Wastepaper-Tissue						
	Model Mill RWL	39.2	(9.4)	8.8	(17.5)	27.0	(54.0)
	Level 1 Reduction	5.8	(1.4)	1.3	(2.6)	4.0	(8[illegible])
	Level 1 RWL	33.4	(8.0)	7.5	(14.9)	23.0	(46.0)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	33.4	(8.0)	7.5	(14.9)	23.0	(46.0)
112	Wastepaper-Board						
	Model Mill RWL	15.4	(3.7)	6.5	(12.9)	7.7	(15.3)
	Level 1 Reduction	7.1	(1.7)	3.8	(7.6)	5.8	(11.5)
	Level 1 RWL	8.3	(2.0)	2.7	(5.3)	1.9	(3.8)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	8.3	(2.0)	2.7	(5.3)	1.9	(3.8)
113	Wastepaper-Molded Products						
	Model Mill RWL	47.1	(11.3)	5.7	(11.4)	10.7	(21.3)
	Level 1 Reduction	10.0	(2.4)	1.4	(2.8)	5.7	(11.3)
	Level 1 RWL	37.1	(8.9)	4.3	(8.6)	5.0	(10.0)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	37.1	(8.9)	4.3	(8.6)	5.0	(10.0)
114	Wastepaper-Construction Products						
	Model Mill RWL	9.2	(2.2)	5.8	(11.5)	8.2	(16.3)
	Level 1 Reduction	5.01	(1.2)	4.8	(9.6)	7.7	(15.3)
	Level 1 RWL	4.2	(1.0)	1.0	(1.9)	0.5	(1.0)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	4.2	(1.0)	1.0	(1.9)	0.5	(1.0)

TABLE VI-2 (Continued)

Subcategory No.	Name	Raw Waste Load (RWL) Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
201	Nonintegrated-Fine						
	Model Mill RWL	48.5	(11.6)	8.5	(17.0)	30.1	(60.1)
	Level 1 Reduction	14.2	(3.4)	3.0	(6.0)	7.2	(14.3)
	Level 1 RWL	34.3	(8.2)	5.5	(11.0)	22.9	(45.8)
	Level 2 Reduction	1.7	(0.4)	-	-	4.2	(8.5)
	Level 2 RWL	32.6	(7.8)	5.5	(11.0)	18.7	(37.3)
202	Nonintegrated-Tissue						
	Model Mill RWL	73.4	(17.6)	13.3	(26.5)	39.0	(77.9)
	Level 1 Reduction	37.1	(8.9)	7.8	(15.5)	14.4	(28.8)
	Level 1 RWL	36.3	(8.7)	5.5	(11.0)	24.6	(49.1)
	Level 2 Reduction	2.1	(0.5)	-	(--)	8.3	(16.5)
	Level 2 RWL	34.2	(8.2)	5.5	(11.0)	16.3	(32.6)
204	Nonintegrated-Lightweight						
	Model Mill RWL	266.5	(63.9)	15.3	(30.6)	45.6	(91.2)
	Level 1 Reduction	52.9	(12.7)	5.0	(9.9)	17.1	(34.3)
	Level 1 RWL	213.6	(51.2)	10.3	(20.7)	28.5	(56.9)
	Level 2 Reduction	4.2	(1.0)	-	-	8.3	(16.5)
	Level 2 RWL	209.4	(50.2)	10.3	(20.7)	20.2	(40.4)
205	Nonintegrated-Filter						
	Model Mill RWL	171.8	(41.2)	5.0	(10.0)	25.0	(50.0)
	Level 1 Reduction	45.9	(11.0)	1.5	(3.0)	10.2	(20.5)
	Level 1 RWL	125.9	(30.2)	3.5	(7.0)	14.8	(29.5)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	125.9	(30.2)	3.5	(7.0)	14.8	(29.5)
211	Nonintegrated-Paperboard						
	Model Mill RWL	102.4	(24.6)	10.0	(20.0)	42.3	(84.5)
	Level 1 Reduction	40.0	(9.6)	3.5	(7.0)	16.5	(33.0)
	Level 1 RWL	62.4	(15.0)	6.5	(13.0)	25.8	(51.5)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	62.4	(15.0)	6.5	(13.0)	25.8	(51.5)

The control technologies and their effects are described below by subcategory. Cumulative waste load reductions have been adjusted to reflect material balances for each subcategory. The applicability and effects of implementing designated production process controls will vary at specific mills. To predict the combined effect of applicable controls would require development of a revised flow and material balance for any particular mill.

Table VI-3 shows the effects of the same internal controls applied to the pure mills established for each subcategory. As discussed in Section V, pure mill raw waste loadings have in some cases been graphically projected from actual mill data. Likewise, raw waste load reductions resulting from implementing production process controls at the pure mills have in some cases been appropriately scaled from corresponding model mill data.

011 Alkaline-Dissolving

The Alkaline-Dissolving model mill has a raw waste load of 198.1 kl/kkg (47.5 kgal/t) of production, a BOD5 loading of 53.8 kg/kkg (107.6 lb/ton), and a TSS load of 76.8 kg/kkg (153.7 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is: 221.4 kl/kkg (53.1 kgal/t), BOD5 65.2 kg/kkg (130.3 lb/ton), and 96.8 kg/kkg (193.5 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure	
Flow	185.2 kl/kkg	(44.4 kgal/t)	207.2 kl/kkg	(49.7 kgal/t)
BOD5	32.6 kg/kkg	(65.3 lb/ton)	39.6 kg/kkg	(79.1 lb/ton)
TSS	64.5 kg/kkg	(129.2 lb/ton)	81.1 kg/kkg	(162.2 lb/ton)

The additional application of the Level 2 technology items could produces the following predicted Level 2 raw waste loads:

	Model		Pure	
Flow	177.2 kl/kkg	(42.5 kgal/t)	198.5 kl/kkg	(47.6 kgal/t)
BOD5	32.0 kg/kkg	(64.0 lb/ton)	38.8 kg/kkg	(77.5 lb/ton)
TSS	60.2 kg/kkg	(120.6 lb/ton)	76.0 kg/kkg	(151.9 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o segregation of noncontact cooling water in the woodroom operation;
- o reduction in the wastage of blow condensate and relief condensate from the digester;

TABLE VI-3

PURE MILL RAW WASTE LOADS

Subcategory	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
011 Alkaline-Dissolving						
Pure Mill RWL	221.4	(53.1)	65.2	(130.3)	96.8	(193.5)
Level 1 RWL	207.2	(49.7)	39.6	(79.1)	81.1	(162.2)
Level 2 RWL	198.5	(47.6)	38.8	(77.5)	76.0	(151.9)
012 Alkaline-Market						
Pure Mill RWL	164.7	(39.5)	37.7	(75.3)	48.4	(96.7)
Level 1 RWL	137.6	(33.0)	25.7	(51.4)	46.1	(92.1)
Level 2 RWL	123.0	(29.5)	25.4	(50.7)	40.8	(81.5)
013 Alkaline-BCT						
Pure Mill RWL	152.2	(36.5)	45.7	(91.3)	42.5	(85.0)
Level 1 RWL	125.9	(30.2)	25.8	(51.6)	38.9	(77.7)
Level 2 RWL	102.2	(24.5)	25.8	(51.6)	36.3	(72.5)
014 Alkaline-Fine						
Pure Mill RWL	108.0	(25.9)	28.7	(57.4)	53.4	(106.7)
Level 1 RWL	88.4	(21.2)	15.7	(31.3)	42.1	(84.1)
Level 2 RWL	72.1	(17.3)	15.7	(31.3)	37.6	(75.2)
015 Alkaline-Unbleached						
. Linerboard						
Pure Mill RWL	46.7	(11.2)	14.2	(28.3)	16.3	(32.5)
Level 1 RWL	36.3	(8.7)	10.2	(20.3)	15.5	(31.0)
Level 2 RWL	35.5	(8.5)	10.2	(20.3)	11.9	(23.7)
. Bag						
Pure Mill RWL	70.5	(16.9)	18.9	(37.7)	20.7	(41.4)
Level 1 RWL	54.6	(13.1)	13.5	(27.0)	19.8	(39.5)
Level 2 RWL	53.4	(12.8)	13.5	(27.0)	18.7	(37.4)

TABLE VI-3 (Continued)

PURE MILL RAW WASTE LOADS

Subcategory	Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
016 Semi-Chemical						
. 80%						
Pure Mill RWL	32.5	(7.8)	18.5	(36.9)	21.6	(43.1)
Level 1 RWL	29.2	(7.0)	16.6	(33.1)	21.6	(43.1)
Level 2 RWL	21.7	(5.2)	15.6	(31.2)	14.5	(28.9)
. 100%						
Pure Mill RWL	48.4	(11.6)	19.3	(38.6)	38.5	(76.9)
Level 1 RWL	43.4	(10.4)	17.3	(34.6)	38.5	(76.9)
Level 2 RWL	32.1	(7.7)	16.3	(32.6)	25.8	(51.6)
017 Alkaline-Unbleached and Semi-Chemical						
Pure Mill RWL	55.8	(13.4)	18.7	(37.3)	23.5	(47.0)
Level 1 RWL	35.4	(8.5)	13.5	(26.9)	18.0	(36.0)
Level 2 RWL	35.4	(8.5)	13.5	(26.9)	17.0	(34.0)
019 Alkaline-Newsprint						
Pure Mill RWL	93.8	(22.5)	21.1	(42.2)	56.7	(113.3)
Level 1 RWL	67.9	(16.3)	14.8	(29.5)	45.9	(91.8)
Level 2 RWL	57.5	(13.8)	14.8	(29.5)	38.9	(77.9)
021 Sulfite-Dissolving						
Pure Mill RWL	266.4	(63.9)	168.5	(336.9)	100.1	(200.2)
Level 1 RWL	204.7	(49.1)	103.2	(206.4)	92.7	(185.5)
Level 2 RWL	183.9	(44.1)	102.1	(204.2)	87.2	(174.4)
022 Sulfite-Papergrade						
. 100%						
Pure Mill RWL	203.9	(48.9)	68.5	(136.9)	34.7	(69.3)
Level 1 RWL	120.5	(28.9)	39.4	(78.7)	33.0	(66.0)
Level 2 RWL	117.2	(28.1)	39.4	(78.7)	30.7	(61.4)

TABLE VI-3 (Continued)

PURE MILL RAW WASTE LOADS

Subcategory	Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
. 67%						
Pure Mill RWL	152.6	(36.6)	48.7	(97.3)	33.1	(66.2)
Level 1 RWL	90.0	(21.6)	28.0	(55.9)	31.5	(63.0)
Level 2 RWL	87.6	(21.0)	28.0	(55.9)	29.3	(58.6)
032 Thermo-Mechanical Pulp						
Pure Mill RWL	60.0	(14.4)	18.3	(36.5)	38.7	(77.4)
Level 1 RWL	42.5	(10.2)	15.7	(31.3)	26.3	(52.6)
Level 2 RWL	42.5	(10.2)	15.7	(31.3)	26.3	(52.6)
033 Groundwood-CMN						
. 74%						
Pure Mill RWL	88.4	(21.2)	18.6	(37.1)	48.5	(97.0)
Level 1 RWL	54.6	(13.1)	11.6	(23.2)	35.5	(71.0)
Level 2 RWL	54.6	(13.1)	11.6	(23.2)	29.0	(58.0)
. 100%						
Pure Mill RWL	134.3	(32.2)	22.9	(45.8)	77.6	(155.1)
Level 1 RWL	83.0	(19.9)	14.3	(28.6)	56.8	(113.5)
Level 2 RWL	83.0	(19.9)	14.3	(28.6)	46.4	(92.7)
034 Groundwood-Fine						
. 59%						
Pure Mill RWL	68.4	(16.4)	17.6	(35.2)	53.9	(107.9)
Level 1 RWL	54.2	(13.0)	13.0	(25.9)	37.9	(75.8)
Level 2 RWL	43.8	(10.5)	12.2	(24.2)	34.0	(68.0)
. 100%						
Pure Mill RWL	110.9	(26.6)	18.6	(37.2)	55.2	(110.4)
Level 1 RWL	88.0	(21.1)	13.7	(27.4)	38.8	(77.6)
Level 2 RWL	71.9	(17.0)	12.9	(25.8)	34.8	(69.6)

TABLE VI-3 (Continued)

PURE MILL RAW WASTE LOADS

Subcategory	Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
101 Deink-Fine and Tissue						
. Tissue						
Pure Mill RWL	81.3	(19.5)	48.7	(97.4)	143.0	(286.0)
Level 1 RWL	58.4	(14.0)	40.7	(81.3)	130.2	(260.5)
Level 2 RWL	55.5	(13.3)	40.7	(81.3)	128.2	(256.5)
. Fine						
Pure Mill RWL	107.2	(25.7)	50.0	(99.9)	215.7	(431.3)
Level 1 RWL	77.2	(18.5)	41.7	(83.4)	196.4	(392.8)
Level 2 RWL	73.4	(17.6)	41.7	(83.4)	193.4	(386.8)
102 Deink-Newsprint						
Pure Mill RWL	67.6	(16.2)	15.9	(31.7)	123.0	(246.0)
Level 1 RWL	57.5	(13.8)	13.4	(26.7)	118.0	(236.0)
Level 2 RWL	55.5	(13.3)	13.4	(26.7)	103.0	(206.0)
111 Wastepaper-Tissue 100% WP-Industrial- No S.C.						
Pure Mill RWL	56.7	(13.6)	13.2	(26.3)	40.5	(81.0)
Level 1 RWL	48.4	(11.6)	11.2	(22.4)	34.5	(69.0)
Level 2 RWL	48.4	(11.6)	11.2	(22.4)	34.5	(69.0)
112 Wastepaper-Board						
. Board						
Pure Mill RWL	15.4	(3.7)	10.6	(21.2)	9.9	(19.7)
Level 1 RWL	8.3	(2.0)	4.4	(8.7)	2.5	(4.9)
Level 2 RWL	8.3	(2.0)	4.4	(8.7)	2.5	(4.9)
. Linerboard						
Pure Mill RWL	27.9	(6.7)	8.9	(17.8)	10.8	(21.5)
Level 1 RWL	15.0	(3.6)	3.7	(7.3)	2.7	(5.3)
Level 2 RWL	15.0	(3.6)	3.7	(7.3)	2.7	(5.3)

TABLE VI-3 (Continued)

PURE MILL RAW WASTE LOADS

Subcategory	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
. Corrugated						
Pure Mill RWL	4.2	(1.0)	5.3	(10.7)	4.0	(7.9)
Level 1 RWL	2.1	(0.5)	2.2	(4.4)	1.0	(2.0)
Level 2 RWL	2.1	(0.5)	2.2	(4.4)	1.0	(2.0)
. Chip & Filler						
Pure Mill RWL	10.0	(2.4)	3.5	(6.9)	4.5	(8.9)
Level 1 RWL	5.4	(1.3)	1.4	(2.8)	1.1	(2.2)
Level 2 RWL	5.4	(1.3)	1.4	(2.8)	1.1	(2.2)
. Folding Box						
Pure Mill RWL	16.3	(3.9)	6.1	(12.1)	7.1	(14.1)
Level 1 RWL	8.8	(2.1)	2.5	(5.0)	1.8	(3.5)
Level 2 RWL	8.8	(2.1)	2.5	(5.0)	1.8	(3.5)
. Setup Box						
Pure Mill RWL	20.4	(4.9)	7.3	(14.7)	5.7	(11.4)
Level 1 RWL	10.8	(2.6)	3.0	(6.0)	1.4	(2.8)
Level 2 RWL	10.8	(2.6)	3.0	(6.0)	1.4	(2.8)
. Gypsum						
Pure Mill RWL	11.7	(2.8)	5.8	(11.6)	15.9	(31.8)
Level 1 RWL	6.3	(1.5)	2.4	(4.8)	6.9	(13.8)
Level 2 RWL	6.3	(1.5)	2.4	(4.8)	6.9	(13.8)
113 Wastepaper Molded-No S.C.						
Pure Mill RWL	52.5	(12.6)	6.5	(13.0)	11.4	(22.7)
Level 1 RWL	41.3	(9.9)	4.9	(9.8)	5.4	(10.7)
Level 2 RWL	41.3	(9.9)	4.9	(9.8)	5.4	(10.7)

TABLE VI-3 (Continued)

PURE MILL RAW WASTE LOADS

Subcategory	Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
114 Wastepaper Construction						
. 100% Wastepaper						
Pure Mill RWL	14.6	(3.5)	7.6	(15.2)	19.4	(38.7)
Level 1 RWL	6.7	(1.6)	1.3	(2.5)	1.2	(2.4)
Level 2 RWL	6.7	(1.6)	1.3	(2.5)	1.2	(2.4)
. 50% Wastepaper/50% TMP						
Pure Mill RWL	12.5	(3.0)	13.9	(27.8)	10.2	(20.4)
Level 1 RWL	5.8	(1.4)	2.3	(4.6)	0.7	(1.3)
Level 2 RWL	5.8	(1.4)	2.3	(4.6)	0.7	(1.3)
201 Nonintegrated-Fine						
Pure Mill RWL	48.5	(11.6)	8.5	(17.0)	30.1	(60.1)
Level 1 RWL	34.3	(8.2)	5.5	(11.0)	22.9	(45.8)
Level 2 RWL	32.6	(7.8)	5.5	(11.0)	18.7	(37.3)
202 Nonintegrated-Tissue						
Pure Mill RWL	73.4	(17.6)	13.3	(26.5)	39.0	(77.9)
Level 1 RWL	36.3	(8.7)	5.5	(11.0)	24.6	(49.1)
Level 2 RWL	34.2	(8.2)	5.5	(11.0)	16.3	(32.6)
204 Nonintegrated						
. Lightweight						
Pure Mill RWL	266.5	(63.9)	15.3	(30.6)	45.6	(91.2)
Level 1 RWL	213.5	(51.2)	10.4	(20.7)	28.5	(56.9)
Level 2 RWL	209.3	(50.2)	10.4	(20.7)	20.2	(40.4)
. Electrical						
Pure Mill RWL	407.0	(97.6)	11.6	(23.1)	37.7	(75.3)
Level 1 RWL	326.1	(78.2)	2.8	(5.6)	23.5	(47.0)
Level 2 RWL	319.8	(76.7)	2.8	(5.6)	16.7	(33.4)

TABLE VI-3 (Continued)

PURE MILL RAW WASTE LOADS

Subcategory	Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
205 Nonintegrated-Filter and Nonwoven						
Pure Mill RWL	171.8	(41.2)	5.0	(10.0)	25.0	(50.0)
Level 1 RWL	125.9	(30.2)	3.5	(7.0)	14.8	(29.5)
Level 2 RWL	125.9	(30.2)	3.5	(7.0)	14.8	(29.5)
211 Nonintegrated						
. Board						
Pure Mill RWL	102.6	(24.6)	10.0	(20.0)	42.3	(84.5)
Level 1 RWL	62.6	(15.0)	6.5	(13.0)	25.8	(51.5)
Level 2 RWL	62.6	(15.0)	6.5	(13.0)	25.8	(51.5)
. Electrical Board						
Pure Mill RWL	247.3	(59.3)	10.0	(20.0)	42.3	(84.5)
Level 1 RWL	151.0	(36.2)	6.5	(13.0)	25.8	(51.5)
Level 2 RWL	151.0	(36.2)	6.5	(13.0)	25.8	(51.5)

- o modifications in the washing and screening areas, entailing the addition of a fourth-stage washer or modifications enabling comparable washing efficiencies;
- o implementation of spill collection and high-level alarms in the digester, washing, and screen room areas; and
- o replacement of existing sidehill screens with slotted vibrating screens, enabling fiber recovery and reduced fiber loss.

Level 2:

- o fourth-stage centricleaning system with rejects routed to landfill;
- o replacement of barometric condensers with surface condensers;
- o installation of a pulp mill spill collection system;
- o installation of a green liquor dregs filter; and
- o diversion of water treatment plant backwash water and steam plant blowdown water to a separate lagoon.

012 Alkaline-Market

The Alkaline-Market model mill has a raw waste load of 178.2 kl/kkg (42.8 kgal/t) of production, a BOD5 load of 41.5 kg/kkg (83.0 lb/ton), and a TSS load of 31.8 kg/kkg (63.6 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is: 164.7 kl/kkg (39.5 kgal/t), BOD5 37.7 kg/kkg (75.3 lb/ton), and 48.4 kg/kkg (96.7 lb/ton) TSS.

The application of Level 1 technology items yield the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure	
Flow	149.1 kl/kkg	(35.8 kgal/t)	137.6 kl/kkg	(33.0 kgal/t)
BOD5	28.3 kg/kkg	(56.6 lb/ton)	25.7 kg/kkg	(51.4 lb/ton)
TSS	30.3 kg/kkg	(60.6 lb/ton)	46.1 kg/kkg	(92.1 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model		Pure	
Flow	133.2 kl/kkg	(32.0 kgal/t)	123.0 kl/kkg	(29.5 kgal/t)
BOD5	27.9 kg/kkg	(55.8 lb/ton)	25.4 kg/kkg	(50.7 lb/ton)
TSS	26.8 kg/kkg	(53.6 lb/ton)	40.8 kg/kkg	(81.5 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level I

- o segregate cooling water in woodroom;
- o use digester blow and relief condensates;
- o install fourth-stage brownstock washer;
- o recycle brownstock decker filtrate;
- o brownstock area spill collection;
- o liquor storage area spill collection;
- o evaporator area spill collection and spare liquor tank; and
- o pulp dryer spill collection.

Level 2:

- o jump-stage washing in bleach plant;
- o install evaporator boilout tank;
- o install green liquor dregs filter;
- o centricleaner rejects - divert to landfill; and
- o lagoon for boiler blowdown water and water treatment plant backwash water.

013 Alkaline-BCT

The Alkaline-BCT model and pure mills have the same raw waste load: 152.2 kl/kkg (36.5 kgal/t) of production, a BOD_5 load of 45.7 kg/kkg (91.3 lb/ton), and a TSS load of 42.5 kg/kkg (85.0 lb/ton). The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for these mills:

	Model and Pure Mill	
Flow	125.9 kl/kkg	(30.2 kgal/t)
BOD_5	25.8 kg/kkg	(51.6 lb/ton)
TSS	38.9 kg/kkg	(77.7 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste load:

Model and Pure Mill

Flow	102.2 kl/kkg	(24.5 kgal/t)
BOD5	25.8 kg/kkg	(51.6 lb/ton)
TSS	36.3 kg/kkg	(72.5 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1

- o segregation of woodroom cooling water;
- o digester relief and blow condensate use;
- o fourth stage brownstock washer;
- o recycle more decker filtrate;
- o install brownstock area spill collection;
- o install pulp mill liquor storage spill collection;
- o evaporator condensate recycle;
- o install evaporator area spill collection, and spare tank;
- o install bleach plant spill collection;
- o white water for vacuum, pump sealing; and
- o lagoon for boiler blowdown water and water treatment plant filter backwash water.

Level 2:

- o install jump-stage washing in bleach plant;
- o install green liquor dregs filter; and
- o cleaner rejects to landfill.

<u>014 Alkaline-Fine</u>

The Alkaline-Fine model mill has a raw waste load of 110.5 kl/kkg (26.5 kgal/t) of production, a BOD5 load of 30.5 kg/kkg (61.0 lb/ton), and a TSS load of 66.2 kg/kkg (132.3 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is: 108.0 kl/kkg (25.9 kgal/t), BOD5 28.7 kg/kkg (57.4 lb/ton), and 53.4 kg/kkg (106.7 lb/ton) TSS.

The application of Level 1 technology items could yield the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure	
Flow	90.5 kl/kkg	(21.7 kgal/t)	88.4 kl/kkg	(21.2 kgal/t)
BOD_5	16.7 kg/kkg	(33.3 lb/ton)	15.7 kg/kkg	(31.3 lb/ton)
TSS	52.2 kg/kkg	(104.3 lb/ton)	42.1 kg/kkg	(84.1 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model		Pure	
Flow	73.8 kl/kkg	(17.7 kgal/t)	72.1 kl/kkg	(17.3 kgal/t)
BOD_5	16.7 kg/kkg	(33.3 lb/ton)	15.7 kg/kkg	(31.3 lb/ton)
TSS	46.7 kg/kkg	(93.3 lb/ton)	37.6 kg/kkg	(75.2 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below:

Level 1:

- o segregate woodroom cooling water;
- o dispose of digester relief and blow condensate;
- o fourth-stage brownstock washer;
- o recycle decker filtrate;
- o brownstock area spill collection;
- o liquor storage area spill collection;
- o evaporator and liquor area spill collection and spare tank;
- o bleached pulp area spill collection;
- o whitewater for vacuum pump sealing; and
- o central whitewater chest installation.

Level 2:

- o countercurrent washing in bleach plant;
- o green liquor dregs filter;
- o lime mud pond;

- cleaner rejects to landfill; and
- lagoon for boiler blowdown water and water treatment plant filter backwash water.

015 Alkaline-Unbleached

The Alkaline-Unbleached model mill has a raw waste load of 46.6 kl/kkg (11.2 kgal/t) of production, a BOD5 load of 14.2 kg/kkg (28.3 lb/ton), and a TSS load of 16.3 kg/kkg (32.5 lb/ton). The corresponding raw waste load for the pure mills in this subcategory making liner board is: 46.7 kl/kkg (11.2 kgal/t), BOD5 14.2 kg/kkg (28.3 lb/ton), and 16.3 kg/kkg (32.5 lb/ton) TSS. The raw waste load for a pure mill making bag paper is: 70.5 kl/kkg (16.9 kgal/t), BOD5 18.9 kg/kkg (37.7 lb/ton), and TSS 20.7 kg/kkg (41.4 lb/ton).

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure Linerboard	
Flow	36.2 kl/kkg	(8.7 kgal/t)	36.3 kl/kkg	(8.7 kgal/t)
BOD5	10.2 kg/kkg	(20.3 lb/ton)	10.2 kg/kkg	(20.3 lb/ton)
TSS	15.5 kg/kkg	(31.0 lb/ton)	15.5 kg/kkg	(31.0 lb/ton)

Pure Bag

Flow	54.6 kl/kkg	(13.1 kgal/t)
BOD5	13.5 kg/kkg	(27.0 lb/ton)
TSS	19.8 kg/kkg	(39.5 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model		Pure Linerboard	
Flow	35.3 kl/kkg	(8.5 kgal/t)	35.5 kl/kkg	(8.5 kgal/t)
BOD5	10.2 kg/kkg	(20.3 lb/ton)	10.2 kg/kkg	(20.3 lb/ton)
TSS	11.9 kg/kkg	(23.7 lb/ton)	11.9 kg/kkg	(23.7 lb/ton)

Pure Bag

Flow	53.4 kl/kkg	(12.8 kgal/t)
BOD5	13.5 kg/kkg	(27.0 lb/ton)
TSS	18.7 kg/kkg	(37.4 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- segregate woodroom cooling water;
- use digester blow and relief condensates;
- install fourth stage brownstock washer;
- install improved saveals;
- high pressure freshwater showers on machine;
- whitewater showers;
- whitewater to vacuum pumps; and
- recycle press effluent.

Level 2:

- green liquor dregs filter;
- lime mud pond; and
- fourth-stage centricleaners.

016 Semi-Chemical

The Semi-Chemical model mill has a raw waste load of 32.5 kl/kkg (7.8 kgal/t) of production, a BOD_5 load of 18.5 kg/kkg (36.9 lb/ton), and a TSS load of 21.6 kg/kkg (43.1 lb/ton). The raw waste loading for the pure mill at 80 percent semi-chemical production is the same as that for the model mill. The corresponding raw waste load for the pure mill extrapolated to 100% semi-chemical production is: 48.4 kl/kkg (11.6 kgal/t), BOD_5 19.3 kg/kkg (38.6 lb/ton), and 38.5 kg/kkg (76.9 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure-80%		Pure-100%	
Flow	29.2 kl/kkg	(7.0 kgal/t)	43.4 kl/kkg	(10.4 kgal/t)
BOD_5	16.6 kg/kkg	(33.1 lb/ton)	17.3 kg/kkg	(34.6 lb/ton)
TSS	21.6 kg/kkg	(43.1 lb/ton)	38.5 kg/kkg	(76.9 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste load:

	Model and Pure-80%		Pure-100%	
Flow	21.7 kl/kkg	(5.2 kgal/t)	32.1 kl/kkg	(7.7 kgal/t)
BOD_5	15.6 kg/kkg	(31.2 lb/ton)	16.3 kg/kkg	(32.6 lb/ton)
TSS	14.5 kg/kkg	(28.9 lb/ton)	25.8 kg/kkg	(51.6 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o segregate woodroom cooling water;
- o add third stage press washer;
- o recycle evaporator condensate; and
- o segregate cooling water in recovery building.

Level 2:

- o papermill spill collection;
- o improved saveall;
- o whitewater for vacuum pumps; and
- o recycle press effluent.

The Level 2 items normally are Level 1 controls in other subcategories. However, at some Semi-Chemical mills papermachine is in effect a pulp washer integrated with the pulp mill. In total, the Level 2 items are an expensive package with lesser benefits than in most other subcategories.

017 Alkaline-Unbleached and Semi-Chemical

The Alkaline-Unbleached and Semi-Chemical model mill has a raw waste load of 55.8 kl/kkg (13.4 kgal/t) of production, a BOD5 load of 18.7 kg/kkg (37.3 lb/ton), and a TSS load of 23.5 kg/kkg (47.0 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure	
Flow	35.4 kl/kkg	(8.5 kgal/t)
BOD5	13.5 kg/kkg	(26.9 lb/ton)
TSS	18.0 kg/kkg	(36.0 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste load:

Model and Pure

Flow	35.4 kl/kkg	(8.5 kgal/t)
BOD5	13.5 kg/kkg	(26.9 lb/ton)
TSS	17.0 kg/kkg	(34.0 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o segregate woodroom cooling water;
- o install fourth-stage brownstock washer or equivalent;
- o evaporator and recovery area spill collection and spare tank;
- o improved savealls; and
- o whitewater for vacuum pump sealing and recycle.

Level 2:

- o Green liquor dregs filter.

019 Alkaline-Newsprint

The Alkaline-Newsprint model mill has a raw waste load of 93.8 kl/kkg (22.5 kgal/t) of production, a BOD5 load of 21.1 kg/kkg (42.2 lb/ton), and a TSS load of 56.7 kg/kkg (113.3 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

Model and Pure

Flow	67.9 kl/kkg	(16.3 kgal/t)
BOD5	14.8 kg/kkg	(29.5 lb/ton)
TSS	45.9 kg/kkg	(91.8 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste load:

Model and Pure

Flow	57.5 kl/kkg	(13.8 kgal/t)
BOD5	14.8 kg/kkg	(29.5 lb/ton)
TSS	38.9 kg/kkg	(77.9 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- segregate woodroom cooling waters;
- use relief and blow condensate;
- add fourth-stage brownstock washer;
- recycle more decker filtrate;
- brownstock spill collection;
- brownstock liquor storage tank;
- recycle more evaporator condensate;
- evaporator area spill collection and liquor tank;
- pulp storage spill collection;
- improved savealls;
- whitewater for vacuum pumps;
- whitewater storage;
- recycle press effluent; and
- segregate cooling water (utility area).

Level 2:

- bleaching-countercurrent washing;
- green liquor dregs filter;
- lime mud storage pond;
- cleaner rejects to landfill; and
- lagoon for boiler blowdown water and water treatment plant filter backwash water.

021 Sulfite-Dissolving

The Sulfite-Dissolving model mill has a raw waste load of 256.9 kl/kkg (61.6 kgal/t) of production, a BOD5 load of 153.0 kg/kkg (306.0 lb/ton), and a TSS load of 90.3 kg/kkg (180.6 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is: 266.4 kl/kkg (63.9 kgal/t), BOD5 168.5 kg/kkg (336.9 lb/ton), and 100.1 kg/kkg (200.2 lb/ton) TSS.

The application of Level 1 technology items yield the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure	
Flow	197.2 kl/kkg	(47.3 kgal/t)	204.7 kl/kkg	(49.1 kgal/t)
BOD5	93.7 kg/kkg	(187.4 lb/ton)	103.2 kg/kkg	(206.4 lb/ton)
TSS	83.7 kg/kkg	(167.3 lb/ton)	92.7 kg/kkg	(185.5 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste load:

	Model		Pure	
Flow	177.2 kl/kkg	(42.5 kgal/t)	183.9 kl/kkg	(44.1 kgal/t)
BOD5	92.7 kg/kkg	(185.4 lb/ton)	102.1 kg/kkg	(204.2 lb/ton)
TSS	78.7 kg/kkg	(157.3 lb/ton)	87.2 kg/kkg	(174.4 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o segregate woodroom cooling water;
- o recycle decker filtrate;
- o pulp mill spill collection;
- o improved bleach plant washing;
- o neutralize spent sulfite liquor;
- o liquor area spill collection;
- o pulp dryer spill collection; and
- o segregate utility area cooling water.

Level 2:

- o recycle woodroom hydraulic barker water;
- o evaporate caustic stage filtrate;
- o high pressure showers for pulp dryer;

- o whitewater to pulp mill; and
- o whitewater for vacuum pumps.

022 Sulfite-Papergrade

The Sulfite-Papergrade model mill has a raw waste load of 152.6 kl/kkg (36.6 kgal/t) of production, a BOD_5 load of 48.7 kg/kkg (97.3 lb/ton), and a TSS load of 33.1 kg/kkg (66.2 lb/ton). This loading is the same for the pure mill at 67 percent sulfite-papergrade production. The corresponding raw waste load for the pure mill making 100% sulfite pulp and on-site paper is: 203.9 kl/kkg (48.9 kgal/t), BOD_5 68.5 kg/kkg (136.9 lb/ton), and 34.7 kg/kkg (69.3 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure-67%		Pure-100%	
Flow	90.0 kl/kkg	(21.6 kgal/t)	120.5 kl/kkg	(28.9 kgal/t)
BOD_5	28.0 kg/kkg	(55.9 lb/ton)	39.4 kg/kkg	(78.7 lb/ton)
TSS	31.5 kg/kkg	(63.0 lb/ton)	33.0 kg/kkg	(66.0 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model and Pure 67%		Pure-100%	
Flow	87.6 kl/kkg	(21.0 kgal/t)	117.2 kl/kkg	(28.1 kgal/t)
BOD_5	28.0 kg/kkg	(55.9 lb/ton)	39.4 kg/kkg	(78.7 lb/ton)
TSS	29.3 kg/kkg	(58.6 lb/ton)	30.7 kg/kkg	(61.4 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o segregate woodroom cooling water;
- o add extra red stock washer;
- o pulp mill spill collection;
- o countercurrent washing in bleach plant;
- o neutralize spent sulfite liquor;
- o liquor preparation area spill collection;

- papermill spill collection;
- color plant spill collection;
- improved savealls;
- control whitewater chest;
- whitewater to vacuum pumps;
- recycle press effluent;
- wet lap machine for spills; and
- lagoon for boiler blowdown water and water treatment plant filter backwash waters.

Level 2:

- cleaner rejects to landfill; and
- segregate utility area cooling water.

032 Thermo-Mechanical Pulp

The Thermo-Mechanical Pulp model mill has a raw waste load of 60.0 kl/kkg (14.4 kgal/t) of production, a BOD5 load of 18.3 kg/kkg (36.5 lb/ton), and a TSS load of 38.7 kg/kkg (77.4 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure	
Flow	42.5 kl/kkg	(10.2 kgal/t)
BOD5	15.7 kg/kkg	(31.3 lb/ton)
TSS	26.3 kg/kkg	(52.6 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- segregate woodroom cooling water;
- papermachine spill collection;
- high-level alarms; and
- improved savealls.

There are no Level 2 production process controls designated for this subcategory.

033 Groundwood-CMN

The Groundwood-CMN model mill has a raw waste load of 88.4 kl/kkg (21.2 kgal/t) of production, a BOD_5 load of 18.6 kg/kkg (37.1 lb/ton), and a TSS load of 48.5 kg/kkg (97.0 lb/ton). These loadings are the same for the pure mill at 74 percent Groundwood-CMN production. The corresponding raw waste load for the pure mill at 100 percent Groundwood-CMN production in this subcategory would be: 134.3 kl/kkg (32.2 kgal/t), BOD_5 22.9 kg/kkg (45.8 lb/ton), and TSS 77.6 kg/kkg (155.1 lb/ton).

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure-74%		Pure-100%	
Flow	54.6 kl/kkg	(13.1 kgal/t)	83.0 kl/kkg	(19.9 kgal/t)
BOD_5	11.6 kg/kkg	(23.2 lb/ton)	14.3 kg/kkg	(28.6 lb/ton)
TSS	35.5 kg/kkg	(71.0 lb/ton)	56.8 kg/kkg	(113.5 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model and Pure-74%		Pure-100%	
Flow	54.6 kl/kkg	(13.1 kgal/t)	83.0 kl/kkg	(19.9 kgal/t)
BOD_5	11.6 kg/kkg	(23.2 lb/ton)	14.3 kg/kkg	(28.6 lb/ton)
TSS	29.0 kg/kkg	(58.0 lb/ton)	46.4 kg/kkg	(92.7 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- segregate woodroom cooling water;
- pulp mill spill collection;
- papermill spill collection;
- improve saveall s;
- whitewater for vacuum pumps;
- central whitewater tanks;
- recycle press effluent; and
- collect pulp mill overflow.

Level 2:

- o cleaner rejects to landfill.

034 Groundwood-Fine

The Groundwood-Fine model mill has a raw waste load of 68.4 kl/kkg (16.4 kgal/t) of production, a BOD5 load of 17.6 kg/kkg (35.2 lb/ton), and a TSS load of 53.9 kg/kkg (107.9 lb/ton). The raw waste loading for the pure mill at 59% groundwood production is the same as that for the model mill. The raw waste load for the 100 percent groundwood pure mill in this subcategory is: 110.9 kl/kkg (26.6 kgal/t), BOD5 18.6 kg/kkg (37.2 lb/ton), and 55.2 kg/kkg (110.4 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure-59%		Pure-100%	
Flow	54.2 kl/kkg	(13.0 kgal/t)	88.0 kl/kkg	(21.1 kgal/t)
BOD5	13.0 kg/kkg	(25.9 lb/ton)	13.7 kg/kkg	(27.4 lb/ton)
TSS	37.9 kg/kkg	(75.8 lb/ton)	38.8 kg/kkg	(77.6 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model and Pure-59%		Pure-100%	
Flow	43.8 kl/kkg	(10.5 kgal/t)	71.9 kl/kkg	(17.0 kgal/t)
BOD5	12.2 kg/kkg	(24.4 lb/ton)	12.9 kg/kkg	(25.8 lb/ton)
TSS	34.0 kg/kkg	(68.0 lb/ton)	34.8 kg/kkg	(69.6 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o dry debarking system;
- o segregate woodroom cooling water;
- o pulp mill spill collection;
- o pulp mill high level alarms;
- o papermill spill collection;
- o papermill wet lap machine;

- o papermill color plant spill collection; and
- o segregate utility area cooling waters.

Level 2:

- o reduce groundwood thickener overflow;
- o whitewater to vacuum pumps;
- o recycle press effluent; and
- o cleaner rejects to landfill.

101 Deink-Fine and Tissue

The Deink-Fine and Tissue model mill has a raw waste load of 81.3 kl/kkg (19.5 kgal/t) of production, a BOD_5 load of 48.7 kg/kkg (97.4 lb/ton), and a TSS load of 143.0 kg/kkg (286.0 lb/ton). The corresponding raw waste load for the pure tissue mill would be the same. The loadings for the pure fine mills in this subcategory are: 107.2 kl/kkg (25.7 kgal/t), BOD_5 50.0 kg/kkg (99.9 lb/ton), and 215.7 kg/kkg (431.3 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model or Pure Tissue		Pure-Fine	
Flow	58.4 kl/kkg	(14.0 kgal/t)	77.2 kl/kkg	(18.5 kgal/t)
BOD_5	40.7 kg/kkg	(81.3 lb/ton)	41.7 kg/kkg	(83.4 lb/ton)
TSS	130.2 kg/kkg	(260.5 lb/ton)	196.4 kg/kkg	(392.8 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste load:

	Model or Pure Tissue		Pure-Fine	
Flow	55.5 kl/kkg	(13.3 kgal/t)	73.4 kl/kkg	(17.6 kgal/t)
BOD_5	40.7 kg/kkg	(81.3 lb/ton)	41.7 kg/kkg	(83.4 lb/ton)
TSS	128.2 kg/kkg	(256.5 lb/ton)	193.4 kg/kkg	(386.8 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o pulp mill spill collection;
- o high-pressure showers;

- o whitewater to vacuum pumps;
- o whitewater to pulp mill;
- o wet lap machine for spills and runout; and
- o segregate cooling waters.

Level 2:

- o cleaner rejects to landfill; and
- o lagoon for boiler blowdown water and water treatment plant filter backwash waters.

102 Deink-Newsprint

The Deink-Newsprint model mill has a raw waste load of 67.6 kl/kkg (16.2 kgal/t) of production, a BOD5 load of 15.9 kg/kkg (31.7 lb/ton), and a TSS load of 123.0 kg/kkg (246.0 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model or Pure	
Flow	57.5 kl/kkg	(13.8 kgal/t)
BOD5	13.4 kg/kkg	(26.7 lb/ton)
TSS	118.0 kg/kkg	(236.0 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model or Pure	
Flow	55.5 kl/kkg	(13.3 kgal/t)
BOD5	13.4 kg/kkg	(26.7 lb/ton)
TSS	103.0 kg/kkg	(206.0 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o improved stock washing in pulp mill;
- o improved saveall;

- whitewater for vacuum pump sealing; and
- whitewater for machine showers.

Level 2:

- cleaner rejects to landfill.

111 Wastepaper-Tissue

The Wastepaper-Tissue model mill has a raw waste load of 39.2 kl/kkg (9.4 kgal/t) of production, a BOD_5 load of 8.8 kg/kkg (17.5 lb/ton), and a TSS load of 27.0 kg/kkg (54.0 lb/ton). The corresponding raw waste load for the pure industrial tissue mill in this subcategory is: 56.7 kl/kkg (13.6 kgal/t), BOD_5 13.2 kg/kkg (26.3 lb/ton), and 40.5 kg/kkg (81.0 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure	
Flow	33.4 kl/kkg	(8.0 kgal/t)	48.4 kl/kkg	(11.6 kgal/t)
BOD_5	7.5 kg/kkg	(14.9 lb/ton)	11.2 kg/kkg	(22.4 lb/ton)
TSS	23.0 kg/kkg	(46.0 lb/ton)	34.5 kg/kkg	(69.0 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- high level alarms;
- cleaner rejects to landfill;
- improve level of recycle of effluent to process; and
- improve level of recycle of sludge to process.

There are no Level 2 control items suggested for this subcategory.

112 Wastepaper-Board

The Wastepaper-Board model mill has a raw waste load of 15.4 kl/kkg (3.7 kgal/t) of production, a BOD_5 load of 6.5 kg/kkg (12.9 lb/ton), and a TSS load of 7.7 kg/kkg (15.3 lb/ton). The corresponding raw waste load for the pure board mill in this subcategory is: 15.4 kl/kkg (3.7 kgal/t), BOD_5 10.6 kg/kkg (21.2 lb/ton), and 9.9 kg/kkg (19.7 lb/ton) TSS.

The application of Level 1 technology items yields the following modified Level 1 raw waste loads for the model and pure board mills:

	Model		Pure Board	
Flow	8.3 kl/kkg	(2.0 kgal/t)	8.3 kl/kkg	(2.0 kgal/t)
BOD5	2.7 kg/kkg	(5.3 lb/ton)	4.4 kg/kkg	(8.7 lb/ton)
TSS	1.9 kg/kkg	(3.8 lb/ton)	2.5 kg/kkg	(4.9 lb/ton)

	Pure Mill Raw Waste Load					
	Flow		BOD		TSS	
Product	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t
	Pure Mill					
Linerboard	27.9	(6.7)	8.9	(17.8)	10.8	(21.5)
Corrugated	4.2	(1.0)	5.3	(10.7)	4.0	(7.9)
Chip & Filler	10.0	(2.4)	3.5	(6.9)	4.5	(8.9)
Folding Box	16.3	(3.9)	6.1	(12.1)	7.1	(14.1)
Set-Up Box	20.4	(4.9)	7.3	(14.7)	5.7	(11.4)
Gypsum	11.7	(2.8)	5.8	(11.6)	15.9	(31.8)
	Level 1 Raw Waste Load					
Linerboard	15.0	(3.6)	3.7	(7.3)	2.7	(5.3)
Corrugated	2.1	(0.5)	2.2	(4.4)	1.0	(2.0)
Chip & Filler	5.4	(1.3)	1.4	(2.8)	1.1	(2.2)
Folding Box	8.8	(2.1)	2.5	(5.0)	1.8	(3.5)
Set-Up Box	10.8	(2.6)	3.0	(6.0)	1.4	(2.8)
Gypsum	6.3	(1.5)	2.4	(4.8)	6.9	(13.8)

The Level 1 items for this subcategory are tabulated below.

Level 1:

- o improved savealls;
- o increased whitewater usage; and
- o high-level alarms.

There are no Level 2 items suggested for this subcategory.

113 Wastepaper-Molded Products

The Wastepaper-Molded Products model mill has a raw waste load of 47.1 kl/kkg (11.3 kgal/t) of production, a BOD5 load of 5.7 kg/kkg (11.4 lb/ton), and a TSS load of 10.7 kg/kkg (21.3 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is: 52.5 kl/kkg (12.6 kgal/t), BOD5 6.5 kg/kkg (13.0 lb/ton), and 11.4 kg/kkg (22.7 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure	
Flow	37.1 kl/kkg	(8.9 kgal/t)	41.3 kl/kkg	(9.9 kgal/ton)
BOD5	4.3 kg/kkg	(8.6 lb/ton)	4.9 kg/kkg	(9.8 lb/ton)
TSS	5.0 kg/kkg	(10.0 lb/ton)	5.4 kg/kkg	(10.7 lb/ton)

The Level 1 items for this subcategory are tabulated below.

Level 1:

- improved recycle of effluent; and
- lagoon for boiler blowdown water and water treatment plant filter backwash water.

There are no Level 2 production process controls designated for this subcategory.

114 Wastepaper-Construction Products

The Wastepaper-Construction Products model mill has a raw waste load of 9.2 kl/kkg (2.2 kgal/t) of production, a BOD5 load of 5.8 kg/kkg (11.5 lb/ton), and a TSS load of 8.2 kg/kkg (16.3 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is: 14.6 kl/kkg (3.5 kgal/t), BOD5 7.6 kg/kkg (15.2 lb/ton), and 19.4 kg/kkg (38.7 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model		Pure	
Flow	4.2 kl/kkg	(1.0 kgal/t)	6.7 kl/kkg	(1.6 kgal/t)
BOD5	1.0 kg/kkg	(1.9 lb/ton)	1.3 kg/kkg	(2.5 lb/ton)
TSS	0.5 kg/kkg	(1.0 lb/ton)	1.2 kg/kkg	(2.4 lb/ton)

The pure mill with 50 percent waste paper and 50 percent TMP pulp has the following raw waste loads:

	Pure-50% WP and 50% TMP	
Flow	12.5 kl/kkg	(3.0 kgal/t)
BOD	13.9 kg/kkg	(27.8 lb/ton)
TSS	10.2 kg/kkg	(20.4 lb/ton)

The application of Level 1 production process controls results in the following predicted Level 1 raw waste loads for the pure mill using 50 percent waste paper and 50 percent TMP pulp:

Flow	5.8 kl/kkg	(1.4 kgal/t)
BOD	2.3 kg/kkg	(4.6 lb/ton)
TSS	0.7 kg/kkg	(1.3 lb/ton)

The Level 1 items for this subcategory are tabulated below.

Level 1:

- o improved saveall;
- o whitewater showers;
- o high-level alarms; and
- o more effluent recycle.

There are no Level 2 controls designated for this subcategory.

201 Nonintegrated-Fine

The Nonintegrated-Fine model mill has a raw waste load of 48.5 kl/kkg (11.6 kgal/t) of production, a BOD_5 load of 8.5 kg/kkg (17.0 lb/ton), and a TSS load of 30.1 kg/kkg (60.1 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure	
Flow	34.3 kl/kkg	(8.2 kgal/t)
BOD_5	5.5 kg/kkg	(11.0 lb/ton)
TSS	22.9 kg/kkg	(45.8 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model and Pure	
Flow	32.6 kl/kkg	(7.8 kgal/t)
BOD_5	5.5 kg/kkg	(11.0 lb/ton)
TSS	18.7 kg/kkg	(37.3 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o papermill stock spill collection;
- o color plant spill collection;
- o improved savealls;
- o high-pressure machine fresh water showers;
- o whitewater to vacuum pumps and recycle; and
- o segregate cooling waters.

Level II

- o cleaner rejects to landfill; and
- o lagoon for boiler blowdown water and water treatment plant filter backwash water.

202 Nonintegrated-Tissue

The Nonintegrated-Tissue model mill has a raw waste load of 73.4 kl/kkg (17.6 kgal/t) of production, a BOD_5 load of 13.3 kg/kkg (26.5 lb/ton), and a TSS load of 39.0 kg/kkg (77.9 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills.

	Model and Pure	
Flow	36.3 kl/kkg	(8.7 kgal/t)
BOD_5	5.5 kg/kkg	(11.0 lb/ton)
TSS	24.6 kg/kkg	(49.1 lb/ton)

Similarly, the additional application of the Level 2 technology items could produce the following predicted Level 2 raw waste loads:

	Model and Pure	
Flow	34.2 kl/kkg	(8.2 kgal/t)
BOD_5	5.5 kg/kkg	(11.0 lb/ton)
TSS	16.3 kg/kkg	(32.6 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o papermill spill collection system;
- o papermill high-level alarms;
- o papermill improved savealls; and
- o segregate cooling water.

Level 2:

- o cleaner rejects to landfill;
- o fourth-stage centricleaner; and
- o lagoon for boiler blowdown water and water treatment plant filter backwash waters.

204 Nonintegrated-Lightweight

The Nonintegrated-Lightweight model mill has a raw waste load of 266.5 kl/kkg (63.9 kgal/t) of production, a BOD5 load of 15.3 kg/kkg (30.6 lb/ton), and a TSS load of 45.6 kg/kkg (91.2 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same, except for the manufacture of electrical paper which has the following loadings: 407.0 kl/kkg (97.6 kgal/t), BOD5 11.6 kg/kkg (23.1 lb/ton), and 37.7 kg/kkg (75.3 lb/ton) TSS.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure		Pure-Electrical	
Flow	213.6 kl/kkg	(51.2 kgal/t)	326.1 kl/kkg	(78.2 kgal/t)
BOD5	10.3 kg/kkg	(20.7 lb/ton)	2.8 kg/kkg	(5.6 lb/ton)
TSS	28.5 kg/kkg	(56.9 lb/ton)	23.5 kg/kkg	(47.0 lb/ton)

The additional application of the Level 2 technology items produces the following predicted Level 2 raw waste loads:

	Model and Pure		Pure-Electrical	
Flow	209.4 kl/kkg	(50.2 kgal/t)	319.8 kl/kkg	(76.7 kgal/t)
BOD5	10.3 kg/kkg	(20.7 lb/ton)	2.8 kg/kkg	(5.6 lb/ton)
TSS	20.2 kg/kkg	(40.4 lb/ton)	16.7 kg/kkg	(33.4 lb/ton)

The Level 1 and 2 modifications suggested for this subcategory are tabulated below.

Level 1:

- o spill collection;
- o high-level alarms;
- o whitewater for vacuum pumps;
- o high-pressure showers;
- o increase whitewater and broke storage;
- o segregate cooling waters; and
- o recycle effluent.

Level 2:

- o cleaner rejects to landfill;
- o fourth-stage centricleaner; and
- o lagoon for boiler blowdown water and water treatment plant filter backwash waters.

205 Nonintegrated-Filter and Nonwoven

The Nonintegrated-Filter and Nonwoven model mill has a raw waste load of 171.8 kl/kkg (41.2 kgal/t) of production, a BOD_5 load of 5.0 kg/kkg (10.0 lb/ton), and a TSS load of 25.0 kg/kkg (50.0 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same.

The application of Level 1 technology items yields the following modified Level 1 raw waste loads for the model and pure mills:

	Model and Pure	
Flow	125.9 kl/kkg	(30.2 kgal/t)
BOD_5	3.5 kg/kkg	(7.0 lb/ton)
TSS	14.8 kg/kkg	(29.5 lb/ton)

The Level 1 modifications for this subcategory are tabulated below.

Level 1:

- o spill collection;
- o improved saveall;

- o high pressure showers;
- o whitewater showers;
- o segregate cooling water; and
- o improved recycle and use of effluent.

There are no Level 2 production process controls designated for this subcategory.

211 Nonintegrated-Board

The Nonintegrated paperboard model mill has a raw waste load of 102.4 kl/kkg (24.6 kgal/t) of production; a BOD5 loading of 10.0 kg/kkg (20.0 lb/ton), and a TSS loading of 42.3 kg/kkg (84.5 lb/ton). The corresponding raw waste load for the pure mill in this subcategory is the same, except for a higher flow allowance of 247.3 kl/kkg (59.3 kgal/t) for the manufacture for electrical board.

The application of Level 1 technology items yields the following predicted Level 1 raw waste loads for the model and pure mills:

	Model and Pure		Pure-Electrical	
Flow	62.4 kl/kkg	(15.0 kgal/t)	151.0 kl/kkg	(36.2 kgal/t)
BOD5	6.5 kg/kkg	(13.0 lb/ton)	6.5 kg/kkg	(13.0 lb/ton)
TSS	25.8 kg/kkg	(51.5 lb/ton)	25.8 kg/kkg	(51.5 lb/ton)

The Level 1 control items suggested for this subcategory are tabulated below.

Level 1:

- o whitewater to vacuum pumps;
- o whitewater to machine showers;
- o recycle press effluent;
- o segregate cooling water;
- o improve effluent recycle; and
- o add grey stock chest and cooling tower.

There are no Level 2 controls suggested for this subcategory.

OTHER PROCESS CONTROLS

The bleach plant is commonly the largest contributor to water pollution at bleached kraft mills. For this reason, much effort in the past few years has been spent on taking the bleach plant effluent back into the liquor recovery cycle, where the organic constituents can be burned. One process which lends itself to this is oxygen bleaching. The oxygen bleaching theory has existed for a long time, but has just recently begun to come into commercial use. Other processes which return bleach plant effluent to the liquor cycle are the Rapson-Reeve closed-cycle process and Uddeholm-Kamyr non-polluting bleach plant.

Oxygen Bleaching

Oxygen bleaching is currently used at only one mill in the United States, the Chesapeake Corporation in Virginia. Oxygen bleaching is used outside the U.S., at one mill in Canada, one in South Africa, one in France, one in Japan, and three in Sweden.

The advantage of oxygen bleaching comes from the recycling of the alkaline O_2 stage effluent to the black liquor recovery system. In order to recycle the effluent it is necessary to keep the chloride content of the O_2 stage low. For this reason, the O_2 bleach sequences being used generally have the O_2 stage preceding any Cl_2 or ClO_2 stage. The exception to this is the Chesapeake Corporation, which uses a CDO_D sequence and therefore cannot recycle the O_2 stage to the recovery system.

In work done by the NCASI, effluent characteristics from conventional and oxygen bleaching sequences were compared. The conventional sequences CEHDED and CEDED were compared in the lab to those from OCEDED and OCED for both hardwood and softwood kraft pulps. By recycling all of the O_2 stage effluent, a BOD_5 reducton of 81 percent and a color reduction of 89 percent over the conventional sequences were achieved for softwood pulps. For hardwood, reductions of 81 percent of BOD_5 and 92 percent of color were achieved.(84)

The Cellulose d'Aquitaine mill in St. Gaudens, France, has reportedly reduced its total BOD_5 load by about 30 percent and the total color load by 50 percent, by converting from a CEDED sequence to an OCEDED.(95) The claimed operating cost for the new oxygen bleach sequence is $2.10/ton less than the old sequence. The Enstra oxygen bleaching operation in South Africa achieved a cost reduction of $5/ton with an AODED sequence. The capital cost of adding an oxygen stage was given as $2.0 million (1972) for a 272 kkg/day (300 ton/day) mill, and $4.0 million for a 680 kkg/day (750 ton/day) mill.(96)

Caustic Extract Stream Closeup

The caustic extraction stage effluent is the major source of BOD_5 and color in bleached kraft mills. Because of this, much work has been done to develop a method by which most of the organic dissolved solids can be removed from this stream and burned in the recovery boiler. Methods which are being investigated to accomplish this include the use of: adsorption resins; ultrafiltration and reverse osmosis; and freeze concentration. These and other treatment processes are discussed further in Section VII of this report.

The adsorption resin approach is being pursued by three companies: Uddeholm-Kamyr, Rohm and Haas, and Dow Chemical Company. The Rohm and Haas and the Dow Chemical processes are at the pilot plant stage. The Uddeholm-Kamyr color removal process has been in commercial operation in Skoghal, Sweden, since 1973, and is now used on a full scale at a mill in Iwanuma, Japan.

Based on the experience in these full-scale operations with the purification of E1 caustic effluent, the concept has been expanded into purification of the entire effluent from the bleach plant. The first full-scale installation started up in the spring of 1978 at Skoghal, Sweden. In this system a full countercurrent wash is used, and the effluent from the E1 stage is reused on the C stage after two stages of decolorization by resin adsorption.(97)

The pollutants are removed by elution with caustic or oxidized white liquor. The eluate at 10 percent concentration is mixed with the weak black liquor to be evaporated and burned in the recovery boiler. During the activation process the chlorination effluent is simultaneously decolorized. The flow diagram of this process is shown in Figure VI-32.

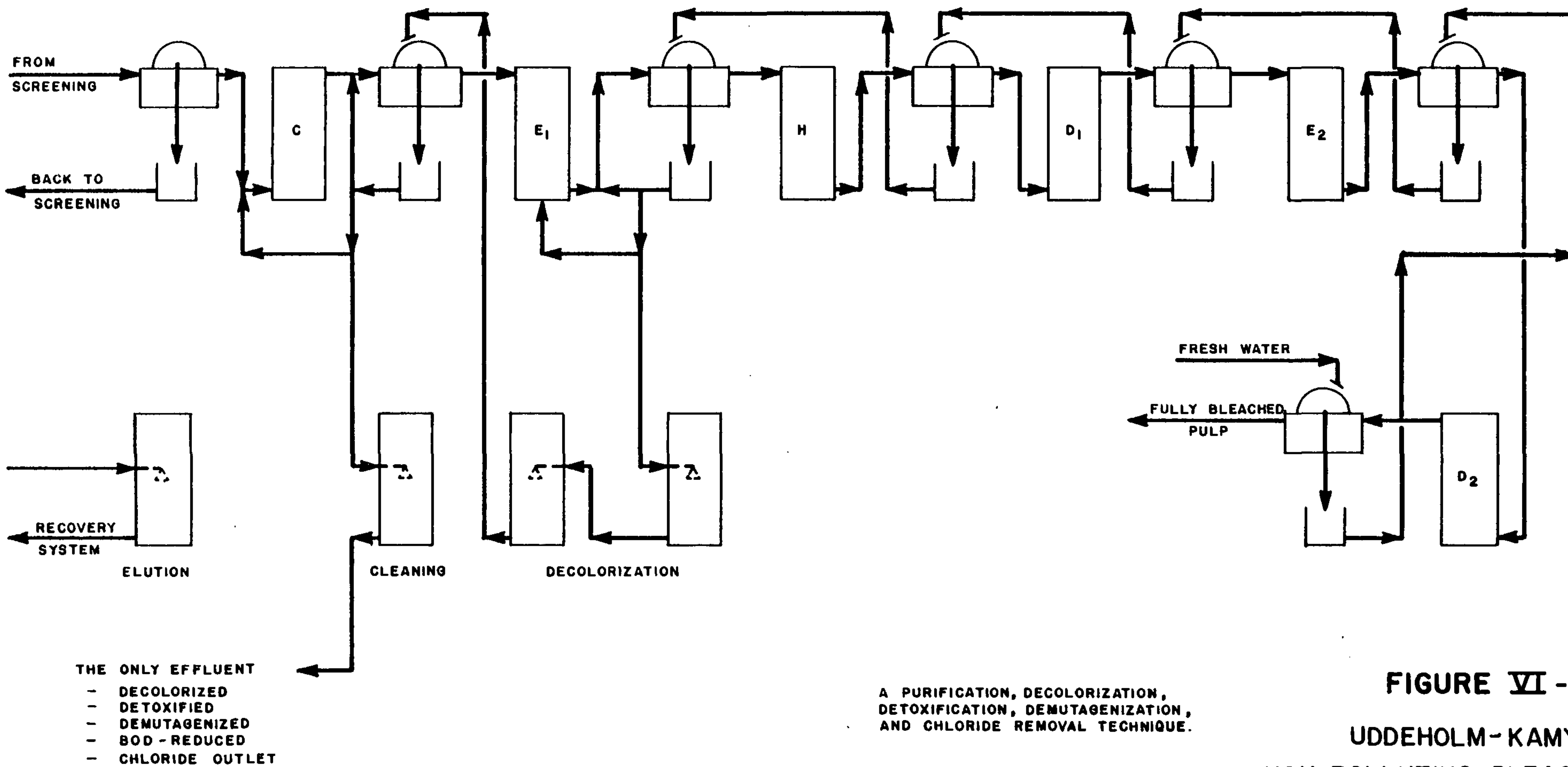
Acid required for activation of the resin is adequately supplied by using chlorination filtrate in the activation stage. The total mill BOD5 load is reduced by 30 percent and the color load by 90 percent.

The operating costs for the Uddeholm-Kamyr system are reported as $1.20 per ton (1977). The investment cost of an installation for treatment of the effluent from a 454 kkg/day (500 ton/day) fully bleach kraft pulp bleach plant is in the range of $3 to $6 million (1977) depending on wood species, kappa number and local conditions.

Rapson-Reeve Closed-Cycle Process

The Rapson-Reeve closed-cycle process for kraft pulp mills encompasses what likely will be the standard design parameters in kraft pulp mills several years from now.(98) The closed-cycle mill concepts, as proposed by ERCO-Envirotech, Ltd. and illustrated in Figure VI-33 are included in the process being developed at Great Lakes Paper Co. Ltd., Thunder Bay, Ontario. Main features of the closed-cycle process include:

- stripping of contaminated condensates for reuse;
- closed screen room;
- use of spill tanks;
- countercurrent washing in bleachery;
- use of 70 percent ($\pm$) chlorine dioxide in first stage;
- recovery of salt from recovery cycle; and



A PURIFICATION, DECOLORIZATION, DETOXIFICATION, DEMUTAGENIZATION, AND CHLORIDE REMOVAL TECHNIQUE.

FIGURE VI - 32

UDDEHOLM-KAMYR

NON-POLLUTING BLEACH PLANT

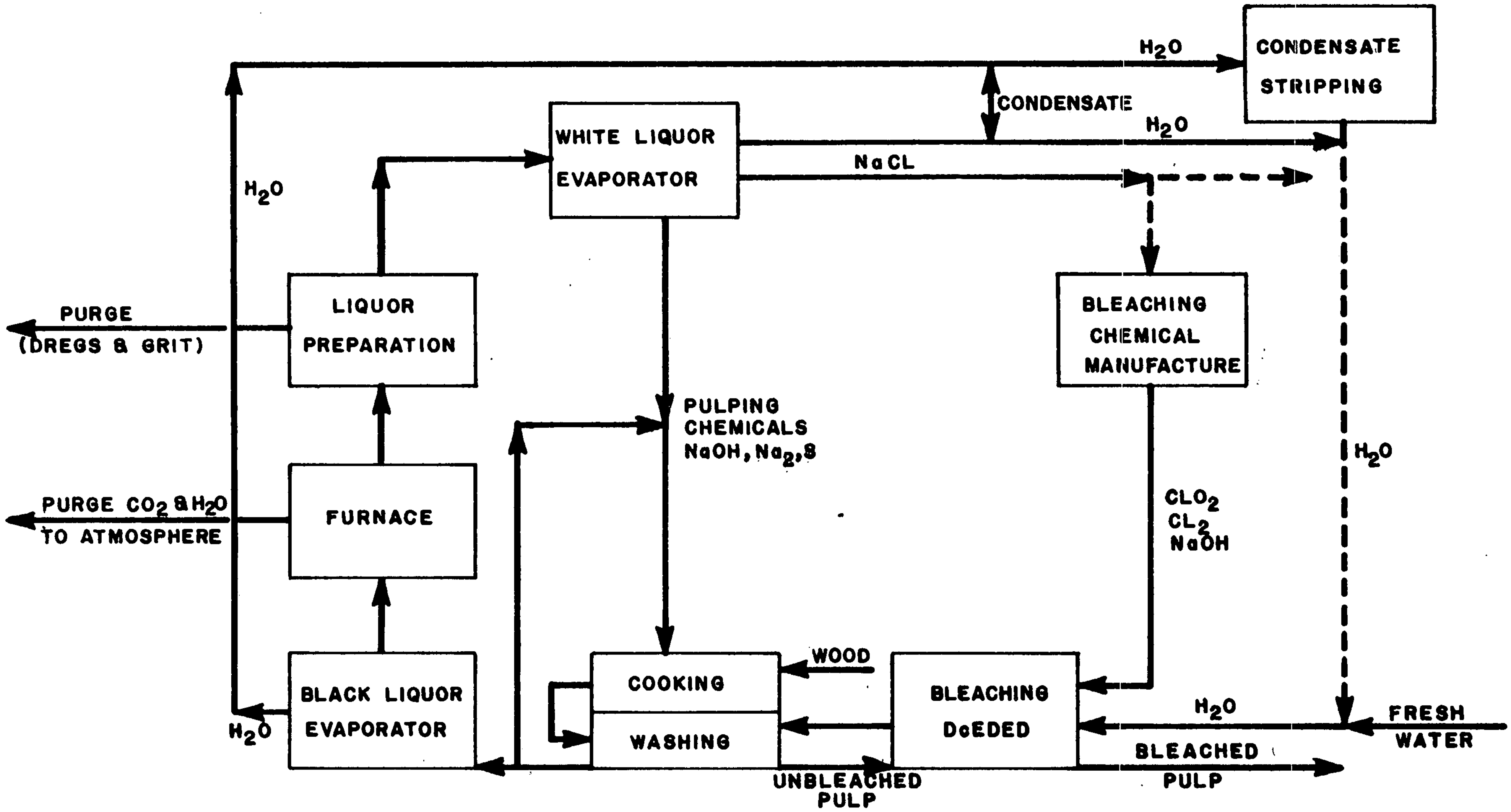


FIGURE VI - 33
RAPSON - REEVE PROCESS
CLOSED CYCLE BLEACHED KRAFT PULP MILL

- reuse of bleach plant filtrate.

Of these features, the only one which is unique to the closed-cycle mill is the salt recovery process. In the closed-cycle mill the white liquor is evaporated and sodium chloride is crystalized and removed from the white liquor. Most of the salt is reused for generation of ClO_2; however, some must be purged from the cycle. Figure VI-34 shows the salt recovery process.

The major benefits of the closed-cycle mill are as follows:

- no contaminated effluent from the kraft pulp mill;
- decreased water consumption;
- energy savings;
- fiber and pulp yield gains;
- decreased chemical costs; and
- return on investment.

Present full-scale operating experience is less favorable than the early literature had generally projected. At Great Lakes Paper some contaminated effluent is reportedly still being discharged from the bleachery. Chlorination stage effluent goes to the kiln scrubber, and some "E" stage filtrate is sewered. The salt recovery system has been operated, but the recovered salt is not used onsite. Corrosion problems have occurred, apparently even in the recovery furnace, and have seriously restricted full implementation of the closed-cycle process.

There are a number of advantages to high chlorine-dioxide substitution in the closed-cycle mill. These include:

- maximum pulp viscosity, strength, brightness, and stability;
- increased yield;
- reduced shives;
- decreased pulp resin content;
- decreased acidity load;
- decreased sodium chloride load; and
- decreased overall bleaching costs.

Even in a mill which is not completely closed, the use of chlorine dioxide will decrease effluent BOD_5, color, chemical oxygen demand (COD), dissolved solids and toxicity.

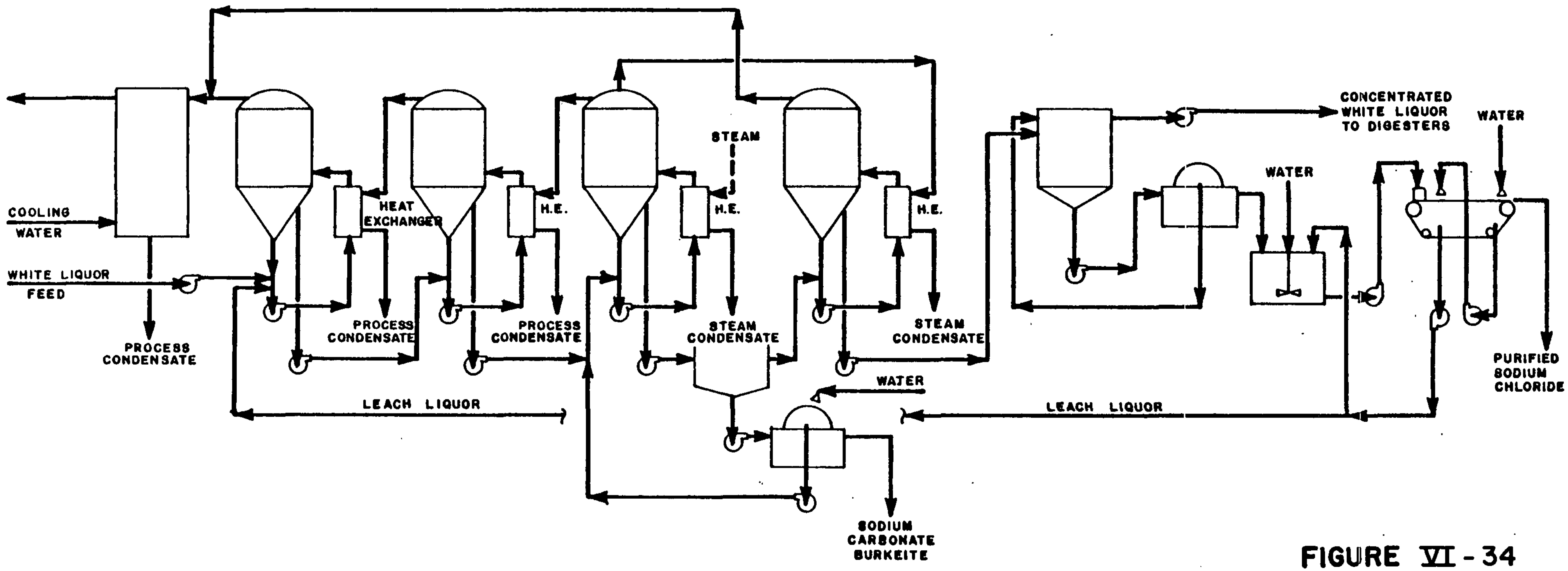


FIGURE VI - 34

RAPSON-REEVE

CLOSED CYCLE MILL

SALT RECOVERY SYSTEM

The disadvantages of high chlorine dioxide substitution for chlorine include increased water input with ClO_2 solution and increased capital investment for generation of ClO_2. If the mill is not completely closed, savings in NaOH applied to the bleach plant, and for waste neutralization, may not offset the cost of using ClO_2 instead of Cl_2. In addition, excess salt cake is produced if HCl is not used. The bleach sequence for the closed-cycle bleached kraft mill is D_CEDED. The washing is straight countercurrent except on the last two stages. The D filtrate is split between the D_1 and the E_2 stages. Excess E filtrate goes to salt recovery process, cooking liquor dilution, and to the brown stock washers. The D_C filtrate goes to brown stock washing, screen room dilution, and to the kiln scrubber.

The first-stage washer shower has a displacement ratio of 0.65 for D filtrate and 0.75 for E filtrate. This results in a total displacement ratio of 1.4. The only fresh water used in the bleach plant is on timed wire cleaning showers on each washer. Some of the E_2 stage filtrate is used for caustic dilution. The diluted caustic is used for extraction, as a buffer, and for anti-chlor and pH control.

The salt recovery process (SRP) is necessary in the closed-cycle mill in order to remove the sodium chloride which would otherwise build up in the system. The major sources of sodium chloride contamination are as follows:

Sources of Sodium Chloride	Range kg/kkg	(lb/t)
Salt Water Borne Logs	1 - 28	2 - 55
"Brackish" process water	2.5 - 25	5 - 50
Saltcake	.05- 7.5	.1 - 1.5
Other makeup	.05- 7.5	.1 - 15
NaOH Filtrate reuse	.1 - 10	.2 - 20
Dioxide "Spent Liquor"	.05- .25	.1 - .5
Bleachery Filtrate Recycle	10 -175	10 - 175

The sodium chloride contribution from the kraft bleach plant varies drastically with the sequence used.

Sequence	Sodium Chloride Contribution kg/kkg	(lb/t)
C E D E D	115	(230)
C_D E D E D	97.5	(195)
D_C E D E D	60	(120)

In the SRP system the white liquor is evaporated to a high concentration of sodium hydroxide and sodium sulfide. This crystalizes the sodium chloride, sodium carbonate and sodium sulfate. The sodium chloride is separated and purified and then may be used for ClO_2 generation. The sodium carbonate and sodium sulfate leave the SRP sytem as concentrated white liquor. The SRP system is a two-stage system which yields Na_2CO_3 and Na_2SO_4 from stage one, then NaCl from stage two.

The following constraints must be considered in the design of such a closed-cycle mill:

- o dry barking or closed water system;
- o brown stock washer capability for minimum soda loss;
- o closed screen room;
- o corrosion resistant construction of first bleaching stage washers;
- o bleached washer capability for displacement ratio of 3:0;
- o seal tanks sized for adequate accumulation;
- o extra evaporator capacity to handle spills;
- o condensate steam stripper;
- o salt recovery capabilities; and
- o extra recovery capability for more organics.

The following is a list of acceptable materials of construction for the closed-cycle pulp mill:

Digesters:	Carbon steel, 304 Stainless Steel (SS), 316 SS
Washers:	Carbon steel, 304 SS, 316 SS
Evaporators:	Carbon steel, 304 SS, 316 SS
Screens:	304 SS, 316 SS, 317 SS
D Stages:	Ti (titanium), FRP, (Fiberglass Reinforced Polyester) Hastelloy C-276
E Stages:	High Moly Alloys or 317 SS
Seal Tanks:	FRP
Pumps:	High Moly Alloys, 317 SS, 316 SS
Mixers:	Ti, FRP, 316 SS, 304 SS
Pipes:	High Moly, FRP, 316 SS, 304 SS

Recent experiences have indicated that with high recycled salt levels, even 317 SS may be marginal. Also, a critical part of a closed cycle, or any minimal liquor loss pulping operation, is adequate storage to avoid accidental discharge of liquids.

According to a Swedish study (72) 50 percent of chemical, fiber and liquid volume losses are due to accidental discharge. The capacity of spill tanks at Great Lakes is: fiber spills 454,000 l (120,000 gal.); acid bleach filtrate - 681,000 l (180,000 gal.); alkaline bleach filtrate - 870,550 l (230,000 gal.); and causticizing spills - 1,022,000 l (270,000 gal.).

According to ERCO-Envirotech, for a closed-cycle kraft mill a 635 kkg/day (700 air dry tons (ADT) per day), an SRP system would have a capital cost of $4.2 million. Implementation of internal controls could run as high as $3.8 million. Additional controls required for a closed-cycle mill are: dry barking or a closed wet barking system; closed screen room; countercurrent washing in bleachery; condensate steam stripping; reuse of bleach plant filtrate, and spill tanks. This makes the total added cost for a closed-cycle mill $8 million or more. The additional ClO_2 generating capacity, and any major bleachery modifications requiring more corrosion resistant materials, will result in yet higher costs.

ERCO-Envirotech have stated that the closed-cycle mill would result in the following operating cost savings: 1.) heat savings from decreased steam consumption and increased steam production; 2.) fiber savings; 3.) yield increase; 4.) water savings; and 5.) savings in effluent treatment costs. It was originally thought that chemical costs would be lower for a closed-cycle mill than for a conventional mill. However, actual chemical costs at Great Lakes Paper Co., Ltd. have been higher than those for a conventional mill.

Present savings at Great Lakes are about $1 million. The original estimate was for $4 million in savings; however, this is somewhat deceiving because the comparison was made with a mill having none of the internal controls mentioned previously. Most mills, however, use many of the mentioned controls to some extent, with the exception of condensate steam stripping. Therefore, it is probably safe to assume that a mill with good internal controls could realize most of the cost savings that ERCO-Envirotech has attributed to their closed-cycle mill.

Sequential Chlorination

Another method of reducing the pollution load from the bleach plant is with sequential chlorination.

MacMillian Bloedel Research views the sequential chlorination sequences as an interim solution while technology develops on oxygen bleaching, ClO_2 generation and salt recovery. When these technologies are fully developed, they might be incorporated with lower capital expenditures.

Hooker Chemical has done much work on sequential chlorination. Their work has been exclusively on modification of fully bleached sequences. The first sequential chlorination system studied by Hooker Chemical was the APS-I. In this system the standard CEHD or CEDED is modified by replacing the conventional chlorination with sequential chlorination at a D:C ratio of 50:50. Hypochlorination is substituted for the first extraction stage. The system can be used for hardwood or softwood pulps. Substantial reductions in effluent color and toxicity, and moderate reductions in BOD_5 were reported.(99)

Chemical costs for the APS-I system were equivalent or slightly higher than those for the conventional sequence. Estimated capital costs range from $20,000 to $500,000 (1973 costs), depending on the mill size and condition of the existing bleach plant. Pulp quality is equivalent to that from the control sequences.

The Hooker APS-II and III systems operate differently than the APS-I. Chlorination is replaced by sequential chlorination, at a high D:C ratio (75:25), followed by caustic extraction. This minimizes the chloride content of the bleach plant effluent and permits recycling of the effluent into the kraft recovery system, which results in incineration of the major organic waste load. The APS-II and III systems suggest a sequence of antipollution steps which may be implemented one at a time. These steps and the BOD_5 and color reductions obtained by each step are shown in Table VI-4. This process is reported to use existing or slightly modified bleach plant equipment and produces pulp with properties equivalent or superior to the conventional processes. Hooker also claims reduced chemical and operating costs. The process recovers caustic, sodium sulfate, and sodium chloride which would normally be sewered.

No-Sulfur Pulping

In the past two years many semi-chemical corrugating medium mills have changed their pulping processes from neutral sulfite semi-chemical (NSSC) and green liquor processes to non-sulfur pulping. A survey conducted in early 1978 by *Pulp and Paper* magazine showed that 10 of the 41 semi-chemical mills in the U.S.A. and Canada had changed to non-sulfur processes and another four mills were considering the change.(100)

The main reasons for changing to non-sulfur pulping included: the poor market for the salt cake byproduct; the high chemical costs of sodium carbonate and sulfur for NSSC; and the sulfur emissions problems associated with the NSSC process. Responses to the survey indicates that the non-sulfur mills generally have somewhat lower raw waste loads, as well.

There are basically three non-sulfur processes: 1.) the Owens-Illinois process; 2.) the soda ash process; and 3.) the modified soda ash process. Owens-Illinois was the first to develop a no-sulfur process in 1972. Their process uses 15-50 percent caustic as Na_2O. The remainder is soda ash. Spent liquor is burned in a modified kraft-type furnace or fluidized bed.

In the soda ash process, soda ash is used at 6 to 8 percent on wood. Spent liquor is burned in a fluidized bed, and the soda ash is recovered.

The modified soda ash process uses a small amount of caustic along with the soda ash, typically 7-8 percent NaOH (as Na_2O).

Displacement Bleaching

There are presently only two mills in the country which use a displacement bleaching process. The first was at the EasTex mill in Evadale, Texas, which started up in 1975.(101) This was followed by the start of a system at Weyerhaeuser Corporation in Plymouth, North Carolina, in 1976. Both systems are Kamyr designs, with conventional D/C first stage tower and washer preceding an EDEDW displacement tower. The caustic is applied at the repulper of the conventional washer. The pulp is then pumped into the bottom of the displace-

TABLE VI-4

WASTE LOAD REDUCTIONS FROM IMPLEMENTATION OF
HOOKER APS II AND APS III SYSTEMS

tep No., Operation	Effluent kgal/ton	BOD_5 lbs/ton	% BOD_5 Reduction	Color lbs/ton	% Color Reduction
ontrol standard	18 - 20	25	-	650	-
PS-II					
. Countercurrent wash-jump slate, split flow	11 - 13	25	-	650	-
. Replace chlorination with sequential chlorination - 75:25 D:C ratio	11 - 13	22	12	376	42
. Recycle D/C effluent to dilute incoming brown stock	6 - 8	22	12	376	42
. Dilute sequential chlorination stock with part E_1 and recycle remainder to recovery via brown stock washers and smelt dis-solving system	4 - 6	10	60	87	87
. Use salt separation process to purge NaCl and separate Na_2SO_4 from precipitator catch	4 - 6	10	60	87	87
PS-III					
. Treat D/C effluent in a resin packed column and regenerate resin with a portion of E_1 effluent.	4 - 6	9	64	23	96

ment tower at about 10 percent consistency. The displacement tower has a retention time of about 90 minutes. Each stage in the tower has a retention time of about 90 minutes. Each stage in the tower is followed by a stage of diffusion washing with the filtrate being extracted to a seal tank and then partially reused.

There are four filtrate tanks for the displacement towers. These tanks are of a stacked design with one set of tanks for the caustic extraction and one set for the chlorine dioxide. Some caustic extract is generally reused back on the conventional washer as well as being mixed with the NaOH for the displacement tower. Some dioxide filtrate is also mixed with ClO_2 to be reused on the D_1 and D_2 stages. Overflows from the seal tanks are sewered. Water use for a D/CEDED displacement bleach sequence is typically 3.0 to 4.5 kgal/t compared to a conventional tower washer system often exceeding 12 kgal/t.

The benefits are primarily the lower water use and slightly lower initial capital costs. Based on limited data, it appears that chemical usage may be higher than that for conventional bleaching systems.

SECTION VII

EFFLUENT TREATMENT TECHNOLOGIES

REVIEW OF SELECTED EFFLUENT TREATMENT TECHNOLOGIES

Introduction

The pulp, paper and paperboard industry employs many types of wastewater treatment systems to reduce the levels of pollutants contained in mill effluents. This section describes and evaluates the performance of existing treatment systems employed within each subcategory of the industry. Also presented in this section is a discussion and evaluation of other applicable effluent treatment technologies.

Preliminary/Primary Treatment

Wastewater must often be screened to remove materials that could seriously damage or clog downstream treatment equipment. Automatically cleaned screens are commonly employed prior to primary treatment.

The primary treatment process of removing suspended organic and inorganic materials can be accomplished by sedimentation (with or without flocculants or coagulants), flotation, or filtration. Sedimentation can involve mechanical clarifiers, flotation units, or sedimentation lagoons.

The most widely applied technology for removing suspended solids from pulp, paper, and paperboard mill wastewaters is the mechanical clarifier. Circular tanks of concrete construction are normally used with rotating sludge scraper mechanisms mounted in the center. The wastewater effluent usually enters the tank through a well that is located on a center pier. Settled solids are raked to a center sump or concentric hopper. The solids are generally conveyed to solids dewatering facilities prior to disposal. Floating material is collected by a surface skimmer attached to the rotating mechanism, discharged to a hopper and is then disposed of.

Dissolved air flotation (DAF) units have also been applied to effluents from papermills and have in some cases effectively removed suspended solids.(102) DAF units are somewhat limited because of their inability to handle high pollutant concentrations and shock loads.

Fine screens, microstrainers, and pressure filters are not commonly used in the industry for suspended solids removal. Adequate fine screening systems cost approximately the same as an equivalent clarifier and reportedly have more inherent operating problems.(103)

Because of the biodegradable nature of a portion of the settleable solids present in pulp, paper and paperboard wastewaters, clarification results in some BOD5 reduction. Typical BOD5 removals through primary clarification in integrated pulp and paper mills varies between 10 and 30 percent. The exact BOD5 removal depends on the relative amount of soluble BOD5 present in the raw wastewater. Primary clarification can result in significantly higher BOD5 reductions at nonintegrated mills than at integrated mills. Responses to the data request program indicate that roughly 50 percent of the raw wastewater BOD5 is commonly removed at nonintegrated mills through primary clarification.

Easty(58) has recently observed that very little reduction of fatty acids, resin acids or their chlorinated derivatives occurs during primary clarification. This observation suggests that these compounds are not associated with the suspended solids content of the wastewater. Polychlorinated biphenyls (PCB's) have been observed to undergo significant reductions through primary treatment.(12) At a waste paper tissue mill, PCB's were reduced from 25 to 2.2 micrograms per litre (ug/l) through primary clarification, while TSS was reduced from 2,020 to 77 milligrams per litre (mg/l).(12) It has not yet been established whether reductions occur for other chloro-organic compounds; this phenomenon is undergoing further study as part of future data evaluation efforts.

Biological Treatment

Introduction. Currently, the most common types of biological treatment used in the pulp, paper and paperboard industry include oxidation basins, aerated stabilization basins, and the activated sludge process or its modifications. Other biological systems include oxygen activated sludge, the Zurn/Attisholz process, rotating biological contactors and anaerobic contact filters.

A principal benefit obtained from biological treatment is the reduction of oxygen-consuming pollutants which can cause depletion of dissolved oxygen in receiving waters. Fish and other aquatic organisms are particularly sensitive to reduced levels of dissolved oxygen. Significant reductions in toxic pollutants have also been observed through application of biological treatment as illustrated by recent data gathering efforts (see Section V). When adequately designed and operated, biological treatment consistently achieves 80 to 90 percent and higher BOD5 reductions when applied to pulp and paper mill effluents. Biological treatment can also yield a nontoxic effluent a high percentage of the time.(104)

Due to the variance of influent wastewater characteristics, specific pollutant removal capabilities are not readily obtainable unless long-term field sampling is employed. In a laboratory study, Leach, Mueller, and Thakore determined the specific biodegradabilities of six toxic pollutants in pulp and papermill wastewater.(105) The relative ease with which these six compounds were degraded was, in descending order: dehydroabietic acid; pimaric acid; tetrachloroguiacol; monochlorodehydroabietic acid; dichlorodehydroabietic acid; and trichloroguaiacol. The researchers reported that chlorinated bleach plant derivatives are more difficult to degrade than are nonchlorinated wood derivatives.

A recent study investigated influent and effluent concentrations of nonconventional and toxic pollutants after full-scale biological treatment.(59) Removal rates of these pollutants, as derived from the published design and treatment data, are shown in Table VII-1. The relative removal rates generally agree with those obtained in laboratory studies.(105)

BOD_5 and toxic pollutant removals from bleached kraft wastewater through application of activated sludge treatment and aerated stabilization were investigated in an attempt to establish a relation between pollutant concentration and toxicity.(104) The authors concluded that, in general, a reduction in BOD_5 to about 45 mg/l was sufficient to achieve detoxification. Also, a total resin and fatty acid concentration of less than 1 mg/l was necessary to effect detoxification. The correlation between total resin and fatty acid content and toxicity was better than the correlation between BOD_5 and toxicity.

Impact of Temperature Variations. All biological treatment systems are affected by temperature, particularly by large and/or sudden temperature changes. The effect of temperature variations on aerobic biological systems has been demonstrated in both theory and practice; therefore, temperature is of importance in the choice of design and operation of treatment systems. Pelczar and Reid (106) have stated that all processes of growth are dependent on chemical reactions and the rates of these reactions are influenced by environmental conditions, including temperature. The discussion below presents theoretical and operating data on temperature variations and their effects. Included is an evaluation of the effect of temperature on biological treatment system as measured by BOD_5 and TSS removals.

BOD_5 is a measurement of the dissolved oxygen used by microorganisms for the biochemical oxidation of organic matter in a wastewater. BOD_5 removal occurs in two stages: a first stage in which the carbonaceous (organic) matter is oxidized and a second stage in which nitrification occurs. The oxidation of the carbonaceous matter results from the biological activity of bacteria and other organisms in the wastewater. For a stated set of environmental conditions, growth of microorganisms will follow a predictable and reproducible pattern closely allied to the amount of BOD_5 present in a wastewater and its rate of utilization by the microorganisms present.(107)

The heterogeneous population of bacteria found in aerobic biological systems treating wastewaters at temperatures such as those resulting from the production of pulp and paper encompass three classified groupings of bacteria: psychrophilic, mesophilic, and thermophilic organisms.

Seasonal wastewater temperature variations change the specific growth rate of the heterogeneous population, and to a lesser extent, the relative distribution of the types of bacteria comprising the population. McKinney (108) has depicted the rate of growth for mesophilic organisms with the maximum rate occurring in the range of 35° to 40°C. Similar growth rate-temperature distributions exist for both psychrophilic and thermophilic organisms, with the optimal growth rate occurring in the range of 10° to 15°C for psychrophiles,

TABLE VII-1

CALCULATED TOXIC AND NONCONVENTIONAL POLLUTANT REMOVAL RATES(a)(59)

	Mill 9(b) 10-Day ASB	Mill 11(b) 6-Day ASB	Mill 12(c) 3.5-Hr AS	Mill 13(b) 12-Day ASB	Mill 14(b) 7-Day ASB	Mill 15(b) 15-Day ASB
Resin Acids						
Abietic	0.85	0.86	0.3	1.5	1.0	0.45
Dehydroabietic	1.05	2.65	0.6	1.85	1.1	0.72
Isopimaric	0.30	0.37	0.26	1.25	3.0	0.12
Pimaric	0.10	0.14	0.3	0.3	0.1	0.15
Unsaturated Fatty Acids						
Oleic		0.7	0.35	0.55		0.67
Linoleic		2.6	0.30	0.15		0.47
Linolenic		0.4				
Other Acidics						
Epoxysteric Acid						0.03
Dichlorosteric Acid				10.4		0.12
Chlorinated Resin Acids						
Monochlorodehydroabietic		0.10	0.006	0.03		0.01
Dichlorodehydroabietic		0.05	0.019	0.10		0.03
Chlorinated Phenolics						
Trichloroguaiacol		0.03				
Tetrachloroguaiacol		0.02				
Chloroform		2.2	2.1			

(a) Removal rates shown as micrograms removed per milligrams/litre (mg/l) of biomass per day.
(b) Aerated stabilization basin (ASB) biomass assumed to be 200 mg/l.
(c) Activated sludge (AS) biomass reported to be 2,500 mg/l.
NOTE: Blank spaces indicate no data.

and 60° to 65°C for thermophiles.(109) However, the predominant group found at all normal operating temperatures in aerobic systems are the mesophiles.(110)

A number of studies have been conducted to quantify various aspects of microbial growth, temperature, and BOD5 reduction. Degradation of BOD5 in pulp and paper wastewater has been evaluated and found to proceed at rates similar to other wastewater sources.(111, 112, 113, 114, 115, 116, 117, 118)

Soluble BOD5 removal by microorganisms approximates first-order kinetics.(110) A temperature decrease of 10°C from the optimal temperature would necessitate an increase in detention or reaction time of approximately 35 percent to attain the same effluent BOD5 level as that attained at the optimal temperature. Conversely, an increase in temperature of 10°C would theoretically shorten the detention time by 25 percent to attain the same effluent BOD5 level.

The above concept is of substantial practical importance in treatment system design, since flexiblity in design allows treatment systems to sustain efficient operation over a wide range of conditions (i.e., increasing microbial (solids) recirculation rates will increase waste/microbe contact time when microbial activity is reduced in colder temperatures). Additional studies relate the specific effects of changes in temperature on BOD5 and suspended solids removal to performance for specific systems.(119)

Oxidation Basins. The first type of biological treatment systems used in the pulp, paper and paperboard industry were oxidation basins. These are large natural or manmade basins of various depths; natural aeration from the atmosphere is relied on as an oxygen source. Since oxidation through natural aeration results in a relatively low-rate process, large land areas are required to implement this technology. Because of availability of land and a warm climate that increases bioactivity, most oxidation basins are found in southern states. This technology can be more effective if settleable solids are removed from the wastewater before it enters the basins, since solids can contribute to the BOD5 wastewater loads and an excess of settleable solids would tend to rapidly fill the basins.

Typical design BOD5 loads range from 56 to 67 kilograms per hectare (kg/ha) of surface area/day (50 to 60 lb/acre/day).(37) Retention times can vary from 20 to over 60 days.(37) This method of treatment has two principal advantages: 1) it can be capable of handling (buffering) accidental discharges of strong wastewater without significant upset; and 2) it requires no mechanical devices with inherent maintenance problems. Thus, oxidation basins are capable of good performance on a continuous basis. Generally, suspended solids are effectively removed in oxidation basins. Literature presenting data on the removal of toxic and nonconventional pollutants through application of oxidation basin technology is limited.

Aerated Stabilization Basins (ASB). The aerated stabilization basin (ASB) evolved from the necessity of increasing performance of existing oxidation basins due to increasing effluent flows and/or more stringent water quality standards. Induced aeration provides a greater supply of oxygen, thus substantially reducing the retention time required to achieve treatment comparable to that attained in an oxidation basin. Nitrogen and phosphorus (nutrients) are usually added prior to the ASB if the wastewater is determined to be nutrient deficient. These additions are commonly made in the form of ammonia and phosphoric acid. The longer the retention period of the waste undergoing biological oxidation, the lower the nutrient requirement. The specific detention time used depends upon the characteristics of the wastewaters to be treated. Retention times of 8 to 10 days, and sometimes up to 15 days, have been used in order to obtain BOD_5 levels of less than 30 mg/l.(120, 121, 122)

Aeration is normally accomplished using either gear-driven turbine type surface aerators or direct-drive axial flow-pump aerators. Diffused air can also be employed. Oxygen transfer efficiencies under actual operating conditions range from 0.61 to 1.52 kilograms (kg) of oxygen per kilowatt-hour (kWh), or about (1.0 to 2.5 lb of oxygen per horsepower-hour) depending on the type of equipment used, the amount of aeration power per unit lagoon volume, basin configuration, and the biological characteristics of the system.(123, 124) It is necessary to maintain a dissolved oxygen (DO) level of 0.2 to 0.5 mg/l in the basin to sustain aerobic conditions.

BOD_5 and suspended solids levels, oxygen uptake, and DO levels throughout the basins are related to aerator location and performance and basin configuration. There have been extensive studies (125) of eleven existing aerated stabilization basins that have subsequently been used in the design of other ASB's.

Some solids accumulate in the bottom of ASB's, but these are relatively inert and can be removed with periodic dredging. Solids accumulation diminishes as the detention time and degree of mixing within the basin increases. At some mills a settling basin or clarifier is used to improve effluent clarity.

The removal efficiency of an ASB treating unbleached kraft waste was evaluated over a 1-month period in late 1976.(126) Although the raw wastewater exhibited an LC-50 of from 1 to 2 percent by volume, all but one of the 26 treated effluent samples were either nontoxic or exhibited greater than 50 percent fish survival after 96 hours of exposure. The one failure was attributed to a black liquor spill at the mill. Average reductions of 87 percent BOD_5, 90 percent toxicity and 96 percent total resin acids were achieved. Dehydroabietic acid was the only resin acid identified in the treated effluent; pimaric, isopimaric and abietic acids tended to concentrate in the foam.

Pilot-scale ASB treatment of bleached kraft wastewater was evaluated over a 5-month period.(104) Two basins, one with a 5-day and one with a 3-day hydraulic detention time, were studied with and without surge equalization. The raw wastewater BOD_5 varied from 108 mg/l to 509 mg/l and was consistently toxic. The median survival times (MST) of fish ranged from 7 to 1,440 minutes, while total resin and fatty acid concentrations ranged from 2 to 8 mg/l.(104) Mean BOD5 removals with surge equalization were 85 percent for the 5-day basin and 77 percent for the 3-day basin. Mean effluent BOD5 levels with surge equalization were 40 mg/l for the 5-day basin and 59 mg/l for the 3-day basin. Detoxification was attained 98 percent of the time by the 5-day basin with surge equalization, and 85 percent of the time by the 3-day basin with surge equalization. Mean reported effluent BOD5 values for the 5-day and 3-day basins without equalization were 51 mg/l and 67 mg/l, respectively. The detoxification rate without equalization dropped to 73 percent for the 5-day basin and 70 percent for the 3-day basin. The authors concluded that surge equalization appeared to have a more significant effect on detoxification than BOD5 removal.

Since the surge capacity of an aerated stabilization basin is related to hydraulic detention time, the 6-to 10-day basins which are commonly employed in the pulp, paper, and paperboard industry in the United States should have a higher capacity for shock loading than those used in this study.

Aerated stabilization basins provide a high degree of BOD5 reduction and also can remove or reduce the wastewater toxicity. ASB capital and operating cost may be lower than those for the activated sludge process. The treatment efficiency is not as dependent on ambient air temperature as with oxidation basins; however, efficiency can be more dependent on ambient air temperature for ASB's than for higher rate processes (i.e., activated sludge).

Activated Sludge Process. The activated sludge process is a high-rate biological wastewater treatment system. The biological mass grown in the aeration tanks is settled in a secondary clarifier and returned to the aeration tanks, building up a large concentration of active biological material. There can be 3,000 to 4,000 mg/l of active sludge mass in the aeration basin section associated with an activated sludge system as opposed to the 50 to 200 mg/l common to aerated stabilization basins. Loadings in excess of 45.4 kilograms of BOD5 per 35.3 litres (100 lbs of BOD5 per 1,000 ft3) of aeration capacity per day are sometimes used, allowing for relatively small aeration tanks.

Since biological organisms are in continuous circulation throughout the system, complete mixing and suspension of solids in the aeration basin are required. Mechanical surface aerators similar to those used in aerated stabilization basins are normally used; diffused air can also be used.

The characteristically short detention times tend to make the activated sludge process more susceptible to upset due to shock loads. When the process is disrupted, it may require several days for biological activity to return to normal. Particular operator attention is required to avoid such shock loadings at mills utilizing this process. This effect can be avoided through provision of sufficient equalization to minimize the effects of shock loadings.

Compared with aerated stabilization basins, the activated sludge process has less shock load tolerance, greater solids handling problems, and higher costs.

However, the activated sludge process requires less land than ASB's. Thus it may be preferred in cases where sufficient land for ASB installation is either unavailable or too expensive.

The contact stabilization process is a variation of the activated sludge process in which two aeration steps are used rather than one. The incoming wastewater is contacted for a short period with active organisms prior to sedimentation. Settled solids are then aerated for a longer period to complete waste assimilation. Contact stabilization has been applied successfully to treat kraft mill effluent.

The ability of activated sludge basins to detoxify bleached kraft mill effluents was analyzed over a 5-month period.(104) Two pilot-scale activated sludge systems (8-hr and 24-hr detention) were operated with and without surge equalization. Raw wastewater BOD_5 varied from 108 to 509 mg/l. The raw wastewater was consistently toxic. Reported raw wastewater median survival times (MST) to fish ranged from 7 to 1,440 minutes. Total resin and fatty acid concentrations in the raw wastewater ranged from 2 to 8 mg/l. Mean BOD_5 removals for the 8-hr and 24-hr activated sludge lagoon with a 12-hr surge equalization basin achieved an average of 76 percent and 72 percent BOD_5 removal, respectively. Effluent BOD_5 concentration for the 24-hr system ranged from 5 mg/l to 263 mg/l, with a mean of 64 mg/l. The 24-hr system detoxified the effluent 76 percent of the time.

The 8-hr activated sludge system removed an average of 72 percent of the BOD_5. Final effluent BOD_5 concentrations ranged from 14 to 270 mg/l with a mean of 64 mg/l. The effluent was detoxified 72 percent of the time.(104) The 24-hr activated sludge system, when operated without equalization, was subjected to more vigorous mixing plus addition of 10 mg/l alum. Under these conditions, an average of 90 percent BOD_5 removal was obtained and detoxification was achieved 100 percent of the time. The 8-hr activated sludge system, when operated without surge equalization, was also subjected to more vigorous mixing with no addition of alum. Under these conditions, an average of 84 percent BOD_5 removal was obtained, although detoxification was attained only 55 percent of the time.(104) The authors concluded that equalization did not affect BOD_5 removal efficiency, but improved the detoxification efficiency by 15 to 30 percent. Addition of alum to the activated sludge system appeared to reduce toxicity. The authors speculated that the mechanism of toxicity removal was a chemical reaction.(104) Failures to detoxify were attributed in some instances to hydraulic shocks, black liquor spills or inadequate treatment system operation, although in many instances, no cause could be determined.(104)

Pure Oxygen Activated Sludge System. The pure oxygen activated sludge process uses oxygen, rather than air, to stimulate biological activity. This scheme allows for a lesser detention time and lower aeration power requirement than activated sludge; however, additional power is required for oxygen generation which may result in a net increased power requirement. Solids volumes that must be dewatered and disposed of are similar to those produced by air activated sludge systems.

Field test data by Union Carbide Corp. confirms that the oxygen activated sludge process is capable of achieving final effluent BOD5 concentrations on the order of 20 to 30 mg/l with pulp, paper, and paperboard mill wastes.(127) Effluent TSS after clarification was generally in the range of 40 to 60 mg/l.(127) A summary of pilot scale information is presented in Table VII-2.

TABLE VII-2

OXYGEN ACTIVATED SLUDGE TREATABILITY
PILOT SCALE

Production Process	Retention (Hrs)	BOD5 (mg/l) Influent	BOD5 (mg/l) Effluent	TSS (mg/l) Influent	TSS (mg/l) Effluent
Alkaline-Unbleached	1.3 - 2.2	277 - 464	20 - 41	57 - 86	46 - 61
Alkaline-Unbleached	1.8 - 3.0	214 - 214	16 - 22	123 - 123	36 - 36
Alkaline-Unbleached	2.0 - 2.9	265 - 300	25 - 30	95 - 120	60 - 70

Sulfite/newsprint effluent was treated using an oxygen activated sludge pilot plant facility over an 11-month period. BOD5 reductions during this time were over 90 percent.(128) Final BOD5 and TSS concentrations ranged from 23 to 42 mg/l and 61 to 111 mg/l, respectively.(30) The effluent from the oxygen activated sludge system was found to be acutely toxic.(128) Total resin acids before and after oxygen activated sludge treatment were 25 and 6 mg/l, respectively.(128) Ammonia was found at levels on the order of 50 mg/l. The treated effluent was air stripped to determine if ammonia was the major cause of the high toxicity. Although air stripping reduced the ammonia concentration to less than 1 mg/l and the total resin acid concentration to 1 mg/l, the effluent remained acutely toxic.

Easty (59) studied two examples of pure oxygen activated sludge systems: one treating an integrated bleached kraft wastewater and the other treating an unbleached kraft pulp mill wastewater. Both significantly reduced all identified pollutants. The pollutants evaluated included resin and fatty acids, their chlorinated derivatives, and chloroform. The first system incorporated an oxygen activated sludge basin with hydraulic detention of 3 hours and 10 minutes and a sludge recycle rate of 35 percent. The pH was maintained between 6.2 and 7.5. It was determined from Easty's data that 43 to 92 percent of identified toxic pollutants were removed, with the chlorinated resin acids exhibiting relatively low removal efficiencies. This is consistent with observed biodegradabilities of the nonconventional pollutants.(109)

The second oxygen activated sludge system operated with a detention time of 3.7 hours and a mixed liquor suspended solid (MLSS) concentration of 2,500 mg/l.(59) Bench-scale alum/polyelectrolyte coagulation followed. The effluent was adjusted to pH 5 with alum and 1 mg/l polyelectrolyte was added. Essentially complete removal of all identified resin and fatty acids was obtained. It should also be noted that initial concentrations in the raw waste were relatively low. Since no data was reported for the oxygen activated sludge system without chemically assisted clarification, the relative effects of each of the two processes on removal efficiencies could not be determined.

Zurn/Attisholz (Z/A) Process. The Zurn/Attisholz (Z/A) process is a two-stage activated sludge system. The first stage operates at DO less than 1.0 mg/l and the second stage maintains DO at 4 to 5 mg/l. Nutrient and power requirements for the two-stage system are similar to those for the conventional activated sludge process. A total Z/A detention time of 4 hours may be required to achieve BOD and solids reductions comparable to activated sludge and aerated stabilization systems.

Seven full-scale Zurn/Attisholz systems are currently in use at pulp and paper mills in the United States. These installations treat wastewaters from the following types of manufacturing:

Deink-Fine and Tissue	(5 mills)
Sulfite-Papergrade	(1 mill)
Integrated-Miscellaneous	(1 mill)

Most of these mills reportedly maintain final effluent BOD_5 and TSS concentrations in the range of 20 to 25 mg/l each.(129) One mill reportedly achieves BOD_5 and TSS levels in the range of 5 to 10 mg/l each.(129) Another mill also attained a 96 percent BOD_5 and 99 percent TSS reduction using the Z/A process.(130)

A pilot study comparing a two-stage to a single-stage activated sludge system has recently been performed. It was concluded that the two-stage system achieved a higher toxicity reduction in treating bleached kraft wastewater than did a single-stage system.(131, 132)

Rotating Biological Contactor (RBC). This system involves a series of discs on a shaft supported above a basin containing wastewater. The discs are 40 to 45 percent submerged in the wastewater and are slowly rotated; a biological slime grows on the disc surfaces. Closely spaced 12-ft-diameter discs mounted on a 25-ft shaft can result in 100,000 ft^2 of surface area.

Pilot-scale evaluations of the RBC system treating bleached kraft wastewater with an average influent BOD_5 content of 235 mg/l have resulted in substantial BOD_5 reductions.(133) The degree of removal is related to the hydraulic loading rate, as seen in Table VII-3.

TABLE VII-3

PILOT RBC FINAL EFFLUENT QUALITY FOR BLEACHED KRAFT WASTEWATER

Hydraulic Loading Rate (gpd/ft2)	70% of Time Final Effluent BOD5 Less Than (mg/l)	90% of Time Final Effluent BOD5 Less Than (mg/l)
3	70	90
2	30	45
1	22	39

Note: Raw Effluent BOD5 = 235 mg/l

Sludge production reportedly ranged from 0.3 to 0.5 lb of solids per lb of BOD5 removed.(133)

Two pilot plant evaluations (134) reported essentially complete detoxification of board mill, integrated kraft and magnesium-based sulfite mill effluents. Final efflunt BOD5 of 59 mg/l for the kraft mill, 65 mg/l for the board mill, and 338 mg/l for the sulfite mill effluent were reported. Raw wastewater BOD5 levels for these mills were 290 mg/l, 285 mg/l and 1,300 mg/l, respectively. No TSS data were reported.(134) This pilot plant work indicates good toxicity and BOD5 reduction capabilities. To date, mill-scale systems in the United States treating pulp mill wastewater have encountered operating difficulties.

Anaerobic Contact Filter. This process involves use of a basin filled with crushed rock or other media. Wastewater is passed through the media at a temperature of 90 to 95°F under anaerobic conditions; detention times on the order of three days are common. Steam stripping, nutrient addition, neutralization and dilution of waste liquor with wash water may be required as pretreatments.

A laboratory study of the process showed that 80 to 88 percent BOD5 removal from sulfite wastewaters to levels as low as 34 mg/l have been achieved.(135) The major advantage of the process is a low solids production (0.08 pounds of solids per pound BOD5). This results because methane gas rather than biological solids is the byproduct of anaerobic digestion. The author concludes that the cost for the anaerobic process was approximately the same as that for aerated stabilization.(135)

Partial detoxification of sulfite mill wastewater was obtained in a laboratory study.(121) The anaerobic contact filter altered the LC-50 from 4.5 percent to 7.8 percent for rainbow trout. No specific data concerning the toxic pollutants was reported.

Chemically Assisted Clarification

Introduction. Dissolved and colloidal particles in treated effluents are not readily removed from solution by simple settling. The stability of these materials in solution results primarily from electrostatic forces of like charge.(136) Destabilization can occur through minimizing these forces by the addition of chemical coagulants. Once destabilized, the particles agglomerate and associated TSS, BOD_5 and color can be reduced through settling. This process can be enhanced by slow mixing and/or by the addition of small amounts of polyelectrolyte. The latter serve as nuclei for floc formation. Coagulants in common use include lime, alum, ferric chloride, ferric sulfate and magnesia. Detailed discussions of the chemistry of coagulants are available.(136)

Suspended solids levels and the BOD_5 associated with the suspended solids can be substantially reduced at much lower coagulant dosages than are required for effective color removal. This is because color is primarily caused by particles with diameters of 10^{-3} to 10^{-1} micrometres, while total solids are due primarily to colloidal clay (10^{-1} micrometres), bacteria (1-10 micrometres) and chemical floc (10^{2}-10^{3} micrometres).(137) Large particles generally settle at a faster rate.

Rebhum (138) and others suggest that the most efficient method of pulp and paper mill effluent flocculation is a solids-contact type clarifier. Ives (139) suggested a theory for the operation of solids-contact clarifiers which considers their integrated roll as flocculators, fluidized beds, and phase separators. His theory suggests that the criterion for good performance is the dimensionless product of velocity gradient, time, and floc concentration. He suggests that model floc blanket studies can be meaningful for full-scale operation provided that the concentration of floc in the blanket and the blanket depth are the same in both model and prototype.

Ives also suggests a number of design considerations for solids-contact clarifiers. For floc particles to form a blanket in a circular tank, the upflow velocity of the water must be equal to the hindered settlement velocity of floc suspension. It is important that the floc removed from the blanket balance the rate of floc formation. The clarifier should be symmetrical; the inlet flow should be uniformly dispersed and the collection at the outlet should also be uniform. The clear water zone should have a minimum depth equal to half the spacing between collection troughs.

Upon floc formation, settling is accomplished in a quiescent zone. The clarification process results in a sludge which must be collected, dewatered and disposed of. The quantity, settleability, and dewaterablity of the sludge depend largely on the coagulant employed. In some cases the coagulant can be recovered from the sludge and reused.

Case studies of full, pilot and laboratory-scale chemical clarification systems are discussed in the following sections.

Case Studies-Full Scale Systems. Recent experience with full-scale alum-assisted clarification of biologically treated kraft mill effluent suggests that with proper pH adjustment, final effluent qualities of 15 mg/l each of BOD_5 and TSS can be achieved. The desired alum dosage to attain these levels would be between 100 and 150 mg/l. A significantly lower alum dosage could provide insufficient floc formation, while a higher dosage would result in proportionately high levels of chemical solids and sludge quantities that must be removed and disposed of.

Chemical clarification following activated sludge is currently being used at a groundwood chemi-mechanical mill. According to data provided by mill personnel, alum is added at a dosage of about 150 mg/l to bring the pH to 6.1. This pH has been observed to achieve best results. Polyelectrolyte is also added at a rate of 0.9 to 1.0 mg/l to improve flocculation. Neutralization using NaOH is practiced prior to final discharge to bring the pH within acceptable discharge limits. The chemical/biological sludge is recycled through the activated sludge system with no observed adverse effects on biological organisms. Average reported results for 12 months of sampling data (as supplied by mill personnel) show a raw wastewater to final effluent BOD_5 reduction of 426 mg/l to 12 mg/l and TSS reduction of 186 mg/l to 12 mg/l.

The same groundwood chemi-mechanical mill was evaluated as part of a study conducted for the EPA.(140) Data obtained over 22 months shows average final effluent BOD_5 and TSS concentrations of 13 and 11 mg/l, respectively. As part of this study, four full-scale chemically assisted precipitation systems in other industries were evaluated. Alum coagulation at a canned soup and juice plant reduced final effluent BOD_5 concentrations from 20 mg/l to 11 mg/l and TSS levels from 65 mg/l to 22 mg/l. Twenty-five mg/l of alum plus 0.5 mg/l polyelectrolyte are added to the biologically treated wastewater to achieve these final effluent levels. A winery utilizing biological treatment followed by chemically assisted clarification was also evaluated. Final effluent of 39.6 mg/l BOD_5 and 15.2 mg/l TSS from a raw wastewater of 2,368 mg/l BOD_5 and 4,069 mg/l TSS was achieved. The influent wastewater concentrations to the clarifiers were not reported. The chemical dosage was 10 to 15 mg/l of polymer.(140) A detailed summary of the results of the study of full-scale systems is presented in Table VII-4.(140)

Scott (141) reported on a cellulose mill located on the shore of Lake Baikal in the USSR. This mill produces 99,880 kkg (110,000 tons) of tire cord cellulose per year and 10,987 kkg (12,100 tons) of kraft pulp per year. Water use is about 287,660 m^3/day (76 mgd). The pH is adjusted and nutrients are added prior to an activated sludge system with 8 hours hydraulic detention time. Return sludge is aerated for 2 hours in a separate basin. The mixed liquor volatile suspended solids (MLVSS) are settled for 3 hours. The settled effluent passes to a chemically assisted clarifier where 30 mg/l of aluminum oxide plus 1.0 mg/l of polyacrylamide flocculant, a nonionic polymer are added for color and TSS removal. The clarifier effluent flows to 22 gravity fil-

TABLE VII - 4

SUMMARY OF CHEMICALLY ASSISTED CLARIFICATION TECHNOLOGY PERFORMANCE DATA (140)

Major Industrial Category	Industrial Plant & Location	Subcategory or Products	Description of Biological Treatment	AVERAGE OF PERIOD - CLARIFIER Influent BOD_5	Influent TSS	Effluent BOD_5	Effluent TSS	MAXIMUM DAY Clarifier Effluent BOD_5	TSS	MAXIMUM 30 CONSECUTIVE DAYS AVERAGE Clarifier Effluent BOD_5	TSS	Recent Removals Across Clarifier BOD_5	TSS	Surface Overflow Rates and Detention Time	Chemicals Added and Dosage Rate Average	NPDES Permit Average Maximum Day BOD_5	TSS	Average of Period Plant Influent Flow	BOD_5	TSS
Pulp and Paper	B-12	Groundwood Chemi-Mech.	Aerated Stabilization Basin 2 lb BOD_5/1000 cu.ft./D Hydraulic detention time - 8 days at 2.25 MGD Nitrogen & phosphorous added	Average of 12 months of daily data N.D.	Average of 12 months of daily data 1295.7 lb/day	Average of 12 months of daily data 140.7 lb/day	Average of 12 months of daily data 172.8 lb/day	504.4 lb/day	1502.6 lb/day	Based on 12 months of daily data 201.3 lb/day	Based on 12 months of daily data 250.5 lb/day	Based on annual average Based on mean of 30 consecutive day averages N.D.	87%	For annual ave. flow of 1.6 MGD 369 gal/day/ sq.ft. For max.day flow of 2.8 -641 gal/day/ sq.ft.	Alum - Silica -	30 Day average 275 lb/D ORDER NPDES NO. 1 July'75	30 Day average 400 lb/D No.74-69 CA0004821 effective	MGD 1.95 average of 12 months of daily data	475.7 mg/l average of 12 months of daily data	1.6 lbs/ 1000 gal. average of 12 months of daily data
				average of 10 months of daily data 315.5 lb/day	average of 10 months of daily data 737.7 lb/day	average of 10 months of daily data 198.2 lb/day	average of 10 months of daily data 177.2 lb/day	473.3 lb/day	1400.2 lb/day	Based on 10 months of daily data 239.7 lb/day	Based on 10 months of daily data 257.9 lb/day	Based on annual average (10 months) 29% Based on mean of 30 consecutive day averages 35%	76% 76%	For annual average flow of 1.9 MGD - 432 gal/day /sq.ft. For max.day flow of 2.5 MGD - 564 gal/ sq.ft.	Alum - 150 mg/l average Polymer 0.5 mg/l average	Average flow of 2.2 mgd. Max. day 550 lb/D 30 mg/l	Max. Day 800 lb/D 40 mg/l	1.9 MGD Average of 10 months of daily data	N.D.	1.7 lbs/ 1000 gal Average of 10 months of daily data
Synthetic Fiber Manufacturer	B-13	Dacron® and ethlyene glycol	Activated sludge (extended aeration) F/M - 0.05 to 0.1 lb. BOD_5 applied/lb MLSS MLSS - 2000-2500 mg/l	Data not provided.		Average of 4 quarterly averages with chemicals 113.3 lb/D	Average of 4 quarterly averages with chemicals 203.8 lb/D	Data not provided.		Data not provided.		Data not available for calculations		For average period flow- 2.097 MGD 220 gal/D/ sq.ft. 7 hours detention	Polymer only cationic 0-10 mg/l Average 8 mg/l	Daily average 750 lb/D NPDES NO. 31 Dec. 73 to 31 Dec. 76 Ave. flow 2.5 MGD	Daily average 1040 lb/D NC0000663	Data not provided.		
For "Site" System			Hydraulic detention time 30 hours at 2 MGD Nitrogen & phosphorous added	Data not provided.		Average of 4 quarterly averages without chemicals 151 lb/D	Average of 4 quarterly averages without chemicals 665.3 lb/D	Data not provided.		Data not provided.		Data not available for calculations		For average period flow- 1.67 MGD 176 gal/D/ sq.ft. 7 hours detention	None added	Daily maximum 100 lb/D	Daily maximum 2000 lb/D	Data not provided.		
Canned Foods	B-10	Canned soup, juices	2 stage trickling filter filter followed by aerated lagoon with 5 days detention with sub-surface static aeration 18" diameter x 12 feet long.	Annual average June '75 to May '76 20 mg/l No back up data provided	Annual average June '75 to May '76 65 mg/l No back up data provided	Figures provided without back up data 11 mg/l Annual average June '75 to May '76	22 mg/l Annual average June '75 to May '76	Data not provided		Data not provided.		No back up data provided for calculation		558 gal/day/ sq. ft. @ 4.3 MGD = 3.5 hours detention time	Campbell soup had no record of when chemicals were added or not added Alum can be added at lagoon effluent weir @ 25 mg/l Polymer added at flow splitting box before clarifiers 0.5 mg/l	Daily average - 45 mg/l TSS Daily maximum - 90 mg/l TSS Daily average - 30 mg/l BOD_5 Daily maximum - 75 mg/l BOD_5 NO. H221 *AD		4.3 MGD average Number provided, no back-up data provided	473 mg/l average Number provided, no back-up data provided	364 mg/l average Number provided, no back-up data provided
Wine Making	B-11	Wine	Activated sludge 18.6 lb BOD/1000 cu.ft. F/M = 0.07 MLSS = 4069 Detention Time = 8 days 0.176 MGD Phosphorous and nitrogen added	Average of period from April 26, 1976 to July 31, 1976 2368 mg/l	Average of period from April 26, 1976 to July 31, 1976 4069 mg/l	Average of period from April 26, 1976 to July 31, 1976 39.6 mg/l Data after post aeration and chlorination	15.2 mg/l	Data after post aeration and chlorination 70 mg/l for period April 26, 1976 to July 31, 1976	36 mg/l	Data not available		Average of period from April 26, 1976 to July 31, 1976 N/A	99.6%	At average flow 0.17 MGD 140 gal/D shift 11.5 hours	Polymer at 10-15 mg/l Testing period for proper dosage	Process Season - Daily average - 30 mg/l - BOD_5 Daily maximum - 50 mg/l - BOD_5 Daily average - 20 mg/l - TSS Daily maximum - 50 mg/l TSS		0.177 MGD Average of period April 26, 1976 to July 31, 1976 Caution - [illegible] not include the the pres[illegible]ason which is the season o[illegible]st loading.	2368 mg/l	215.5 mg/l

ters, each with 74.0 m^2 (796 ft^2) of area.(141) No data is given on the efficiency of the clarification process. Total plant removals are detailed in the discussions of filtration.

Case Studies-Pilot and Laboratory Scale. As part of an EPA-sponsored study, biologically treated effluent from an alkaline kraft mill was evaluated with alum precipitation on a laboratory scale.(59) Existing full-scale treatment consisted of a primary clarifier, aerated stabilization basin and polishing pond. Twenty-four-hour composite samples of the polishing pond effluent were taken on three separate days. The samples were adjusted to pH 4.6 with alum and four drops of polymer per litre of sample were added. The results are summarized below:

	Polishing Pond Effluent Range (mg/l)	Alum-Treated Effluent Range (mg/l)
Total Resin and Fatty Acids	2.82 - 3.75	Undetected
Total Chlorinated Derivatives	0.43 - 0.45	Undetected - 0.04
Chloroform	0.025 - 0.032	0.018 - 0.022
BOD_5	43. - 51.	0. - 14.

As part of a study of various solids reduction techniques, Great Southern Paper Co. supported a pilot study of chemical clarification.(142) Great Southern operates an integrated unbleached kraft mill. Treatment consists of primary clarification and aerated stabilization followed by a holding pond. The average suspended solids in the discharge from the holding pond were 65 mg/l for the period January 1, 1973 to December 31, 1974. In tests on this wastewater 70 to 100 mg/l of alum at a pH of 4.5 provided optimum coagulation. Three alum dosages were tested. At the optimum dosages, the removals after 24 hours of settling ranged from 83 to 86 percent. Influent TSS of the sample tested was 78 mg/l. Effluent TSS concentrations ranged from 11 to 13 mg/l.

In a recent EPA-sponsored laboratory study, alum, ferric chloride and lime in combination with five polymers were evaluated in further treatment of biological effluent from four pulp and paper mills.(143) Of the three chemical coagulants, alum provided the most consistent flocculation at minimum dosages, while lime was the least effective of the three. The optimum alum dose was determined for four of the effluents and ranged between 40 and 180 mg/l at a constant dosage of 2 mg/l polymer. Column tests were run on three of the four effluents, with and without chemical addition. Initial TSS levels were 110 mg/l, 5.5 mg/l and 70 mg/l, respectively. After 6 hours of settling, the samples to which alum was added showed a small net increase in TSS. This was attributed to more solids being introduced into suspension as a result of alum than were removed.(143) The untreated samples remained at about the same TSS level during the 6-hour test. These results are largely inconclusive and conflict with previous data presented. This may be due in part to inherent differences in laboratory *vs* full-scale and pilot-scale conditions.

Althof and Eckenfelder report on the use of ferric sulfate, lime and alum to effect effluent color reductions at two bleached kraft mills and one unbleached kraft paperboard mill.(144, 145) Their results, as shown in Table VII-5, provide both an optimum pH and optimum dosage for each case.

All three coagulants were able to achieve a reduction in color of from 1,000 to 300 platinum-cobalt (Pt-Co) units to 125 to 300 Pt-Co units. Note that the dosage required for color reduction is higher than that generally applied for BOD_5 and TSS reduction only.

Chemically assisted clarification will improve effluent quality as documented by numerous full, pilot and laboratory-scale studies conducted on pulp, paper, paperboard and other wastewaters. Therefore, chemically assisted clarification has been included as an alternative treatment option in Sections VIII and IX of this document.

Filtration

This process refers to granular bed (rather than membrane) filtration. The granular material may be sand, or sand with other materials such as coal, diatomaceous earth and/or garnet in combination with sand. The various media, grain sizes and bed depths may be varied for optimal results. It is common to vary grain sizes, with the larger sizes at the top of the filter bed to improve TSS removal and extend filter run time between backwashings. The addition of a proper chemical flocculant prior to filtration can further improve performance.

Filtration technology was evaluated as part of a recent study conducted for the EPA.(140) Results obtained during this study of nine pulp and paper and other industrial effluents utilizing filtration are shown in Tables VII-6 and VII-7. Also summarized in the tables are the results of pertinent published results from other filtration studies. Table VII-6 summarizes those systems not utilizing coagulants prior to filtration, while Table VII-7 addresses those employing coagulants.

As seen, those facilities not utilizing chemical coagulants achieved final effluent levels of TSS ranging from 5.9 to 35 mg/l with reductions of 45 to 70 percent across the filter. Those using coagulants prior to filtration achieved final effluent TSS levels ranging from 5 to 27.5 mg/l with removals of 52 to 85 percent. At the paperboard mill employing single medium sand filtration without chemical addition, an effluent TSS level of 7 mg/l was attained subsequent to filtration.

An EPA-sponsored laboratory study evaluated the efficiency of sand filtration on four pulp and paper mill effluents.(143) A flow rate of 5 gpm/ft^2 was used and the results are shown in Table VII-8.

As seen, in one of the two cases where coagulation was not employed prior to filtering, substantially better results were obtained than when coagulants were added. It was explained by the authors that natural coagulation which may have occurred during shipment of samples could have affected the results.

TABLE VII-5

COLOR REDUCTIONS ACHIEVED USING
FERRIC SULFATE, ALUM, AND LIME (144, 145)

	Ferric Sulfate				Alum				Lime			
Mill Type	Optimum Dosage (mg/l)	Percent Color Reduction	Final Color Value (Pt-Co.Units*)	Optimum pH	Optimum Dosage (mg/l)	Percent Color Reduction	Final Color Value (Pt-Co.Units*)	Optimum pH	Optimum Dosage (mg/l)	Percent Color Reduction	Final Color Value (Pt-Co.Units*)	Optimum pH
Bleached Kraft	500	92	250	3.5-4.5	400	92	200	4-5	1,500	92	300	12.-12.5
Bleached Kraft	275	91	125	3.5-4.5	250	93	100	4-5	1,000	85	200	12.-12.5
Unbleached Kraft Paperboard	250	95	150	4.5-5.5	250	91	100	5-6	1,000	85	150	12.-12.5

*Platinum-Cobalt Units

TABLE VII-6

TSS REDUCTION CAPABILITIES AND RELATED FACTORS FOR THE FILTRATION TECHNOLOGY WHEN NO CHEMICALS ARE USED (140)

Source of Data	Source of Wastewater	Biological Treatment Process Description	Filter Influent TSS Concentration & Source of Data	Filter Influent TSS Size - Percent < microns*	Hydraulic Loading	Filter Media: No. of Media, Depth, U.S., E.S., Type of Filtration	TSS Filter Effluent	Percent Removal Across Filter, Avg. for Period of Data
A-1	Oil refinery	Activated sludge: F/M - 0.3 MLSS - 1200 mg/l Capacity of 2 basins - ND Detention time - ND Average flow - 4.37 MGD DO min - 1.0 mg/l	10.8 mg/l average of daily data for June 1976	<1.25 - 19.0 <2.5 - 57.0 <5.0 - 89.8	at 4.37 MGD & 3 filters - 3.2 gpm/sq ft	2 media: coal, sand - coal - 18", 0.6 to 0.8 mm sand - 9" 0.4 to 0.5 mm in depth filtration	5.9 mg/l, average of daily data June 1976	TSS - 45%
A-2	Oil refinery	Activated sludge: 10 lb BOD/ 1000 cu ft, F/M - ND MLSS - ND, DO min - Detention time - 24 hrs @ 1.15 MGD, Mechanical Aeration Average flow - 1.15 MGD	ND	<1.25 - 28.5 <2.5 - 76.3 <5.0 - 89.2	at 1.15 MGD & 3 filters - 2.4 gpm/sq ft	2 media: coal, sand - coal - 24"; UC - ND ES - ND. sand - 12" UC - ND, ES - ND in depth filtration	ND	ND
A-3	Oil refinery	Activated sludge: complete mix, F/M - .02 lb BOD/lb MLVSS, MLSS - 3,500 mg/l DO min - Detention time - 12 hrs @ 23 MGD, Mechanical Aeration Average flow - 19.11 MGD	ND	<1.25 - 53.0 <2.5 - 88.3 <5.0 - 97.5	at 19.11 MGD & 9 filters - 3.5 gpm/sq ft	2 media: coal, sand - coal - 24"; UC - ND ES - ND. sand - 12" UC - ND, ES - ND in depth filtration	11 mg/l, average of 12 monthly averages	ND
A-7	Paperboard products	Activated sludge - complete mix, 20.5 lb BOD/1000 cu ft F/M - .5, MLSS - 3,500 mg/l DO min - Detention time - 12 hrs @ 2 MGD Average flow - 2.0 MGD	ND	<1.25 - 69.3 <2.5 - 91.6 <5.0 - 95.8	at 2.0 MGD & 3 filters - 3.7 gpm/sq ft	1 media: sand sand - 6'0"; ES - 2-3 mm, Sp.Gr. - 2.7	7.0 mg/l, average of 5 monthly averages Feb 76-June 76	ND
A-4	Manmade fiber processing	Activated sludge - 18 lb BOD/ 1000 cu ft, F/M - MLSS - DO min - Detention time - 48 hrs @ 0.5 MGD Average flow - 2.8 MGD	49.5 mg/l average of 2 monthly averages Does not include old aeration system flow	ND	at 2.83 MGD & 3 filters - 2.15 gpm/sq ft	4 medias: 2 coal, sand, garnet - Coal - 12" Sp.Gr.-1.45 UC & ES - ND Coal - 12" Sp.Gr.-1.5 UC & ES - ND Sand - 9", UC & ES - ND Garnet - 3", UC & ES - ND	16.2 mg/l, average of 2 monthly averages	67%, includes post aeration
Literature Greater Southern Paper Co. Cedar Springs, GA, Pilot study	kraft neutral - sulfite semichemical pulp & paper	Aerated stabilization basin:	average for 3 runs - 68 mg/l	ND	2 gpm/sq ft	ND	average for 3 runs - 35 mg/l	50% Reported by Researchers
Literature Clinton Corn Processing Co. Clinton, IA	food processing	Activated sludge complete mix F/M - MLSS - DO min - Detention time - Average flow -		ND				77%, Nov. 25, 1974 to Feb. 16, 1975
Literature Welch Foods Brockton, NY	grape processing	Activated sludge	season average - 28 mg/l	ND			8.4 mg/l season average	70%, season average
Literature New Brunswick Research & Productivity Council Pilot Plant	pulp mill	Aerated lagoon - lb BOD/1000 cu ft - DO min - Detention time - 12.5 days Total aeration only 8 days Average flow -	40 mg/l grab samples	<5μ - 60% between 5 & 10μ 30%	2.4 to 3.6 gpm/sq ft	3 media - 7" of coarse coal, 3" medium sand - ES - .56, UC - 1.32 5" of coarse sand - ES - 1.42, UC - 1.34	21 mg/l	50%

*Based on one grab sample.

ND = No Data

TABLE VII-7

TSS REDUCTION CAPABILITIES AND RELATED FACTORS FOR THE FILTRATION TECHNOLOGY WHEN CHEMICALS ARE USED (140)

Source of Data	Type of Wastewater	Biological Treatment Process Description	Filter Influent TSS Concentration and Source of Data	Filter Influent TSS Size - Percent <Microns *	Hydraulic Loading Gal. Per Min. Per Square Foot	Filter Media # of Medias, Depth U.C., E.S., Type of Filtration	TSS in Filter Effluent	Percent Removal Across Filter Ave. for Period of Data	Chemicals Added
A-9	Carpet Yarn Dyeing	Activated sludge - extended air 16 lb BOD_5/1000 cu. ft. FM - MLSS - 3500-4000 mg/l DO Min - Detention time - 48 hrs. @ 0.5 MGD Average flow - 0.44 MGD	N.D.	1.25u - 46.4 2.5u - 78.5 5.0u - 93.5	at 0.44 MGD and 2 filters 1.9 gpm/sq. ft.	3 Media -coal,sand,garnet Coal - 18" UC - N.D. ES - N.D. Sand - 10" UC - N.D. ES - N.D. Garnet - 9" UC - N.D. ES - N.D.	20.2 mg/l Average of 11 monthly averages	N.D.	Alum - 80-120 mg/l polymer - 1.5 mg/l Added just ahead of secondary clarifier
A-4	Man-made fiber processing	Activated sludge - 18 lb BOD_5/1000 cu. ft. F/M - MLSS - DO Min. - Detention time - 26 hrs @ 2.83 MGD Average flow - 2.83 MGD	53.2 mg/l Average of 10 monthly averages - from grab samples Does not include old snotion system flow	1.25u - 29.7 2.5u - 83.9 5.0u - 91.1	at 2.83 MGD and 3 filters 2.15 gpm/sq.ft.	4 Media - 2 coal,sand,garnet Coal - 12" Sp Gr - 1.45 UC & ES - N.D. Coal - 12" Sp.Gr. - 1.5 UC & ES - N.D. Sand - 9" UC & ES - N.D. Garnet - 3" UC & ES - N.D.	7.7 mg/l Average of 10 monthly averages following: post- aeration & activated carbon	85%	Alum - 10 mg/l Polymer - 0.1 mg/l Activated Carbon - 35 mg/l added in-line just ahead filters
A-5	Reconstituted tobacco	Activated sludge - 15.1 lb BOD_5/1000 cu.ft. F/M - .07 MLSS - 3500 mg/l DO Min - Detention time - 120 hrs @ 1.0 MGD Average flow - 1.0 MGD	N.D.	1.25 u - 21.2 2.5u - 52.9 5.0u - 78.2	at 1.0 MGD and 3 filters 46 gpm/sq.ft.	2 Media - coal,sand Coal - 24" ES - 1.2 mm UC - N.D. Sand - 19" ES - 0.5 mm UC - N.D.	N.D.	N.D.	Polymer added at overflow weir of aeration basin Dosage - N.D.
A-8	Paper towels and napkins	Aerated stabilization basin	143 mg/l Average of 6 monthly averages of one grab sample	1.25u - 49.8 2.5u - 84.2 5.0u - 90.4	4 gpm/sq.ft.	2 Medias-coal,sand Coal - 18" ES - 1.5 mm Sand - 12" ES - 0.7 mm	N.D.	N.D.	N.D.
A-6	Pet food manufacturer	Activated sludge - complete mix N.D. F/M - N.D. MLSS - 3500 mg/l DO Min - Detention time - 90 hrs @ 0.3 MGD Mechanical aeration Average flow - 0.3 MGD	N.D.	1.25u - 30 2.5u - 55 5.0u - 85	@ .3 MGD and 3 filters 2 gpm/sq.ft.	2 Media- coal, sand Coal - 36" Sand - 24"	6.5 mg/l average for April 1976	N.D.	Cationic polymer added to flow just ahead of clarifier Dosage - N.D.
Literature - Cellulose mill on Lake Baikal USSR full scale installation	Tire cord cellulose and kraft paper pulp	Activated sludge - MLSS - 2500 mg/l DO Min - Detention time - 8 hrs @ 76 MGD Average flow -	N.D.	N.D.	2.7 gpm/sq.ft	1 Media - sand ES - 1.2 - 2.0 mm 9.6 ft deep	5 mg/l following 6 hr. settling lagoon & 6 hr aerated lagoon	N.D.	Alum - 30 mg/l Polymer - 1.0 mg/l nonionic ahead of chemical clarifier
Literature- Amoco Oil Yorktown,VA.	Oil refining	Aerated lagoon - F/M - MLSS - DO. Min. - Detention time - Average flow -	57.6 mg/l	N.D.	3.6 gpm/sq.ft.	3 Media-coal,sand,garnet Coal - 22" Sand - 11" Illmenite - 7"	27.5 mg/l Average of 5 period averages June 1971 to December 1972	52%	Alum - just ahead. filters

NOTES: *Based on one grab sample.
ND = No Data

Filtration is an available technology for application in treating pulp, paper and paperboard wastewaters. If properly designed and operated, filtration can yield significant solids removals.

TABLE VII-8

SAND FILTRATION RESULTS(143)

Mill No.	Initial TSS (mg/l)	TSS Removal (%) w/chem	TSS Removal (%) w/o chem
1	110	64	14
2	5.5		36
3	70	71	68
5	60		23

Activated Carbon Adsorption

Currently, there are two basic approaches for the use of activated carbon: 1) use in a tertiary sequence following conventional primary and biological processes; and 2) use in a "physical-chemical" treatment in which raw wastewater is treated in a primary clarifier with chemical coagulants prior to carbon adsorption.

The tertiary approach attempts to reduce organics to the carbon system to provide longer carbon life. The physical-chemical treatment process removes biodegradable and other impurities using activated carbon. Activated carbon can achieve high removals of dissolved and colloidal pollutants in water and wastewater. When applied to a well treated secondary effluent, it is capable of reducing BOD_5 to less than 2 mg/l.(147)

The primary means by which removal occurs is by surface adsorption. The key to the carbon adsorption process is the extremely large surface area of the carbon, typically 500 to 1,400 square metres per gram (m^2/g), (17,335 to 48,538 ft^2/lb).(146)

Activated carbon will not remove certain low molecular weight organic substances, particularly methanol, a common constituent of pulping effluents.(148) Additionally, carbon columns do a relatively poor job of removing turbidity and associated organic matter.(149) Some highly polar organic molecules such as carbohydrates also will not be removed through carbon columns.(149, 150) However, most of these materials are biodegradable and therefore should not be present in appreciable quantities in a well biooxidized secondary effluent.

Activated carbon may be employed in several forms including: 1) granular; 2) powdered; and 3) fine. The ultimate adsorption capacities for each may be similar.(151) The optimal carbon form for a given application should be determined by laboratory and/or pilot testing. Each of the three forms of carbon listed above is discussed in the following sections.

Granular Activated Carbon. Granular activated carbon has been used for many years by municipalities and industry to purify potable and process water. In recent years it has also been used for removal of organics in industrial and municipal wastewater treatment plants.(152)

The granular activated carbon (GAC) process usually consists of one or more trains of carbon columns, consisting of one or more columns per train. The flow scheme may be down through the column, up through the packed carbon bed or up through the expanded carbon bed.

The optimum column configuration, flow scheme and carbon requirements can best be determined through field testing. Design aspects for various systems are readily available in the literature.(146)

It is economically advantageous in most granular activated carbon applications to regenerate the exhausted carbon. Controlled heating in a multiple-hearth furnace is currently the best procedure for removing adsorbed organics from activated carbon.

Typically, the regeneration sequence is as follows:

1. Pump exhausted carbon in a water slurry to regeneration system for dewatering.

2. After dewatering, feed carbon to a furnace at 816 to 927°C (1,500 to 1,700°F) where the adsorbed organics and other impurities are oxidized and volatized.

3. Quench regenerated carbon in water.

4. Wash carbon to remove fines; hydraulically transport regenerated carbon to storage.

5. Scrub furnace off-gases and return scrubber water to plant for treatment.

The West Wastewater Treatment plant at Fitchburg, Massachusetts treats combined papermill and sanitary wastes at a 15-mgd chemical coagulation/carbon adsorption facility.(154) Approximately 90 percent of the flow originates from three papermills, with the remaining 10 percent originating from municipal sanitary wastewater. The industrial wastewater undergoes 5 minutes of rapid mixing and 30 minutes of flocculation prior to mixing with the chlorinated sanitary wastewater. The combined waste is then settled after lime and alum addition. This pretreatment has resulted in a 96 percent suspended solids reduction and a 39 percent BOD_5 reduction. The wastewater is then pumped through granular activated carbon filters that yield a 99 percent suspended solids reduction and 97 percent BOD_5 reduction over the raw effluent. Final effluent concentrations are reported as 5.0 mg/l BOD_5 and 7.0

mg/l TSS. No data has been reported concerning toxicity or toxic pollutant removal/ reduction from the plant.

Pilot testing by Beak Consultants, Ltd. (154), with laboratory analysis confirmed by B.C. Research, indicate that approximately 80 percent of each of the following resin and fatty acids were removed from raw bleached kraft effluent by application of granular carbon adsorption: pimaric, isopimaric, abietic, dehydroabietic, oleic, linoleic and linolenic. Initial total resin acid content was 10.6 to 12.6 mg/l and was reduced to a total fatty acid content of 2.2 to 3.9 mg/l after treatment. A contact time of 7.5 minutes with a carbon exhaustion rate of 5 to 6 pounds per 1,000 gallons was employed in the study. Detoxification of the raw woodroom wastewater was successful. However, the authors report that the carbon system, did not detoxify whole mill effluent during a simulated black liquor spill, even with a contact time of 30 minutes.

It is noteworthy that the carbon exhaustion rate for BOD5 removal was 20 times shorter than that for toxicity removal. These results imply that 1) carbon life may be significantly increased if competing organics are removed prior to carbon adsorption; and 2) the carbon adsorption capacity for resin and fatty acids is greater than that for other biodegradable organics.

Several researchers have considered the reuse of wastewaters following carbon adsorption treatment. Kimura (155) showed that the use of activated carbon following biological treatment and sand filtration was capable of completely detoxifying kraft board mill wastewater. In this application, the final effluent was recycled as process water.

According to Smith and Berger (156), pulp and papermill wastewater suitable for reuse can be obtained using granular carbon without a biological oxidation step, particularly if the raw waste exhibits a BOD5 of 200 to 300 mg/l. Color due to refractory organic compounds contained in pulping effluents can also be reduced by such treatment. Table VII-9 presents the pilot plant results obtained by the authors.

Condensate streams account for only 2 to 10 percent of the flow, but contribute significantly higher or proportions of toxicity and BOD5 when discharged. Tests by Hasen and Burgess (157) showed that 70 to 75 percent of the BOD5, COD and TOC in kraft evaporator condensate could be removed using 3.8 lb of carbon per 1,000 gallons of wastewater. Treatment with granular activated carbon was also able to reduce the effluent toxicity effects on bay mussels by a factor of up to 17. The toxicity removal efficiency was found to be much more dependent on contact time than were BOD5 and COD removals. For example, a contact time of 30 minutes and carbon dosage of 40,000 mg/l (0.334 lb/gal.) resulted in an 80 percent COD reduction to 186 mg/l and 85 percent larval survival in a 10 percent condensate solution. However, an extended contact time of 19 hours under otherwise similar conditions resulted in an increase to only 82 percent COD reduction or 163 mg/l, while larval survival in 10 percent solution increased to essentially 100 percent.

Weber and Morris (158) found that the adsorption capacity of granular activated carbon increased with a decrease in pH. The effect on the rate of adsorption with changes in temperature is not well defined.

TABLE VII-9

RESULTS OF GRANULAR ACTIVATED CARBON COLUMN PILOT PLANT TREATING UNBLEACHED KRAFT MILL WASTE(156)

	Columns(a) Preceded by Lime Precipitation and Biological Oxidation						Columns(a) Preceded by Lime Precipitation		
	Influent	Effluent	Removal	Influent	Effluent	Removal	Influent	Effluent	Removal
BOD_5, (mg/l)	48	23	52%	102	32	69%	82	12	85%
COD, (mg/l)	--	--	--	--	--	--	320	209	35%
SS, (mg/l)	--	--	--	--	--	--	115	74	36%
Turbidity, (JTU)	--	--	--	--	--	--	35	35	0%
Color, (Pt-Co Units)	--	--	--	--	--	--	28	0	100%
Odor	365	13	96%	185	23	88%	--	--	--
pH	--	--	--	--	--	--	11.9	10.5	12%
TSS (mg/l)	--	--	--	--	--	--	1,285	1,205	6%

(a)Columns loaded at 3.6 - 4.0 gpm/ft^2

Powered Activated Carbon . A recent variation of activated carbon technology consists of the addition of powdered activated carbon to biological treatment systems. The adsorbant quality of carbon, which has been known for many years, aids in the removal of organic materials in the biological treatment unit.(159) This treatment technique also enhances color removal, clarification, system stability, BOD_5 and COD removal.(160, 161) Results of pilot testing (162, 163) indicate that this type of treatment, when used as a part of the activated sludge process, is a viable alternative to granular carbon systems. Pilot tests (163) have also shown that powdered activated carbon can be used successfully with rotating biological contactors.

One chemical manufacturing complex has installed a full-scale, 40-mgd powdered activated carbon system that started up during the spring of 1977.(165) This system includes carbon regeneration. The waste sludge, which contains powdered carbon, is removed from the activated sludge system and is thickened in a gravity thickener. The sludge is then dewatered in a filter press prior to being fed to the regeneration furnace. The regenerated carbon is washed in an acid solution to remove metals as well as other inorganic materials. Fresh carbon is added as make-up to replace the carbon lost in the overflow from the activated sludge process or in the regeneration system.

The process was originally developed because biological treatment alone could not adequately remove the poorly biodegradable organics in the effluent. Average values for six months of data on a laboratory scale powdered activated carbon unit using a carbon dosage of 160 mg/l and 6.1-hr hydraulic retention, yielded results shown in Table VII-10.(166)

TABLE VII-10

POWDERED ACTIVATED CARBON
OPERATING DATA ON A CHEMICAL PLANT WASTEWATER(166)

Parameter	Raw Effluent	Final Effluent	% Removal
Soluble BOD_5 (mg/l)	300	23	92.3
Color (APHA Units)	1,690	310	81.6

The powdered activated carbon is thermally regenerated and acid-washed prior to reuse.(166)

It is noteworthy that the estimated capital costs of using powdered activated carbon vs conventional activated sludge systems for the plant are within 10 percent of each other. Operating cost of the powdered activated carbon system was estimated at about 25 percent above that for conventional activated sludge alone.(166)

The powdered activated carbon system described above is a very comprehensive treatment system that includes operations which may not be required at all installations. The need for a filter press system or acid cleaning system as well as a carbon regeneration furnace should be determined on a case-by-case basis.

In a follow-up study on the full-scale powdered activated carbon activated sludge plant the average results of three months of data are reported in Table VII-11. The carbon dosage was 182 mg/l, while the hydraulic retention was 14.6 hours.(167)

TABLE VII-11

FULL SCALE "PACT" PROCESS RESULTS
ON CHEMICAL PLANT WASTEWATER(167)

Parameter	Raw Effluent	Final Effluent	Percent Reduction
Soluble BOD_5 (mg/l)	504	15.2	95
Color (APHA Units)	1,416	311	78

Comparison of the laboratory and full-scale results in Tables VII-10 and VII-11 reflect an increase in BOD_5 and color removal with the full-scale system.

Fine Activated Carbon. The fine activated carbon system studied by Timpe and Lang is the subject of a patent application.(151) It is a multi-stage, countercurrent, agitated system with a continuous transfer of both carbon and liquid. One of the major aspects of the fine activated carbon system is the use of an intermediate size carbon in an attempt to combine the advantages of both powdered and granular carbon while minimizing their limitations. Equipment size and carbon inventory are decreased due to the increased adsorption rate of the intermediate carbon. Timpe and Lang reported that the fine activated carbon system showed distinct advantages over the granular activated carbon system.

Timpe and Lange (151) ran extensive pilot plant tests for treating unbleached kraft mill wastewater with granular and fine activated carbon. Their 30-gpm pilot plant utilized four different treatment processes, as follows:

1. clarification followed by downflow granular carbon activated columns;

2. lime treatment and clarification followed by granular activated carbon columns;

3. biological oxidation and clarification followed by granular activated carbon columns; and

4. lime treatment and clarification followed by fine activated carbon effluent treatment (subject of a patent application.)

All treatment processes were operated in an attempt to obtain a treated effluent with less than 100 APHA color units and less than 100 mg/l TOC. This would allow for reuse of the wastewater in the process. The lime-carbon treatment achieved the desired effluent criteria and was considered the most economical of three processes utilizing carbon columns. A relatively small lime dosage of 320 to 600 mg/l CaO without carbonation prior to carbon treatment was reported to be the optimum operating condition for the lime-carbon process. It was determined that the effluent should contain about 80 mg/l Ca for successful optimization of treatment. The required fresh carbon dosage was 2.5 lb of carbon per 1,000 gallons treated.

Timpe and Lang (151) reported lower rates of adsorption, resulting in larger projected capital and operating costs, for the biological-carbon and primary carbon processes for treating unbleached kraft mill effluent. The lower rates of adsorption were believed to be caused by coagulation of colloidal color bodies on the carbon surface. They also determined that the use of sand filters prior to the activated carbon was not necessary. The carbon columns operated with a suspended solids concentration of 200 mg/l without problems when backwashed every day or two. Filtration or coagulation of the effluent from the fine activated carbon process was necessary in order to remove the color bodies that formed on the outer surfaces of the activated carbon granules.

It was found that nonadsorptive mechanisms accounted for a significant amount of color and TOC removal in the clarification-carbon process. It was felt that the removals were not due to any biological degradation which might have occurred with the carbon columns. The color colloids were subsequently removed as large settleable solids during the backwashing process.(151) Table VII-12 tabulates the pilot plant results obtained from Timpe and Lang's investigation.

Existing Activated Carbon Installations. It is estimated that there are 100 full-scale activated carbon systems currently treating industrial and/or municipal wastewater treatment.(168) A summary of selected municipal and industrial carbon treatment systems is presented in Tables VII-13, VII-14 and VII-15.

Foam Separation

This process involves physical removal of surface active substances. This is accomplished by the injection of fine air bubbles into a basin containing the effluent. Surface-active substances in the effluents (i.e., resin acids) are attracted to the large surface area of the air bubbles. The air bubbles cause

TABLE VII-12

RESULTS OF ACTIVATED CARBON PILOT PLANTS
TREATING UNBLEACHED KRAFT MILL EFFLUENT(168)

Description of Carbon Process	Columns Preceded By Biological Oxidation & Clarification			Columns Preceded By Primary Clarification			Columns Preceded By Primary Clarification			Columns Preceded By Lime Treatment & Clarification			FACET System		
	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal
Hydraulic Load (gpm/ft2)	2.13			1.42			0.71			1.42			N.A.		
Carbon	Granular			Granular			Granular			Granular			Intermediate		
Contact Time, Min.	140									108					
BOD (mg/l)										26% Removal					
TOC (mg/l)	148	57	61%	220	83	62%	310	121	61%	177	100	44%	158	101	36%
Turbidity (JTU)											5-15				
Color, Units	740	212	71%	925	185	80%	1160	202	83%	252	76	70%	157	73(a)	
Fresh Carbon Dosage (lb carbon/ 1000 gal.)	8			20.5			28			2.5			3.9		
pH										11.3					

(a)Filtered

TABLE VII-13

INDUSTRIAL WASTEWATER TREATMENT ACTIVATED CARBON INSTALLATIONS(169)

Industry Location	Installation Date	Design Flow Rate (1000 gpd)	Organic Contaminants	Pretreatment	Contact Time (min)	Adsorber Type	Carbon Regeneration
1. Carpet Mill, British Columbia	6/73	50	Dyes	Screens		Moving bed	None
2. Textile Mill, Virginia	7/70	60	Dyes	Filtration	57	Moving bed	None
3. Oil Refinery, California(a)	3/71	4200	COD	Equalization, oil flotation	60	Gravity beds in parallel	Multiple hearth furnace
4. Oil Refinery, Pennsylvania(b)	3/73	2200	BOD	Equalization, oil flotation, filtration		Moving bed	Multiple hearth furnace
5. Detergent, New Jersey	6/72	15	Xylene alcohols, TOC	None	540	Downflow beds in series	Multiple hearth furnace
6. Chemicals, Alabama	11/72	500	Phenolics, resin, intermediates	Chemical clarification	173	Moving beds	Multiple hearth furnace
7. Resins, New York	3/73	22	Xylene, phenolics, resorcinol	Chemical clarification	30	Downflow beds in series	Rotary kiln
8. Herbicide, Oregon	11/69	150	Chlorophenols, cresol	None	105	Upflow beds in series	Multiple hearth furnace
9. Chemicals, New York	3/69	15	Phenol, COD	Equalization	200	Downflow beds in series	None
10. Chemicals, Texas	11/71	1500	Nitrated aromatics	Activated sludge filtration	40	Moving beds	Rotary kiln
11. Chemicals, New Jersey		100	Polyols	Equalization, clarification		Moving bed	Multiple hearth furnace
12. Explosives, Switzerland	3/72	5	Nitrated phenols	Equalization	150	Downflow beds in series	None
13. Pharmaceuticals, Switzerland	10/72	25	Phenol	Equalization, pH adjusted settling	90	Downflow beds in series	None
14. Insecticide, England	1962		Chlorophenol	Equalization, clarification		Downflow beds in series	Rotary kiln
15. Wood Chemicals, Mississippi	8/73	3000	TOC	pH adjustment flotation filtration	50	Moving beds	Multiple hearth furnace
16. Dyestuffs, Pennsylvania	8/73	1500	Color, TOC	Equalization, clarification, filtration	50	Moving beds	Multiple hearth furnace

(a) Used only during periods of high rainfall.
(b) No longer in operation.

TABLE VII-14

MUNICIPAL CARBON ADSORPTION SYSTEMS FOLLOWING BIOLOGICAL TREATMENT(169)

Site	Average Plant Capacity (mgd)	Contactor Type	No. Of Contactors In Series	Contact Time(a) (Min)	Hydraulic Loading (gpm/ft2)	Total Carbon Depth (ft)	Carbon Size	Effluent Requirements (Oxygen Demand)
1. Arlington, Virginia	30	Downflow Gravity	1	38	2.9	15	8 x 30	BOD 3 mg/l
2. Colorado Springs, Colo	3	Downflow Present	2	30	5	20	8 x 30	BOD 2 mg/l
3. Dallas, Texas	100	Upflow Packed	1	10	8	10	8 x 30	BOD 10 mg/l BOD 5 mg/l (by 1980)
4. Fairfax County, VA	36	Downflow Gravity	1	36	3	15	8 x 30	BOD 3 mg/l
5. Los Angeles, Calif.	5(b)	Downflow Gravity	2	50	4	26	8 x 30	COD 12 mg/l
6. Montgomery County, MD	60	Upflow Packed	1	30	6.5	26	8 x 30	BOD 1 mg/l COD 10 mg/l
7. Occoquan, Va.	18	Upflow Packed	1	30	5.8	24	8 x 30	BOD 1 mg/l COD 10 mg/l
8. Orange Cty, Calif.	15	Upflow Packed	1	30	5.8	24	8 x 30	COD 30 mg/l
9. Piscataway, Md	5	Downflow Pressure	2	37	6.5	32	8 x 30	BOD 5 mg/l
10. St. Charles, MD	5.5	Downflow Gravity	1	30	3.7	15	8 x 30	
11. South Lake Tahoe, CA	7.5	Upflow Packed	1	17	6.2	14	8 x 30	BOD 5 mg/l COD 30 mg/l
12. Windhoek, South Africa	1.3	Downflow Pressure	2	30	3.8	15	2 x 40	COD 10 mg/l

(a)Empty bed (superficial) contact time for average plant flow.
(b)50 mgd ultimate capacity

TABLE VII-15

MUNICIPAL PHYSICAL-CHEMICAL CARBON ADSORPTION TREATMENT FACILITIES(169)

	Site	Average Plant Capacity (mgd)	Contactor Type	No. Of Contactors In Series	Contact Time(a) (Min)	Hydraulic Loading (gpm/ft2)	Total Carbon Depth (ft)	Carbon Size	Effluent Requirements (Oxygen Demand)
1.	Cortland, NY	10	Downflow Pressure	1 or 2	30	4.3	17	8 x 30	TOD 35 mg/l
2.	Cleveland Westerly, Ohio	50	Downflow Pressure	1	35	3.7	17	8 x 30	BOD 15 mg/l
3.	Fitchburg, Mass	15	Downflow Pressure	1	35	3.3	15.5	8 x 30	BOD 10 mg/l
4.	Garland, Texas	30(b)	Upflow Downflow	2	30	2.5	10	8 x 30	BOD 10 mg/l
5.	LeRoy, NY	1	Downflow Pressure	2	27	7.3	26.8	12 x 40	BOD 10 mg/l
6.	Niagara Falls, NY	48	Downflow Gravity	1	20	3.3	9	8 x 30	COD 112 mg/l
7.	Owosso, Michigan	6	Upflow Packed	2	38	6.2	30	12 x 40	BOD 7 mg/l
8.	Rosemount, Minn.	0.6	Upflow Downflow Pressure	3 (max.)	66 (max.)	4.2	36 (max.)	12 x 40	BOD 10 mg/l
9.	Rocky River, Ohio	10	Downflow Pressure	1	26	4.3	15	8 x 30	BOD 15 mg/l
10.	Vallejo, Calif.	13	Upflow Expanded	1	26	4.6	16	12 x 40	BOD 45 mg/l (90% of time)

(a)Empty bed (superficial) contact time for average plant flow
(b)90 mgd ultimate capacity

generation of foam in which surface active compounds are concentrated. The air bubbles float to the surface where the resulting foam can be removed. The process works most efficiently when the effluent is adjusted to pH 8.0.(170)

Foam generation techniques have been evaluated on a pilot scale for pulp, paper, and paperboard wastewaters. This is a significant aspect of the process since the air bubble size determines the surface area available for pollutant attraction. Jet air dispersion was found to be the most efficient technique when compared to turbine and helical generation systems.(171)

Black liquor from kraft pulp mills may contain 2 to 3 percent soaps which produce a very stable foam. The technology for foam breaking is available. Commercial systems including turbine and centrifugal processes have been developed which can successfully break this foam. Pilot investigations show turbine foam breaking to be most advantageous for the foam produced.(171) Several full-scale foam separation facilities have been built for the removal of detergents from municipal wastes.(172, 173) The Los Angeles County Sanitation District system operated on a flow of 12 mgd at a 7-minute detention. Water reclamation was the primary purpose of the unit, which operated successfully and trouble-free during two years of continuous operation.(170) This system, like other municipal systems, has ceased operation due to regulations that require the use of biodegradable detergents.

Bleached kraft whole mill effluent, was analyzed for total resin acid content before and after pilot-scale foam separation.(170) Two mill effluents treated a 2-hour detention using a foam pilot unit. The resin acid content in all cases was reduced by between 46 and 66 percent. The range of total resin acid content in the influents and effluents were 2.6 to 5.1 mg/l and 0.1 to 1.0 mg/l, respectively. In all cases the treated effluent was rendered nontoxic to fish.

Pilot studies have been performed using foam separation as a pretreatment for activated sludge and for aerated stabilization treatment of bleached kraft effluent.(174) These studies have shown the detoxification efficiency of biological treatment to improve from 50 to 85 percent of the time without foam separation to over 90 percent of the time with foam.(174)

Microstraining

At two nonintegrated papermills, full-scale coagulation/microstraining facilities are used for treating rag pulp and fine paper effluents.(175, 176) Coagulant usage include addition of 1 mg/l polymer plus addition of alum or caustic for pH adjustment. Typically solids and BOD_5 removals of 97 percent to 10 mg/l and 67 percent to 50 mg/l, respectively, are achieved. Thus, when properly operating, treatment approaching that achievable by biological treatment has been obtained. Upsets to flocculation have occurred for many reasons, for example, papermachine wash as with high alkaline cleaners.(175)

Electrochemical Treatment

Electrochemical treatment technology involves the application of an electrical current to the effluent to convert chloride to chlorate, hypochlorite and chlorine. The chlorine and hypochlorite can oxidize organic compounds and be reduced again to chloride ions. The process then repeat in a catalytic fashion. The oxidation of organic compounds reduces the BOD5, color and toxicity of the effluent. A significant advantage of the process is that no sludge is produced.

Oher (177) found that whole mill bleached kraft effluent could be reduced in color by 80 percent and caustic extract by more than 90 percent by electrochemical treatment. Utilizing a lead dioxide anode similar effluent results were achieved when compared with a graphite anode. The lead dioxide anode required a fraction of the energy. No toxicity or toxic pollutant data was reported.

In a variation of the process, Barringer Research Ltd. (178) investigated the use of a carbon fiber electrochemical reactor on kraft caustic bleach extracts. The high surface to volume ratio of the carbon greatly decreased reactor volume (a 1.6-mgd unit required a 17-cubic-meter reactor). At an effluent to water volume ratio of 60 percent (v/v) toxicity was reported to be reduced from 100 percent mortality in 22 hrs (60 percent) to 0 percent mortality in 96 hrs. Color reduction of 90 percent 1,300 Pt.-Co. and BOD5 and COD reductions of 50 percent and 60 percent, to 540 mg/l and 1,164 mg/l, respectively, were reported. This process is in full-scale use in the mining industry but has had no pilot or mill-scale facility in the pulp, paper, and paperboard industry.(179) The primary drawback of the process is failure of the carbon cell to perform for extended periods.(179)

Another variation to this process involves the use of hydrogen gas bubbles generated in the process to float solids and separate scum. Selivanov (180) found that an electrochemical unit with graphite anodes and stainless steel cathodes could cause coagulation in kraft whitewater. Release of hydrogen bubbles in the process caused solids removal by floatation. Total suspended solids were reduced to 2 to 4 mg/l. No toxicity data was reported.

Herer and Woodard (181) found significant color and TOC reductions in bleaching wastes by application of electrolytic cells using an aluminum anode. Color removals for chlorination and caustic extraction effluents were 92 percent and 99 percent, respectively, while TOC removals were 69 percent and 89 percent, respectively. Specific concentrations, however, were not reported.

Ion Flotation

This process involves the addition of a surfactant ion of opposite charge to the ion to be removed. The combining of these ions results in a precipitate (the colligend). The colligend is removed by passage of air bubbles through the waste and collection of the resulting floating solids.

Many of the chromophoric (color producing) organics in pulp, paper, and paperboard mill wastewaters are negatively charged, making this process suitable for the removal of color. Chan (182) investigated the process on a laboratory scale. A variety of commercial grade cationic surfactants were tested and Aliquat 221 produced by General Mills was found very effective. The process removed over 95 percent of the chromophoric compounds from bleached kraft effluents. No specific removals of toxicity or toxic pollutants were reported.

Air/Catalytic/Chemical Oxidation

Complete oxidation of organics in pulp and paper wastes to carbon dioxide and water is a significant potential advantage of these processes. Partial oxidation coupled with biological treatment may have economic and/or technical advantages over biological treatment alone.

Past studies of oxidative processes have dealt principally with COD or TOC as a measure of performance. Barclay (183) has done a thorough compilation of related studies, and found that most were performed with wastewater other than those from pulp and paper operations. Some tentative conclusions, though, may still be drawn:

1. Complete oxidation with air can occur under extreme temperature and pressure; high intensity irradiation; with air at ambient conditions with excessive amounts of strong oxidants (O_3, H_2O_2 or ClO_2) or air or oxygen in the presence of catalysts such as certain metal oxides.

2. Sulfite wastes can be partially detoxified by simple air oxidation for a period of seven days.

3. Ozone oxidation achieved only slight detoxification of sulfite wastes after 2 hours, and partial detoxification after 8 hours. (183)

4. Major BOD_5 reductions can only be achieved under conditions similar to those required for nearly complete oxidation.

No data specifically relating to toxic pollutant removal was reported.

Steam Stripping

Steam stripping involves the removal of volatiles from concentrated streams. Hough (184) reports that steam stripping is capable of removing 60 to 85 percent of the BOD_5 from condensate streams. The ability of the process to remove specific pollutants (including the toxic and nonconventional pollutants) depends on the relative boiling points of the pollutants with respect to that of water (i.e., the pollutants must be volatile). Resin acids have boiling points in the range of 250°C (185) and thus are not readily stripped by the process.

Steam stripping was evaluated for its ability to detoxify condensates from sulfite waste liquor evaporators.(186) This stream accounted for 10 percent of the whole mill effluent toxicity and 28 percent of the total BOD_5 load. Toxicity in the condensate stream was attributed to acetic acid, furfural, eugenol, juviabone and abietic acid. Steam stripping had no observable effect on the toxicity of the stream, although the total organic content was reduced.

Steam stripping of kraft mill digester and evaporator condensates was employed on a mill scale for control of total reduced sulfur compounds and toxicity.(186) The 96-hour LC-50 of the condensate was altered from 1.4 percent to 2.7 percent. Thus, the stream remained highly toxic after steam stripping. The process did remove 97 percent of the Total Reduced Sulfur (TRS) compounds, which may have accounted for some of the toxicity reduction. Production process changes, (including minimizing condensate volume, installation of a spill collection system, reduction of fresh water use and conversion to dry debarking) along with steam stripping resulted in a nontoxic effluent.

Ultrafiltration

Ultrafiltration utilizes membranes of a specified molecular size to treat wastewater. The process relies on an external pressure (i.e., pumping) to input the driving force to the wastewater as it is transported through the membranes. The size opening for the ultrafiltration membrane depends on the size molecules to be removed from the wastewater.

Data is available from Easty (59) for nonconventional pollutant removal of two bleached kraft caustic extraction effluents utilizing two types of ultrafiltration systems. Good removals of epoxystearic and dichlorostearic acids and trichloro-and tetrachloroguaiacol were obtained in each case. Chlorinated resin acids were effectively removed by one system but not the other.

The first system employed only one spiral wound membrane, with a surface area of 40 ft^2. Filtration of suspended solids larger than 10 micrometres was performed prior to ultrafiltration. The 7.5-gpm system operated with a pH of 11 to 11.5. The system achieved 50 to 80 percent reduction of chlorinated phenolics and other acidics, but only 0 to 15 percent removal of chlorinated resin acids. The lower percent removals of chlorinated resin acids reflect a low initial concentration of these pollutants in the waste.

The second system treated an effluent volume of 3.3 gpm by a tubular cellulose acetate membrane with a surface area of 12.1 ft^2. The system operated at a pH of 9.5 to 10.5 and inlet and outlet pressures of 220 psi and 100 psi, respectively. Filtration of all particles larger than 10 micrometres was performed prior to ultrafiltration. This system achieved removals of 73 to 93 percent of all chlorinated resin acids, chlorinated phenolics and other acidics.

Color, lignosulfonate, COD and solids removals from sulfite liquor by ultrafiltration were studied by Lewell and Williams.(188) Removals on the order of 30 to 50 percent were observed for color, lignosulfonate, COD and TSS. No toxicity or toxic pollutant data was reported. Costs (1971) were estimated at \$1.50/kgal for a 1.0-mgd permeate flow. It was concluded that ultrafiltration could not compete economically with lime as a means of removing lignosulfonate, color, COD and solids.(188)

Reverse Osmosis

Reverse osmosis employs pressure to force a solvent through the membrane against the natural osmotic force. This is the same type of process as ultrafiltration except that the membranes used for reverse osmosis reject lower molecular weight solutes. This means that lower flux rates occur along with a need for higher operating pressure difference across the membrane than those experienced with ultrafiltration.

Reverse osmosis is employed at a midwest NSSC mill producing 272 kkg/day (300 tons/day) of corrugating medium. The system allows the mill to operate a closed whitewater system. Easty (59) reported that the system achieved BOD_5 reductions of approximately 90 percent and removed essentially all resin and fatty acids. The 85-gpm reverse osmosis unit employs 288 modules, each with 16.7 ft^2 of area provided by 18 cellulose acetate tubes. The system operates at 100 psi and 38°C. During Easty's testing, the whitewater feed contained 300 mg/l TSS and 4,000 to 6,000 mg/l total dissolved solids. Initial resin and fatty acid levels were: abietic, 1.5 mg/l, dehydroabietic, 262 mg/l; isopimaric, 2.75 mg/l; pimaric, 0.82 mg/l; oleic, 4.86 mg/l; linoleic, 7.23 mg/l; and linolenic, 0.27 mg/l.(59) The maximum removal capacity is not known since final concentrations were below detection limits.

Reverse Osmosis/Freeze Concentration

Reverse osmosis can be followed by freeze concentration whereby the effluent is frozen to selectively remove pollutants. Freeze concentration takes advantage of the fact that when most aqueous solutions freeze, the ice crystal is almost 100 percent water.

This process was evaluated by Wiley (189) on three bleach plant effluents. Reverse osmosis alone resulted in a concentrate stream of roughly 10 percent of the volume of the raw feed. Freeze concentration reduced the concentrate stream volume by a factor of five while essentially all the impurities were retained in the concentrate. Thus the two processes employed in tandem resulted in a concentrate stream consisting of roughly 2 percent of the original feed volume containing essentially all of the dissolved solids.(189) It was reported that the purified effluent was of sufficient quality that it could be returned to the process for reuse.(189) Wiley did not investigate final disposal of the concentrate.

Amine Treatment

This treatment is based upon the ability of high molecular weight amines to form organophillic precipitates. These precipitates are separated and re-dissolved in a small amount of strong alkaline solution (whitewater). By so doing, the amine is regenerated for use, with no sludge produced.

The Pulp and Paper Research Institute of Canada (PPRIC) conducted a study (190) to determine the optimum process conditions for employing high molecular weight amines for color, BOD_5 and toxicity reductions of bleached kraft mill effluents. While no specific toxic or nonconventional pollutants were reported, whole mill bleached kraft effluent remained toxic after application of the treatment in two reported tests. Likewise, acid bleach effluent could not be detoxified. However, alkaline bleaching wastewater was detoxified in three out of four samples at 65 percent dilution. Final effluent concentrations for BOD_5, COD and color of bleached kraft whole mill wastewater were 80 to 350 mg/l, 380 to 760 mg/l, and 2,670 APHA units, respectively. Reported removals were 10 to 74 percent, 36 to 78 percent and 90 to 99 percent, respectively, using Kemaminest-1902D in a solvent of Soltrol 170.

Polymeric Resin Treatment

Polymeric resin treatment involves the use of resins in columns to treat wastewater. The process utilizes adsorption and ion exchange mechanisms to remove pollutants from the wastewater. The columns are regenerated after a treatment cycle is completed. Regeneration can be achieved by utilizing an alkaline solution.

The Rhom and Haas process involves the use of amberlite XAD-8 resin to decolorize bleaching effluent after filtration. The resin can be regenerated without producing waste sludge as a byproduct. This regeneration may be accomplished by using mill white liquor.

In one study (191) the adsorption capacity of amberlite XAD-2 resin was compared to Filtrasorb 300 activated carbon. The resin was more effective in removing most aromatic compounds, phthalate esters and pesticides while carbon was more effective at removing alkenes. Neither adsorbant was effective at the removal of acidic compounds. The tests involved use of laboratory solutions of 100 organic compounds at an initial concentration of 100 ug/l.

Another study (192) has shown synthetic resin to be capable of removing a higher percentage of COD from secondary effluent than carbon. Also, resin treated wastewater quality was improved when further treated with carbon, although the reverse was not true. The economics of this system could prove favorable since resin may be regenerated in situ. Thus, total regeneration costs may be more economical than for either system alone since carbon life could be significantly extended.

Elimination of toxic constituents from bleached kraft effluents has been achieved with Amberlite XAD-2 resin.(193, 194) Wilson and Chappel (195) have reported that treatment with Amberlite XAD-2 resin resulted in a nontoxic semi-chemical mill effluent.

EVALUATION OF CURRENT TREATMENT TECHNOLOGIES

Identification Of Current Treatment Technologies

Biological treatment systems are currently employed extensively by pulp, paper, and paperboard mills to reduce BOD5 and TSS loads. A summary of treatment systems currently employed in the pulp, paper and paperboard industry is shown in Table VII-16. As seen, aerated stabilization is the most common treatment process employed at mills discharging directly to a receiving water. At a relatively large number of plants in the nonintegrated and secondary fiber subcategories only primary treatment is employed. Primary treatment can often achieve substantial BOD5 reductions if BOD5 is predominantly contained in suspended solids.

The mills with treatment systems exhibiting the greatest percent BOD5 and TSS removals are shown in Table VII-17 for each subcategory. BOD5 removals for these mills range from 70 to 99 percent with effluent concentrations between 9 and 235 mg/l. Activated sludge is employed at 9 of the 18 mills.

Performance of Current Treatment Technologies

Utilizing the treatment system design information collected through the data request program, profiles of the primary and biological treatment systems utilized by the mills were developed. These design information summaries will be utilized at a later date to assist in evaluating the long-term wastewater data obtained as part of the verification survey and the data to be collected in the supplemental data request program.

A primary clarifier design criteria summary for existing systems is tabulated in Table VII-18. A summary of the ASB aeration basin detention times is presented by subcategory in Table VII-19. These values were determined from reported wastewater flows and aeration basin volumes. Approximately 42 percent of the mills reporting sufficient data had ASB detention times in the range of 6 to 10 days. Approximately 30 percent had systems with over 10 days detention, and the remaining 28 percent had systems with less than 6 days' detention.

Activated sludge basin detention times are shown in Table VII-20. About 46 percent of the mills for which sufficient data were reported had aeration basin detention times of six hours or less. Approximately 28 percent had detention times over 12 hours with the remaining 26 percent between 6 and 12 hours detention time.

Installed aeration capacity was also evaluated both on an organic and mixing basis. The following criteria were established for means of comparison of the existing systems:

TABLE VII-16

SUMMARY OF METHOD OF DISCHARGE AND INPLACE TECHNOLOGY

Subcategory	Number of Mills	Method of Discharge: Direct	Method of Discharge: Indirect	Method of Discharge: Self Contained	Treatment Scheme - Direct Discharge: No External Treatment	Primary Only	Aerated Lagoon	Lagoon w/ Polishing Pond	Activated Sludge	Trickling Filter	Other
011 Alkaline-Dissolving	3	3					2		1		
012 Alkaline-Market	9	9			2		4	1	1		1
013 Alkaline-BCT	8	8					3	4			1
014 Alkaline-Fine	18	14	4				2	2	5		5
015 Alkaline-Unbleached	29	28	1			2	9	5	4	1	7
016 Semi-Chemical	19	17	2		2	1	1	6	3		4
017 Alkaline-Unbleached and Semi-Chemical	10	9	1				7		1		1
019 Alkaline-Newsprint	3	3						1	1		1
021 Sulfite-Dissolving	6	6				3	1		1		1
022 Sulfite-Papergrade	18	17	1		2	6	3		1		5
032 Thermo-Mechanical Pulp	2	2				1			1		
033 Groundwood-CMN	6	5	1			1			1		3
034 Groundwood-Fine	8	7	1		1	1			3		2
101 Deink-Fine & Tissue	17	10	5	2	1		2		7		
102 Deink-Newsprint	3		3								
111 Wastepaper-Tissue	22	11	3	8	2	4	2		1		2
112 Wastepaper-Board	147	45	84	18	3	8	21		4		9
113 Wastepaper-Molded Products	15	2	11	2		1	1				
114 Wastepaper-Construction Products	58	4	36	18	1	1		2			
201 Nonintegrated-Fine	39	18	19	2	3	6	3	1	2		3
202 Nonintegrated-Tissue	26	14	12		1	10	2				1
204 Nonintegrated-Lightweight	18	14	4			6	1			1	6
205 Nonintegrated-Filter & Nonwoven	16	6	10			3	1		1		1
211 Nonintegrated-Paperboard	12	5	7			3	2				
*Integrated-Miscellaneous	88	71	14	3	3	10	18	8	15	2	13
*Secondary Fiber-Miscellaneous	13	7	6			1	1	1	3		2
*Nonintegrated-Miscellaneous	31	24	5	2	1	12	3	1	1		6
TOTAL	644	359	230	55	22	80	89	31	59	4	74

*Groupings of miscellaneous mills - not subcategories.
NOTE: Data for 1976 calendar year.

TABLE VII-17

MILLS REPORTING BEST PERCENT REMOVAL OF BOD5 & TSS BY SUBCATEGORY

Subcategory	Production (tons/day)	Final Effluent Average Day Flow (kgal/t)	BOD5 lb/ton	BOD5 (mg/l)	TSS lb/ton	TSS (mg/l)	Treatment Type	Percent Reduction BOD5	Percent Reduction TSS
011 Alkaline-Dissolving	1,152	57.2	14.9	34	28.99	61	ASB	86	82
012 Alkaline-Market	722	41.1	5.4	16	6.1	18	ASBw/Hold.	94	88
013 Alkaline-BCT	314	44.8	4.2	11	7.7	21	ASB	94	91
014 Alkaline-Fine	765	16.8	1.2	9	3.9	30	Act.Sl.	97	94
015 Alkaline-Unbleached	1,074	11.6	1.5	16	3.3	34	ASB	94	99
016 Semi-Chemical	491	8.1	2.5	38	2.9	43	Act.Sl.	95	97
017 Alkaline-Unbleached and Semi-Chemical	1,700	12.5	4.1	40	6.9	67	Act.Sl.	87	86
019 Alkaline-Newsprint	1,565	23.6	4.6	23	4.7	24	ASB	91	95
021 Sulfite-Dissolving	387	41.6	81.7	235	22.2	64	ASB	71	92
022 Sulfite-Papergrade	493	22.2	10.2	60	14.8	80	ASB	87	92
032 Thermo-Mechanical Pulp	155	19.5	11.1	68	58.7	360	Act.Sl.	71	29
033 Groundwood-CMN	982	28.4	12.7	54	9.0	38	Act.Sl.	70	90
034 Groundwood-Fine	787	13.9	1.0	9	3.9	34	Act.Sl.	95	96
101 Deink-Fine & Tissue	845	21.7	6.9	38	12.5	69	Act.Sl.	95	97
111 Wastepaper-Tissue	164	21.1	2.6	15	0.8	5	Act.Sl.	93	99
112 Wastepaper-Board	322	1.4	0.1	11	0.5	41	ASB	99	98
201 Nonintegrated-Fine	411	26.4	3.5	16	5.4	25	ASB w/Hold.	88	94
202 Nonintegrated-Tissue	194	16.4	4.2	31	1.1	9	No Sec.Trtmt	86	99
204 Nonintegrated-Lightweight	64	53.8	16.1	36	4.7	10	Trick.Filter	86	98
205 Nonintegrated-Filter & Nonwoven	43	69.1	4.1	7	6.2	11	ASB	87	92

Note: Data represents 1976 calendar year.

TABLE VII-18

PRIMARY CLARIFIER OVERFLOW RATE SUMMARY

Subcategory	Number of Mills Reporting	Overflow Rate - gpd/ft2 Average	Less Than 400	400 to 600	Over 600	Exceeding Design Capacity	Insufficient Data Rate/Design
011 Alkaline-Dissolving	2	465	1	1	0	0	0/0
012 Alkaline-Market	4	445	2	2	0	0	0/1
013 Alkaline-BCT	8	473	4	2	2	2	0/2
014 Alkaline-Fine	13	900	0	7	6	0	0/1
015 Alkaline-Unbleached	22	389	12	8	1	1	1/2
016 Semi-Chemical	8	577	4	2	2	0	0/1
017 Alkaline-Unbleached and Semi-Chemical	6	800	1	2	3	2	0/0
019 Alkaline-Newsprint	3	474	1	1	1	0	0/1
021 Sulfite-Dissolving	2	667	0	1	1	1	0/0
022 Sulfite-Papergrade	11	680	0	5	5	4	1/1
032 Thermo-Mechanical Pulp	1	920	0	0	1	0	0/1
033 Groundwood-CMN	3	508	1	0	1	0	1/1
034 Groundwood-Fine	6	439	2	4	0	0	0/0
101 Deink-Fine & Tissue	10	457	4	3	3	0	0/1
102 Deink-Newsprint	0	-	-	-	-	-	-
*Secondary Fiber Miscel.	4	455	2	0	2	0	0/1
111 Wastepaper-Tissue	1	650	0	0	1	1	0/0
112 Wastepaper-Board	44	697	10	10	14	4	10/22
113 Wastepaper-Molded Products	1	657	0	0	1	1	0/0
114 Wastepaper-Construction	2	1,171	0	0	1	0	1/1
201 Nonintetrated-Fine	0	-	-	-	-	-	-
202 Nonintegrated-Tissue	0	-	-	-	-	-	-
204 Nonintegrated-Lightweight	0	-	-	-	-	-	-
205 Nonintegrated-Filter and Nonwoven	0	-	-	-	-	-	-
211 Nonintegrated-Paperboard	0	-	-	-	-	-	-
*Integrated-Miscellaneous	43	565	11	16	14	5	2/5
*Nonintegrated-Miscel. Products	3	1,251	1	1	1	1	0/0
TOTAL	199	640	56	65	60	22	18/43

*Miscellaneous mill groups - not subcategory

TABLE VII-19

AERATED STABILIZATION
BASIN DETENTION TIME SUMMARY

ubcategory	Mills Reporting Data	Detention Time: Over 10 Days	6 to 10 Days	Under 6 Days	Insufficient Data
11 Alkaline-Dissolving	1	0	1	0	0
12 Alkaline-Market	5	1	3	1	0
13 Alkaline-BCT	8	5	0	0	3
14 Alkaline-Fine	5	1	1	0	3
15 Alkaline-Unbleached	15	4	4	3	4
16 Semi-Chemical	11	4	3	1	3
17 Alkaline-Unbleached and Semi-Chemical	8	1	4	2	1
19 Alkaline-Newsprint	2	1	0	0	1
22 Sulfite-Papergrade	3	0	3	0	0
32 Thermo-Mechanical Pulp	0	-	-	-	-
33 Groundwood-CMN	1	0	0	0	1
01 Deink-Fine & Tissue	2	0	1	1	0
02 Deink-Newsprint	0	-	-	-	-
11 Wastepaper-Tissue	0	-	-	-	-
12 Wastepaper-Board	21	1	3	3	14
13 Wastepaper-Molded Products	1	0	0	0	1
01 Nonintegrated-Fine	0	-	-	-	-
02 Nonintegrated-Tissue	0	-	-	-	-
04 Nonintegrated-Lightweight	0	-	-	-	-
11 Nonintegrated-Paperboard	0	-	-	-	-
*Integrated-Miscellaneous	27	5	8	8	5
*Secondary Fiber Miscel.	1	0	1	0	0
TOTAL	112	23	32	21	36

Miscellaneous mill groups - not subcategories.
OTE: Subcategories not included had no mills reporting appropriate data.

TABLE VII-20

ACTIVATED SLUDGE
DETENTION TIME SUMMARY

Subcategory	Mills Reporting Data	Detention Time-Hours: Less Than 4	4 to 6	6 to 8	8 to 12	More Than 12	Insufficient Data
012 Alkaline-Market	1	0	0	0	0	1	0
014 Alkaline-Fine	5	1	1	1	1	0	1
015 Alkaline-Unbleached	6	1	2	0	1	1	1
016 Semi-Chemical	2	0	0	0	0	2	0
017 Alkaline-Unbleached & Semichemical	1	1	0	0	0	0	0
019 Alkaline-Newsprint	1	1	0	0	0	0	0
021 Sulfite-Dissolving	1	0	0	0	0	1	0
022 Sulfite-Papergrade	5	0	0	0	0	2	3
033 Groundwood-CMN	1	0	0	0	0	1	0
034 Groundwood-Fine	7	1	2	0	0	2	2
101 Deink-Fine & Tissue	7	1	2	0	0	0	4
112 Wastepaper-Board	3	0	0	1	0	0	2
114 Wastepaper-Construction Products	1	0	0	0	0	0	1
*Nonintegrated-Miscel.	2	1	1	0	0	0	0
*Integrated-Miscel.	16	4	1	2	4	1	4
*Secondary Fiber Misc.	2	0	0	0	1	1	0
TOTAL	61	11	9	4	7	12	18

*Miscellaneous mill groups - not subcategories.
Note: Subcategories not included had no mills reporting appropriate data.

1. Organic Loading

ASB	36 pounds of BOD_5 per day per hp
AS	30 pounds of BOD_5 per day per hp

2. Mixing

ASB & AS	10 hp per million gallons of volume for the basins.

Table VII-21 shows the comparison for mills with aerated stabilization basins (ASB), and Table VII-22 shows the comparison for activated sludge (AS).

Table VII-23 summarizes reported secondary clarifier overflow rate information. As seen, about 24 percent of those mills reporting sufficient data show a rate greater than 600 gpd/ft^2. Also 19 percent reporting show an existing secondary clarifier rate exceeding the reported design rate for that clarifier.

In order to more accurately assess current effluent qualities, more recent data has been and will be requested from selected mills. This data will not only provide recent treatment levels, but will also provide a basis on which effluent quality variablity may be evaluated.

Model Mill Existing Effluent Treatment Facilities

The existing model mill for each subcategory is assumed to have an adequately designed and properly operating effluent treatment system capable of attaining BPT effluent limitations.

Based on existing effluent treatment systems employed in the industry and their capability of removing pollutants, the direct discharging model mill in each subcategory is considered to have the effluent treatment processes indicated in Table VII-24. Mills discharging to publicly owned treatment works (POTW's) are assumed to have no on-site effluent treatment.

PROJECTED EFFLUENT TREATMENT TECHNOLOGIES FOR MODEL MILLS

Selection of Effluent Treatment Technology Options

Production process controls and effluent treatment technologies have been identified which can be implemented at mills in the pulp, paper and paperboard industry to improve the raw wastewater and/or final effluent quality. Effluent treatment options have been selected for cost analyses and evaluation of effluent quality attainable.

The selection of proposed treatment options involved a consideration of expected treatment efficiency, availability, and the anticipated cost of implementation of the various technologies. In order to assess the overall econo-

TABLE VII-21

AERATED STABILIZATION BASIN
AERATOR HORSEPOWER SUMMARY

Subcategory	Mills Reporting Data	HP for BOD5 Above Criteria	HP for BOD5 Below Criteria	HP for BOD5 Insufficient Data	HP for Mixing Above Criteria	HP for Mixing Below Criteria	HP for Mixing Insufficient Data
011 Alkaline-Dissolving	1	1	0	0	0	1	0
012 Alkaline-Market	5	4	1	0	1	4	0
013 Alkaline-BCT	8	5	0	3	0	7	1
014 Alkaline-Fine	5	1	1	3	2	3	0
015 Alkaline-Unbleached	15	6	5	4	6	9	0
016 Semi-Chemical	11	8	0	3	11	0	0
017 Alkaline-Unbleached and Semi-Chemical	8	3	4	1	5	3	0
019 Alkaline-Newsprint	2	0	1	1	0	2	0
022 Sulfite-Papergrade	3	3	0	0	3	0	0
023 Sulfite-Papergrade	1	0	0	1	1	0	0
033 Groundwood-CMN	1	0	0	1	0	1	0
101 Deink-Fine & Tissue	2	0	0	2	2	0	0
112 Wastepaper-Board	21	5	2	14	18	2	1
113 Wastepaper-Molded Products	1	0	0	1	0	0	1
211 Nonintegrated-Paperboard	1	1	0	0	1	0	0
*Integrated-Miscel.	27	13	5	9	13	13	1
*Secondary Fiber Misc.	1	0	0	1	1	0	0
TOTAL	112	50	19	43	63	45	4

*Miscellaneous mill groups - not subcategories
Note: Subcategories not included had no mills reporting appropriate data.

TABLE VII-22

ACTIVATED SLUDGE
AERATOR HORSEPOWER SUMMARY

Subcategory	Mills Reporting Data	HP for BOD5 Above Criteria	HP for BOD5 Below Criteria	HP for BOD5 Insufficient Data	HP for Mixing Above Criteria	HP for Mixing Below Criteria	HP for Mixing Insufficient Data
012 Alkaline-Market	1	0	1	0	1	0	0
014 Alkaline-Fine	5	1	2	2	5	0	0
015 Alkaline-Unbleached	6	3	2	1	5	0	1
016 Semi-Chemical	2	2	0	0	2	0	0
017 Alkaline-Unbleached and Semi-Chemical	1	0	1	0	1	0	0
019 Alkaline-Newsprint	1	1	0	0	1	0	0
021 Sulfite-Dissolving	1	1	0	0	1	0	0
022 Sulfite-Papergrade	5	2	0	3	4	0	1
033 Groundwood-CMN	1	1	0	0	1	0	0
034 Groundwood-Fine	7	5	0	2	6	0	1
101 Deink-Fine & Tissue	7	3	1	3	5	0	2
112 Wastepaper-Board	3	0	1	2	3	0	0
114 Wastepaper-Construction Products	1	0	0	1	0	0	1
*Nonintegrated-Miscel.	2	1	1	0	2	0	0
*Integrated-Miscel.	16	5	5	6	12	1	3
*Secondary Fiber-Miscel.	2	2	0	0	2	0	0
TOTAL	5	27	14	20	51	1	9

*Miscellaneous mill groups - not subcategories
Note: Subcategories not included had no mills reporting appropriate data.

TABLE VII-23

SECONDARY CLARIFIER
OVERFLOW RATE SUMMARY

Subcategory	No. Mills Reporting Data	Average	Overflow Rate-gpd/ft2 Less Than 400	400 to 600	Over 600	Exceeding Reported Design Overflow Rate	Insufficient Data Rate/Design
012 Alkaline-Market	1	418	0	1	0	0	0/0
014 Alkaline-Fine	8	619	3	2	3	1	0/0
015 Alkaline-Unbleached	6	444	2	4	0	1	0/0
016 Semi-Chemical	5	718	0	1	3	2	1/1
017 Alkaline-Unbleached & Semi-Chemical	1	392	1	0	0	0	0/0
019 Alkaline-Newsprint	2	284	1	0	0	0	1/1
021 Sulfite-Dissolving	1	875	0	0	1	1	0/0
022 Sulfite-Papergrade	7	408	2	4	1	2	0/1
032 Thermo-Mechanical Pulp	1	909	0	0	1	0	0/0
033 Groundwood-CMN	1	639	0	0	1	1	0/0
034 Groundwood-Fine	6	447	1	3	1	1	1/1
101 Deink-Fine & Tissue	6	885	0	4	1	0	1/1
Wastepaper-Board	11	574	3	4	1	0	3/3
113 Wastepaper-Molded	1	456	0	1	0	1	0/0
*Nonintegrated-Misc.	2	194	2	0	0	0	0/0
*Integrated-Miscel.	21	443	9	8	4	4	0/1
*Secondary Fiber-Miscel.	2	606	0	1	1	0	0/0
TOTAL	82	532	24	33	18	14	7/9

*Miscellaneous mill groups - not subcategories.
Note: Subcategories not included had no mills reporting appropriate data.

TABLE VII-24

MODEL MILL EXISTING EFFLUENT TREATMENT

Subcategory		Treatment
011	Alkaline-Dissolving	P/B
012	Alkaline-Market	P/B
013	Alkaline-BCT	P/B
014	Alkaline-Fine	P/B
015	Alkaline-Unbleached	P/B
016	Semi-Chemical	P/B
017	Alkaline-Unbleached and Semi-Chemical	P/B
019	Alkaline-Newsprint	P/B
021	Sulfite-Dissolving	P/B
022	Sulfite-Papergrade	P/B
032	Thermo-Mechanical Pulp	P/B
033	Groundwood-CMN	P/B
034	Groundwood-Fine	P/B
101	Deink-Fine & Tissue	P/B
102	Deink-Newsprint	P/B
111	Wastepaper-Tissue	P/B
112	Wastepaper-Board	P
113	Wastepaper-Molded Products	P/B
114	Wastepaper-Construction Products	P/B
201	Nonintegrated-Fine	P/B
202	Nonintegrated-Tissue	P
204	Nonintegrated-Lightweight	P
205	Nonintegrated-Filter & Nonwoven	P
211	Nonintegrated-Paperboard	P

P - Primary
B - Biological

mic impact of future effluent limitations and standards on the pulp, paper and paperboard industry, three discharge characteristics have been chosen: 1) direct discharge; 2) indirect discharge; and 3) new point source mills.

Direct Discharge Mills

Direct discharge mills are those mills where discharge is direct to a receiving water. The levels of treatment applicable at direct discharge mills are summarized as follows:

Level 1. Level 1 technology comprises implementation of production process controls expected to yield significant reductions in raw waste discharges of BOD_5 and flow, as outlined in Section VI.

Level 2. Level 2 technology consists of additional production process controls which can be implemented in addition to those specified in Level 1. These are expected to result in significant reductions in TSS raw waste loads, with additional reduction in flow and/or BOD_5.

Level 3. Level 3 technology involves the addition of chemically assisted clarification to provide for additional treatment of Level 2 raw waste loads. Implementation of Level 3 technology is expected to yield further reductions in final effluent TSS, BOD_5, and toxic and nonconventional pollutants will be removed to the extent that they are contained in TSS.

Level 4. Addition of chemically assisted clarification and carbon adsorption to further treat Level 2 raw waste loads to yield further reductions in final effluent BOD_5, and TSS. Significant removals of toxic and nonconventional organic pollutants are anticipated.

Indirect Discharge Mills

Based on responses to the data request program, there are 230 pulp, paper, or paperboard mills where discharge is to publicly or privately owned treatment works (POTW's). In several of the integrated mill subcategories under investigation, there are no indirect dischargers; while some of the nonintegrated subcategories have 10 or more indirect dischargers.

As part of the BATEA review program, it is required that pretreatment standards for facilities discharging to POTW's be established. The toxic and nonconventional pollutants under investigation are of primary importance. Because the subcategories under investigation have few or no indirect dischargers, costs for implementation of pretreatment options at indirect discharging mills were not evaluated. This included the following subcategories:

Alkaline-Dissolving (0)	Alkaline-Market (0)
Alkaline-BCT	Alkaline-Unbleached (1)
Alkaline-Unbleached and Semi-Chemical(1)	Semi-Chemical (2)
Alkaline-Newsprint (0)	Sulfite-Dissolving (0)
Sulfite-Papergrade (1)	Groundwood-CMN (1)
Thermo-Mechanical Pulp (0)	
Groundwood-Fine (1)	

( ) Number of indirect discharging mills.

Three levels of technology have been developed for application at the indirect discharge mills and are summarized below:

Level 1. Level 1 technology for indirect discharge mills involves implementation of production process controls expected to yield significant reductions in raw wastewater discharges of BOD_5 and flow, with associated reduction in toxic pollutants (production process controls specified in option Level 1 for direct discharging mills).

Level 2. Implementation of additional production process controls in addition to those specified in Level 1, (these are expected to result in significant reductions in TSS raw wastewater load with additional reduction in flow and/or BOD_5) plus the addition of primary clarification.

Level 3. For all subcategories under consideration, Level 3 provides for the addition of effluent treatment technology to provide further treatment of Level 2 effluent.

For the Alkaline-Fine, Deink-Fine and Tissue, and Deink-Newsprint subcategories, Level 3 effluent treatment would be biological treatment. Preliminary analysis of data for the remaining subcategories under consideration indicates that low levels of toxic and nonconventional pollutants will be present after implementation of Level 2 technology. For the Wastepaper-Tissue, Wastepaper-Board, Wastepaper-Molded Products, Wastepaper-Construction Products, Nonintegrated-Fine, and Nonintegrated-Tissue subcategories, Level 3 effluent treatment would involve the addition of chemicals to improve the efficiency of the primary clarification system. In the event that future analysis of data for these subcategories indicates the presence of significant levels of toxic pollutants, the addition of activated carbon adsorption to treat the effluent from chemically assisted clarification has been contemplated.

New Point Source Discharge Mills

In this evaluation, one level of technology has been considered for application at new point sources. The technology presented includes production process controls and effluent treatment technology. Production process controls under consideration are those included in Level 1 for direct discharge mills. After application of these production process controls, implementation of chemically assisted clarification has been assumed at new mills in the following subcategories:

Wastepaper-Molded Products
Nonintegrated-Fine
Nonintegrated-Tissue
Nonintegrated-Lightweight
Nonintegrated-Filter and Nonwoven

At new mills in the Wastepaper-Tissue, Board and Construction Products subcategories, zero discharge is predicted upon the installation of Level 2 production process controls. This is supported by the observation that many of these mills are currently achieving zero discharge.

At new mills in the remaining subcategories it has been assumed that production process controls, primary clarification, biological treatment, and chemically assisted clarification technologies will be employed.

Design Criteria for Selected Effluent Treatment Technologies

In order to estimate the cost associated with implementation of the various control and treatment options, design criteria for each unit process have been developed. These criteria are summarized in Table VII-25 and are discussed in the following paragraphs. The equipment and installation criteria presented on the following pages are the basis on which capital costs have been estimated in Section IX.

Preliminary Treatment. Many foreign objects enter mill sewers, either through mill floor drains or process sewers. These objects, such as wood chips, bark, wet strength paper, etc., could interfere with the treatment processes or increase wear on the process equipment. Consequently, it is necessary that these objects be removed from the mill sewers prior to treatment. A mechanically cleaned bar screen is generally used at most pulp, paper, and paperboard mills for preliminary treatment. The mill sewers containing larger amounts of solids flow into this facility, with the low solids sewers bypassing it. The bar screen assumed is a mechanically operated, self-cleaning travelling bar screen with a bar spacing of 1-2 inches. A bypass channel and manual bar screen are incorporated into the design to allow for screening during periods of maintenance on the mechanical bar screen. A "dumpster" unit is used for containment of the removed solids.

TABLE VII-25

EFFLUENT TREATMENT DESIGN CRITERIA SUMMARY

Preliminary Treatment
- Bar Screen - mechanically operated
- Flow monitoring - parshall flume
- Continuous sampling

Wastewater Pumping
- Design Flow: 1.3 to 2.0 x average annual flow depending on subcategory
- Basis for power cost - 40ft. TDH, 70% efficient

Primary Clarification
- Thickener type clarifier with rotary sludge scraper and scum collection equipment
- Two parallel units used for flows greater than 5 mgd
- Design overflow criteria - 600 gpd/ft^2 at average flow rate
- Sidewater depth - 12 ft

Aerated Stabilization Basin
- Number of basins: 1
- Loading rate (use larger value)
  - Biological detention - 50 lbs/ac.-ft/day
  - Hydraulic detention - 11 days (10 days aeration, 1 day settling)
- Aeration: 1.25 lbs O_2/lb BOD_5 removed
  - 37 lb O_2/HP-day
- Sidewater depth: 12 feet
- Nutrient addition: BOD_5:N:P = 100:5:1

Activated Sludge Basin
- Number of basins: 2
- Loading rate (use larger value)
  - 50 lbs/BOD/1,000 cu. ft./day
  - 8 hour hydraulic retention time
- Nutrient feed: BOD_5:N:P = 100:5:1
- Aeration design requirements:
  - 1 lb O_2/lb BOD_5 removed
  - 37 lb O_2/aerator hp-day
- Length/width ratio: 4/1
- Side water depth: 12 ft
- Side slope: 1/1

Chemically assisted clarification - Solids contact clarifier
- 2 units for flows greater than 5 mgd
- Overflow rate = 500 gpd/ft^2
- Sidewater depth = 14 ft

TABLE VII-25 (Continued)

Chemical dosage:
- Alum 150 mg/1
- Polyelectrolite 1 mg/1

Neutralization
- Number of units: 1
- Detention time: 1 min at peak daily flow
- Mixer: 1 hp/1,000 gal
- Dosage: 10 mg/1 sodium hydroxide

Activated Carbon Adsorption
- Design flow: 4 gpm/ft2
- Contact time: 30 min
- Carbon exhaustion rate: 3,000 lb/million gallons
- Regeneration furnace: (for flow exceeding 0.25 mgd only)
  - Hearth area: 40 lbs carbon/day/ft2
  - Allow for 40 percent downtime

Solids Dewatering
- Horizontal belt filter press
- 700 lbs of dry solids per hour per meter of belt width
- 8 lbs of polymer/tons of solids

Dissolved Air Flotation Thickening for Secondary Solids
- Sludge loading rate - 2 lbs/hr/ft2
- Hydraulic loading rate - .8 gpm/ft2

Sludge to Landfill
- Sludge solids content - 30 percent primary and biological sludge
20 percent alum sludge

Foam Control Facility:
- Detention time: 5 minutes
- Freeboard: maintain 12 ft for foam buildup

Outfall
- 1,000 foot length

Multiple Port Diffuser
- 12 ft diffuser length per mgd
- Minimum velocity in diffuser - 2.5 fps

It is advantageous to monitor and sample the flow to the treatment process. Therefore, the preliminary treatment facility includes the necessary flumes and monitoring and sampling equipment for complete flow measurement and sampling. The capital costs prepared for the preliminary treatment facility include the necessary excavations, backfill, concrete, mechanical equipment, flow monitoring equipment (with necessary ancillary equipment), and the superstructure.

Mill Effluent Pumping. Normally, the topography of the effluent treatment site is not conducive to gravity flow through the entire treatment process. Consequently, it is necessary to construct an effluent pumping facility which is capable of pumping the maximum daily flow of the treatment facility. The pumping facility used includes a wet well and dry well. The mill effluent flows into the wet well (with detention time of five minutes at maximum daily flow), while the variable speed pumps are located in a dry well adjacent to the wet well. The construction costs prepared for the mill effluent pumping facility include excavation, backfill, concrete, pumps, variable speed controls, ancillary piping and equipment, and superstructure.

A flow peaking factor was used in the design of pumping facilities. The peaking factor used for each model mill was derived from mill survey data and varied from 1.3 to 2.0, depending on the subcategory. A summary of the peaking factor used for the model mills in each subcategory is presented in Table VII-26.

Primary Clarification. Sizing of primary clarification equipment assumes fiber recovery is already being accomplished to the extent possible in the mill. Therefore, external fiber recovery for reuse has not been considered in the treatment process design. All mill sewers containing suspended solids are combined prior to primary clarification. For purposes of determining the amount of sludge produced, reductions by primary clarification of 75 to 80 percent of total suspended solids were used. The clarifier used for the cost model is a heavy-duty thickener type with rotary sludge scraper, and scum removal capabilities. The units were sized based on an average design overflow rate of 600 gpd/ft^2. The rotary sludge scraper drive mechanism is sized for a torque rating of $15D^2$. For flows in excess of 5 mgd, two parallel units, each capable of handling 50 percent of the daily flow, were used. Waste solids are withdrawn by pumping from the primary clarifier at an anticipated solids content of 3 to 4 percent to a mechanical dewatering device. Scum collected in the clarifier discharges into a storage tank where it is then pumped to the dewatering units. The capital costs calculated for primary clarification include excavation, backfill, concrete, mechanical, electrical, instrumentation equipment, scum facilities, waste sludge pumps, and yard piping.

Aerated Stabilization Basin. Aerated stabilization basins provide a high degree of BOD_5 reduction with minimal decreases in efficiencies due to shock loadings. Nutrients are added in proportion to the organic (BOD_5) loading of the facility. The ratio used for the cost analysis is 100:5:1, BOD_5:N:P.

TABLE VII-26

HYDRAULIC PEAKING FACTORS USED FOR WASTEWATER PUMPING

Subcategory		Factor
011	Alkaline-Dissolving	1.3
012	Alkaline-Market	1.3
013	Alkaline-BCT	1.6
014	Alkaline-Fine	1.3
015	Alkaline-Unbleached	1.5
016	Semi-Chemical	1.5
017	Alkaline-Unbleached and Semi-Chemical	1.3
019	Alkaline-Newsprint	1.7
021	Sulfite-Dissolving	1.3
022	Sulfite-Papergrade	1.3
032	Thermo-Mechanical Pulp	1.4
033	Groundwood-CMN	1.3
034	Groundwood-Fine	1.5
101	Deink-Fine and Tissue	1.3
102	Deink-Newsprint	1.3
111	Wastepaper-Tissue	1.7
112	Wastepaper-Board	2.0
113	Wastepaper-Molded Products	1.5
114	Wastepaper-Construction Products	1.5
201	Nonintegrated-Fine	1.5
202	Nonintegrated-Tissue	1.5
204	Nonintegrated-Lightweight	1.3
205	Nonintegrated-Filter and Nonwoven	1.5
211	Nonintegrated-Paperboard	1.5

The basins chosen for calculating the cost was a single cell earthen-basin. In most instances the basins are constructed in areas where the soils are impervious, or can be made impervious by lining with an impervious soil. For cost purposes it is assumed that an impervious soil liner will be required to make the basin watertight. The cost of a synthetic liner is not included.

Aeration for the ASB was sized with mechanical aerators under actual operating conditions for 1.54 pounds of O_2 per horsepower-hour or 37 lbs of O_2 per horsepower day. An aerator capacity of 10 horsepower per million gallons of basin volume was also used to ensure adequate mixing in the basin. The larger of the two aerator horsepower determinations was used.

The sizing of the aerated stabilization basins was evaluated on both organic loading rate and detention time design criteria. The design detention time is 11 days, which assumed 10 days of aeration with one day of quiescent settling. The design organic loading is 50 lb BOD_5 per acre-ft per day. The basin sizes obtained for the above cited detention time and organic loading were compared to determine which criteria was the governing value. The larger volume of the two methods was selected.

The capital costs prepared for the aerated stabilization basin include excavation, dike construction, impervious soil material, nutrient feed systems, yard piping, stone slope protection, instrumentation, and electrical costs.

Activated Sludge Basin. The activated sludge process has numerous modifications in detention times, organic loadings, and oxygenation. The process selected for consideration in this report is commonly referred to as the conventional activated sludge process (6 to 8 hours detention time). Nutrients are added in proportion to the organic (BOD_5) loading to the facility. A BOD_5:N:P ratio of 100:5:1 is used for cost analysis.

Final clarifiers are required with the activated sludge basin to allow separation of the biological mass and treated stream. This biological mass is necessary to achieve high removal efficiencies. The high rate activated sludge system also generates large quantities of biological solids which are not oxidized as in ASB systems. It is necessary, therefore, to continuously remove excess biological solids. These excess solids (waste activated sludge) can be extremely gelatinous with a solids concentration of approximately 0.5 to 1.0 percent by weight.

In an activated sludge system, most of the biological solids settled in the secondary clarifiers are recycled to the aeration basin to maintain an active biological mass in the aeration basin. Pumping capacity is provided for a maximum recycle rate of 75 percent of the average daily flow with an average recycle rate of 40 percent of the average daily flow.

The costs prepared for the activated sludge basin are based on a two-cell concrete tank. The cells would be operated in parallel to provide operational flexibility.

The activated sludge system requires approximately one lb of oxygen/lb of BOD_5 removed. Mechanical aerator performance for the activated sludge (AS) system was assumed to be the same as that described earlier for the ASB. An aerator capacity of 10 horsepower per million gallons of basin volume was also used to ensure adequate mixing in the basin. The larger of the two aerator horsepower determinations was used.

Sizing of the activated sludge system is based on both detention time and organic loading. The detention time is 8 hours (excluding recycle), while the organic loading rate is 50 lb BOD_5 per 1000 cubic ft of aeration volume. The larger volume of the two values was selected for cost analysis.

The capital costs prepared for the activated sludge basins (presented as a function of the basin capacity) includes excavation, tank construction, concrete, nutrient feed systems, yard piping, electrical and instrumentation costs.

Chemically Assisted Clarification. A solids-contract type clarifier is required to accomplish flocculation, settling and sludge removal. The effluent flows into a flocculation chamber in the clarifier. In this chamber flocculants such as alum and polymer are added to the wastewater stream. Low-speed mixers disperse the flocculants throughout the chamber allowing for coagulation and floc formation. The wastewater stream then flows into the clarifier area for solids separation.

For flows in excess of 5 mgd, two parallel units, each capable of 50 percent of the daily flow, were assumed to be used. The design overflow rate for the clarifiers, excluding flocculation area, is 500 gpd/ft^2. The drive mechanism would be designed for a torque of $10D^2$.

At mills where activated sludge treatment is employed, the chemical clarification design reflects an additional solids contact clarifier following the existing secondary clarifier. It is likely that at many mills, an existing secondary clarifier would be modified to allow for chemically assisted clarification; this would result in less capital expenditure. The additional clarifier however, would allow sludge recycle to occur without being affected by chemical addition, and would provide for the possibility of chemical recovery if it becomes economically advantageous.

The primary flocculant used in the design is alum. Polymer is added to improve settling. Addition of 150 mg/l alum and 1 mg/l polymer is assumed. Alum addition tends to lower the pH of the effluent. Optimum alum flocculation is reached at a pH of 5.5 to 6.0. If the effluent pH changes to a value where the effectiveness of flocculation deteriorates and/or the effluent does not meet pH limitations, neutralization may be required. Therefore, neutralization is included whenever chemically assisted clarification is applied. Sodium hydroxide is used for neutralization and an average dosage of 10 mg/l is assumed for cost purposes.

The capital costs presented for chemically assisted clarification include excavation, backfill, concrete, recycle pumps, mechanical equipment, electrical, instrumentation, yard piping, chemical storage and mixing equipment, and ancillary equipment for proper operations.

Neutralization. Pulping processes significantly change the pH of a wastewater. Such variations in pH can affect the wastewater treatment process. Therefore, it is necessary to add chemicals to the wastewater for neutralization. Sodium hydroxide at a dosage of 10 mg/l was utilized for the neutralization chemical.

The capital cost for pH adjustment includes excavation, backfill, concrete, mixer, chemical feed system, electrical and instrumentation costs. The flash mix tank provides a 1-minute detention time at peak flow with a mixer sized at 1 hp/1000 gal. capacity of mix tank.

Carbon Adsorption. The carbon adsorption design assumes downflow granular activated carbon columns. The columns have a design flow rate of 4 gpm/ft^2, and a contact time of 30 minutes. One to ten spare columns are considered, depending on effluent flow.

The carbon dosage rate is assumed to be 3000 lb carbon per million gallons of treated effluent. On-site carbon regeneration is assumed for all flows greater than 0.25 mgd. Flow under 0.25 mgd was determined to operate more economically on a carbon throw-away basis. A regeneration furnace hearth area of 40 lb carbon per day per square foot is assumed. The furnace capacity is designed for 40 percent down time.

The topography of many mill sites may require effluent pumping prior to carbon adsorption. Therefore, an additional pump facility has been assumed when carbon adsorption is applied. The design of the pump facility is similar to that described earlier. The peaking factor, however, is 1.3 for all subcategories.

Sludge Dewatering. Several unit processes are used by the pulp and paper industry for sludge dewatering. A method which is gaining wide acceptance is horizontal belt filter press. Many different types of horizontal belt filter presses are available. However, they basically achieve sludge dewatering through the use of gravity draining of the sludge through a continuously moving belt filter and then further dewater the sludge in a one or two-stage pressure zone. The pressure is applied to the sludge by a second belt which converges on the main belt at the start of the initial pressure zone. These belts rotate continuously over and around a series of varying size rollers which are utilized to exert the pressing action on the sludge mat between the two belts. Some models of the horizontal belt filter press utilize a vacuum system to aid in the initial dewatering prior to the pressure zone(s). Blades, which are at the end of the final stage of the belt filter press, scrapes the dewatered sludge off the belts. The solids content achievable in the dewatered sludge will depend upon the sludge being handled.

Primary sludge usually has a solids content of 3 to 5 percent. These sludges normally contain fibrous material that enhance filterability. Biological sludge can be extremely gelatinous and difficult to dewater, and require thickening prior to dewatering. Biological sludge may be added to primary sludge to further improve dewatering characteristics of a biological sludge.

Chemical coagulants are often added to improve dewaterability, although primary sludge may sometimes be dewatered without coagulants. For cost purposes, 8 lbs of polymer per ton of solids are assumed for both primary and secondary sludge dewatering. A final solids concentration of 30 percent is assumed for the combined sludge.

Alum sludge is also very gelatinous and difficult to dewater. Mixing with primary sludge and addition of polymer, however, can improve dewaterability. For cost purposes, the dewatering of alum sludge was determined based on the design of a separate horizontal belt filter press dewatering facility. An addition of 8 lb of polymer per ton of solids was assumed for alum sludge dewatering. Due to its gelatinous nature, a final solids concentration of 20 percent was assumed for dewatered alum sludge. In an actual mill, the dewatering of alum sludge could be performed by modifying existing facilities used for current sludge dewatering.

The horizontal belt filter press was assumed to have a design loading rate of 700 lb of solids per hour per metre of belt width. Actual throughput rates vary depending on the solids level of the sludge being dewatered and the type of sludge being handled. They can range from 500 to 2,000 lb/hr/metre of belt width. Smaller units have been designed to operate at 8 hrs/day, while larger systems operate 16 hrs/day.

The capital costs for horizontal belt filtration include: solids storage tank and sludge pumping building, mechanical equipment and appropriate ancillary equipment, piping, electrical and instrumentation.

Dissolved Air Flotation Thickening. Waste biological and/or biological-chemical solids from the secondary clarification process require thickening before they can be efficiently dewatered. If these solids are not thickened prior to dewatering the capacity of the horizontal belt filter press is greatly reduced. Air flotation was selected as the thickening process used for the development of costs. Air flotation requires addition of a flocculant such as a polymer to assist in the thickening process. The polymer is added to the waste solids prior to introduction into the flotation unit.

Air flotation requires the diffusion of air into the waste solids. This may be accomplished by a so-called "pressurization system". Basically, three types of pressurization systems are available: total, partial, and recycle pressurization.

The pressurized influent enters the flotation unit and the diffused air bubbles are allowed to surface. Diffusion of the air bubbles promotes coagulation and transports the sludge to the surface where it is skimmed off. It is anticipated that air flotation will increase the secondary waste solids to 3 to 4 percent solids. The filtrate and scum from the air flotation is recycled back to the treatment process. There are numerous process variables to be considered in sizing air flotation units. For this study it was assumed that the hours of operation of the flotation thickening equipment would vary depending on the solids loading.

An air flotation loading rate of 2 lb of dry solids/ft^2/hour was used in design of these facilities. The capital costs for air flotation thickening of waste biological and biological-chemical solids include building process equipment, chemical feed system, electrical, instrumentation, and ancillary equipment.

Solids Disposal. Solids are assumed to be disposed of in a landfill operation. The cost of a landfill is dependent on a variety of factors including sludge characteristics, hydrogeologic conditions of the disposal site, and proximity of the site to the mill. Due to this wide variability, no specific landfill technique was selected for the model mill.

Literature on several acceptable landfill techniques with associated requirements and estimated costs has been published by EPA relating to municipal sludges.(196) The techniques evaluated by EPA include: area fill layer, area fill mount, diked containment, narrow trench, wide trench, co-disposal with soil, and co-disposal with refuse.

The fiber present in pulp and paper wastewater can aid in solids dewatering resulting in sludge with a relatively low moisture content. The presence of clay and aluminum hydroxide in sludges would generally make dewatering more difficult and could result in higher disposal costs. Therefore, mid-range disposal costs for the cited techniques have been assumed for primary and secondary sludge disposal, while upper-range costs of disposal are assumed for chemical sludge disposal. A hauling distance of 10 miles has been considered in development of sludge transportation cost estimates.

Primary Solids Production. Primary suspended solids removal depends upon the relative size and weight of the particles involved. Usually, nonintegrated mills tend to achieve a higher percent TSS removal in primary treatment than integrated mills, due to the fine particles released during pulping processes. Other factors affecting solids removal include the type and amount of additives including inorganic clays employed in papermaking.

Based on information obtained through data request program, model mill primary solids removal rates were developed as shown in Table VII-27. Although these removal rates are believed to be representative, the primary solids removal for a given mill will vary. The primary solids yield may be estimated by the following:

$$\underline{Y1} = CP$$

where: $\underline{Y1}$ = Primary Clarification, Solids Yield (lb/mil gal.)

P = Influent TSS to Primary (lb/mil gal.)

C = Constant (percent solids removal in primary, see Table VII-27).

TABLE VII-27

PERCENT RAW TSS REMOVAL IN PRIMARY CLARIFIER

Subcategory		Percent TSS Removal
011	Alkaline-Dissolving	75
012	Alkaline-Market	75
013	Alkaline-BCT	75
014	Alkaline-Fine	75
015	Alkaline-Unbleached	80
016	Semi-Chemical	80
017	Alkaline-Unbleached & Semi-Chemical	80
019	Alkaline-Newsprint	80
021	Sulfite-Dissolving	80
022	Sulfite-Papergrade	80
032	Thermo-Mechanical Pulp	80
033	Groundwood-CMN	80
034	Groundwood-Fine	80
101	Deink-Fine & Tissue	80
102	Deink-Newsprint	80
111	Wastepaper-Tissue	80
112	Wastepaper-Board	80
113	Wastepaper-Molded Products	80
114	Wastepaper-Construction Products	80
201	Nonintegrated-Fine	80
202	Nonintegrated-Tissue	80
204	Nonintegrated-Lightweight	80
205	Nonintegrated-Filter & Nonwoven	80
211	Nonintegrated-Paperboard	80

Biological Solids Production. The BOD5 content of wastewaters is converted to cell mass by biological treatment systems. These cells in turn die and become assimilated by other cells. The energy required for these processes results in a net reduction in BOD5. Typically, the net biological solids yield, Y, is 0.65 lbs cells per lb BOD5 utilized. Mean death rate, kd, is usually 0.10 day-1.

The secondary solids produced in model mill aerated stabilization basins undergo settling in a quiescent zone following the completely mixed aeration basin. Biological solids removed in this manner are degraded in the sludge blanket which forms on the bottom of the basin. Therefore, a secondary clarifier is not considered for aerated stabilization. Occasionally, the sludge blanket may accumulate to the point where solids are removed by dredging. This would be an intermittant operation, if required.

The activated sludge process characteristics allow the effluent quality to be controlled by the mean cell residence time, θc(111). This is based on the fact that to control the growth rate of microorganisms and hence their degree of waste stabilization, a specified percentage of cells must be wasted daily.(111) This cell recycle also results in a lower sludge yield per pound of BOD5 utilized. Therefore, a biological solids yield of 0.32 lb biomass per lb BOD5 utilized was considered in estimating activated sludge biological solids production.

The solids removed in the activated sludge secondary clarifier would also include some nonbiological solids that were not removed during primary clarification. To approximate the solids from these inorganics, the activated sludge clarifier solids is estimated to remove one tenth of the total suspended solids content of the primary influent. Therefore, the total (biological plus inorganic) solids yield of the activated sludge secondary solids removal is estimated by the following:

$$Y2 = 0.32B + 0.1P$$

Where: Y2 = Total Activated Sludge Solids Yield (lbs/MG)
B = Secondary Influent BOD5 (lbs/MG)
P = Primary Influent TSS (lbs/MG)

Chemical Solids Production. The design criteria for chemically assisted clarification considered the following coagulant dosage:

Alum	150 mg/l
Polyelectrolyte	1 mg/l

After solution in the wastewater, the alum dosage results in about 39 mg/l of aluminum hydroxide. With the polyelectrolyte floc added this increases to approximately 40 mg/l, or 334 lb solids per million gallons of wastewater.

The additional wastewater solids removal with chemically assisted clarification is considered to be 0.1 times the primary influent TSS load. Therefore, the total chemical plus wastewater solids yield for chemically assisted clarification is estimated by the following:

$$Y3 = 0.1P + 334$$

Where: $Y3$ = Total Chemically Assisted Solids Yield
P = TSS to Primary (lbs/MG)

Design Organic Loading to Biological Treatment Systems. The organic load to aerated stabilization basins is considered to be the raw BOD_5 load minus BOD_5 removal in the primary clarifier. Data obtained through the data request program confirms previous data used in BPCTCA guidelines development, that a significantly higher BOD_5 removal in primary treatment of nonintegrated mill wastewaters than for integrated mills. The design organic loading to activated sludge systems is higher than an aerated stabilization basin treating the same wastewater. This results from the additional BOD_5 load contributed by the sludge recycle process. Therefore, based on these criteria, the factors shown in Table VII-28 were developed to estimate the portion of the raw organic load that is used for indirect and new point source biobasin design calculations.

TABLE VII-28

PERCENT OF RAW BOD_5 LOADING ON WHICH INDIRECT AND NEW POINT SOURCE BIOBASIN DESIGN IS BASED

Subcategory		Aerated Stabilization	Activated Sludge
011	Alkaline-Dissolving	90	100
012	Alkaline-Market	90	100
013	Alkaline-BCT	90	100
014	Alkaline-Fine	90	100
015	Alkaline-Unbleached	90	100
016	Semi-Chemical	90	100
017	Alkaline-Unbleached & Semi-Chemical	90	100
019	Alkaline-Newsprint	90	100
021	Sulfite-Dissolving	90	100
022	Sulfite-Papergrade	90	100
033	Groundwood-CMN	90	100
034	Groundwood-Fine	90	100
101	Deink-Fine & Tissue	40	50
102	Deink-Newsprint	40	50

Note: Only those subcategories where biological treatment is considered for indirect and new point source model mills are presented.

Foam Control. In many alkaline pulping installations, foam control is very critical. Included in the cost calculations, as required, is a foam control tank with adequate capacity for storage of foam. The foam builds up in the facility and eventually collapses because of its inability to support its own weight. The foam control tank provides for a 5-minute hydraulic detention.

Outfall Sewer. The outfall sewer is defined as the sewer required to connect the mill to the treatment facility and the treatment facility to the diffuser. For this analysis, 1000 ft of outfall sewer is assumed to be required to make these connections.

Diffuser. Discharge from the outfall sewer is assumed to be through a multiple-port diffuser which will facilitate mixing of the treatment facility effluent with the receiving water. Such induced mixing will minimize any horizontal and vertical stratification of the effluent in the receiving waters. The design includes 12 ft of diffuser length per mgd. This can vary substantially depending on the desired diffusion characteristics. The capital costs include excavation backfill, and laying and jointing of the diffuser pipe.

SECTION VIII

EFFECTIVENESS OF CONTROL AND TREATMENT OPTIONS

INTRODUCTION

Sections VI and VII have presented several levels of production process controls and effluent treatment technologies which can reduce raw waste loads and effluent pollutant levels discharged by the pulp, paper and paperboard industry. In Section VI, two levels of production process controls have been identified and their effectiveness has been evaluated. Information on the effluent treatment technologies under consideration and their effectiveness has been presented in Section VII. The purpose of this section is to summarize the overall effectiveness of the control and treatment options. The pure mill situation is evaluated in this section as it is anticipated that effluent limitations and standards will be developed on the basis of pure mills.

Under investigation are three classifications of pulp, paper and paperboard mills: direct discharge mills; indirect discharge mills; and new point source mills. Direct discharge mills are those mills where discharge is direct to a receiving water. Indirect discharge mills are those mills where discharge is to publicly or privately owned treatment works (POTW). New point source mills can include newly constructed mills or expansions of existing mills. Subsequent discussions of the effectiveness of control and treatment options will present effluent quality data for each discharge classification, where applicable.

A comprehensive data base has been developed for conventional, toxic, and nonconventional pollutants. This data has been gathered from existing data sources (i.e., literature, research), industry responses to the data request program, and sampling surveys. This section will primarily present data on the conventional pollutants that have been developed through evaluations of existing data and responses to the data request program. Continuing efforts by the E.C. Jordan Co. will supplement the data on the conventional pollutants and assess the levels of toxic and nonconventional pollutants being discharged by the industry.

ATTAINABLE EFFLUENT QUALITY

Production process control technologies and effluent treatment technologies have been identified that, upon implementation, will result in improved effluent quality. This section presents preliminary estimates of the overall effluent quality attainable through implementation of the identified technologies. The following basic approach has been utilized: 1) raw waste loads have been developed for pure mills in each subcategory (see Section VI); and 2) the performance of the identified effluent treatment technologies has been evaluated (see Section VII).

Development of the raw waste loads for the pure mill in each subcategory included the identification of in-place production process controls and their extent of application. Based on industry data provided in response to the data request program, raw waste loads were projected for existing pure mills, sometimes based on an extrapolation of data to the pure mill situation (see Section V). An assessment has been made of the overall raw waste load reductions that could be anticipated with the implementation of various production process control technologies at the pure mills.

The application of and effectiveness of BPCTCA effluent treatment technology on the Level 1 and 2 raw waste loads has been evaluated. In reviewing BATEA technology, the treatabilities of pulp, paper and paperboard wastewaters have been determined based on the assumption that well-designed and operated BPCTCA technology is in-place.

Tables VIII-1 through VIII-39 present final effluent quality projected after implementing designated production process controls and effluent treatment technologies at the pure mills established for each subcategory. The effluent quality data is presented in terms of units per unit of production, expressed as kl/kkg (kgal/t) for flow and kg/kkg (lb/t) for effluent BOD5 and TSS levels. BOD5 and TSS levels are also shown as concentrations (mg/l), adjusted where appropriate to show the impact of reduced flow levels achieved through implementation of production process controls. The data is presented separately for the three types of mill discharges, i.e., direct discharge, indirect discharge and new point sources. Blank spaces in the tables indicate that discharge types and technology levels were determined as not being applicable to the respective subcategory.

In continuing project investigations, additional data analysis efforts will establish wastewater treatability by subcategory. Data on the variability of effluent discharges will also be developed. At this time a treatability level of 30 mg/l BOD5 and 50 mg/l TSS has been assumed after application of biological treatment to Level 1 and 2 raw waste loads. Two subcategories which are exceptions are the Deink-Fine and Tissue and Deink-Newsprint subcategories. Based on data currently available, a treatability level of 100 mg/l after biological treatment was established for TSS. This figure will be confirmed by supplemental data gathering as outlined below.

Section VII summarized data on the effectiveness of chemically assisted clarification (CAC) and granular activated carbon adsorption (GAC) in treating pulp, paper and paperboard wastewaters, as well as other industrial and municipal wastewaters. Data has been presented for full-scale and pilot-scale installations. Treatability levels have been presented in the tables for the application of CAC and GAC (Levels 3 and 4) to biologically treated pulp, paper and paperboard effluents. These levels will be reviewed following the acquisition of supplemental data as outlined below.

CONTINUING DATA ANALYSIS EFFORTS

In the coming months, additional data analyses will be undertaken for conventional, toxic and nonconventional pollutants under investigation.

For the conventional pollutants, continuing efforts will focus on defining the effluent quality which can be achieved using well-designed and operated biological treatment technology. At the time of the data request program, BPCTCA technologies had not been fully implemented. Ongoing efforts will include assessment of additional data for approximately 60 mills obtained since the data request program.

Preliminary review of this additional data on conventional pollutants has indicated the need for further supplemental data to better assess conventional pollutant treatability and treatment system variability on a subcategory basis. At the recommendation of the E.C. Jordan Co., the EPA will request additional long-term conventional pollutant data for numerous pulp, paper and paperboard mills.

Statistical analysis of the conventional pollutant data will also be undertaken to determine the variability of the data. The specific statistical procedures for this effort will be selected following a review of existing and supplemental data received.

For the toxic and nonconventional pollutants, ongoing efforts will include further assessment of the levels of pollutants discharged by the pulp, paper and paperboard industry, as well as further assessment of the capabilities of in-place technology to reduce or remove the pollutants under investigation.

Through the verification program, data has been generated on the discharge of toxic and nonconventional pollutants from pulp, paper and paperboard mills. Final data developed through sampling surveys conducted by the E.C. Jordan Co. has only recently become available for the 57 surveyed mills.

TABLE VIII-1
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATGORY 011 - ALKALINE-DISSOLVING

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	221.4	207.2	198.5	198.5	198.5	221.4	207.2	198.5	198.5	198.5
			(kgal/ton)	(53.1)	(49.7)	(47.6)	(47.6)	(47.6)	(53.1)	(49.7)	(47.6)	(47.6)	(47.6)
		BOD5	mg/l	294	191	195	195	195	30	30	30	15	5
			kg/kkg	62.2	39.6	38.8	38.8	38.8	6.6	6.2	6.0	3.0	1.0
			(lb/t)	(130.3)	(79.1)	(77.5)	(77.5)	(77.5)	(13.3)	(12.4)	(11.9)	(6.0)	(2.0)
		TSS	mg/l	437	391	383	383	383	50	50	50	15	7
			kg/kkg	96.8	81.1	76.0	76.0	76.0	11.0	10.4	9.9	3.0	1.4
			(lb/t)	(193.5)	(162.2)	(151.9)	(151.9)	(151.9)	(22.1)	(20.7)	(19.9)	(6.0)	(2.8
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	198.5	198.5
		(kgal/ton)	(47.6)	(47.6)
	BOD5	mg/l	195	15
		kg/kkg	38.8	3.0
		(lb/t)	(77.5)	(6.0)
	TSS	mg/l	383	15
		kg/kkg	76.0	3.0
		(lb/t)	(151.9)	(6.0)

TABLE V[illegible]2
PREDICTED EFFLUENT QUAL[illegible]F PURE MILLS
SUBCATEGORY 012 - A[illegible]LINE-MARKET

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
		Flow	kl/kkg	164.7	137.6	123.0	123.0	123.0	164.7	137.6	123.0	123.0	123.0
			(kgal/ton)	(39.5)	(33.0)	(29.5)	(29.5)	(29.5)	(39.5)	(33.0)	(29.5)	(29.5)	(29.5)
		BOD5	mg/l	229	187	206	206	206	30	30	30	15	5
	Direct		kg/kkg	37.7	25.7	25.4	25.4	25.4	4.9	4.1	3.7	1.8	0.6
			(lb/t)	(75.3)	(51.4)	(50.7)	(50.7)	(50.7)	(9.9)	(8.2)	(7.4)	(3.7)	(1.2)
		TSS	mg/l	294	334	331	331	331	50	50	50	15	7
			kg/kkg	48.4	46.1	40.8	40.8	40.8	8.2	6.9	6.2	1.8	0.9
Existing			(lb/t)	(96.7)	(92.1)	(81.5)	(81.5)	(81.5)	(16.5)	(13.8)	(12.3)	(3.7)	(1.7)
Source		Flow	kl/kkg										
			(kgal/ton)										
Mills		BOD5	mg/l										
			kg/kkg										
	Indirect		(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New	Flow	kl/kkg	123.0	123.0
		(kgal/ton)	(29.5)	(29.5)
Source	BOD5	mg/l	206	15
		kg/kkg	25.4	1.8
		(lb/t)	(50.7)	(3.7)
Mills	TSS	mg/l	331	15
		kg/kkg	40.8	1.8
		(lb/t)	(81.5)	(3.7)

TABLE VIII-3
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 013 - ALKALINE-BCT

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	152.2	125.9	102.2	102.2	102.2	152.2	125.9	102.2	102.2	102.2
			(kgal/ton)	(36.5)	(30.2)	(24.5)	(24.5)	(24.5)	(36.5)	(30.2)	(24.5)	(24.5)	(24.5)
		BOD5	mg/l	300	205	253	253	253	30	30	30	15	5
			kg/kkg	45.7	25.8	25.8	25.8	25.8	4.6	3.9	3.1	1.5	0.5
			(lb/t)	(91.3)	(51.6)	(51.6)	(51.6)	(51.6)	(9.1)	(7.8)	(6.1)	(3.1)	(1.0)
		TSS	mg/l	279	308	355	355	355	50	50	50	15	7
			kg/kkg	42.5	38.9	36.3	36.3	36.3	7.6	6.3	5.1	1.5	0.7
			(lb/t)	(85.0)	(77.7)	(72.5)	(72.5)	(72.5)	(15.2)	(12.6)	(10.2)	(3.1)	(1.4)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	102.2	102.2
		(kgal/ton)	(24.5)	(24.5)
	BOD5	mg/l	253	15
		kg/kkg	25.8	1.5
		(lb/t)	(51.6)	(3.1)
	TSS	mg/l	355	15
		kg/kkg	36.3	1.5
		(lb/t)	(72.5)	(3.1)

TABLE VIII[illegible]
PREDICTED EFFLUENT QUAL[illegible]F PURE MILLS
SUBCATEGORY 014 - ALKALINE-FINE

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	Raw Waste Load Levels 2	Raw Waste Load Levels 3	Raw Waste Load Levels 4	Existing Levels 0	Final Effluent Levels 1	Final Effluent Levels 2	Final Effluent Levels 3	Final Effluent Levels 4
Existing Source Mills	Direct	Flow	kl/kkg	108.0	88.4	72.1	72.1	72.1	108.0	88.4	72.1	72.1	72.1
			(kgal/ton)	(25.9)	(21.2)	(17.3)	(17.3)	(17.3)	(25.9)	(21.2)	(17.3)	(17.3)	(17.3)
		BOD5	mg/l	266	177	217	217	217	30	30	30	15	5
			kg/kkg	28.7	15.7	15.7	15.7	15.7	3.2	2.6	2.2	1.1	0.4
			(lb/t)	(57.4)	(31.3)	(31.3)	(31.3)	(31.3)	(6.5)	(5.3)	(4.3)	(2.2)	(0.7)
		TSS	mg/l	494	476	521	521	521	50	50	50	15	7
			kg/kkg	53.4	42.1	37.6	37.6	37.6	5.4	4.4	3.6	1.1	0.5
			(lb/t)	(106.7)	(84.1)	(75.2)	(75.2)	(75.2)	(10.8)	(8.8)	(7.2)	(2.2)	(1.0)
	Indirect	Flow	kl/kkg	108.0	88.4	72.1	72.1	72.1	108.0	88.4	72.1	72.1	
			(kgal/ton)	(25.9)	(21.2)	(17.3)	(17.3)	(17.3)	(25.9)	(21.2)	(17.3)	(17.3)	
		BOD5	mg/l	266	177	217	217	217	266	177	196	30	
			kg/kkg	28.7	15.7	15.7	15.7	15.7	28.7	15.7	14.1	2.2	
			(lb/t)	(57.4)	(31.3)	(31.3)	(31.3)	(31.3)	(57.4)	(31.3)	(28.2)	(4.3)	
		TSS	mg/l	494	476	521	521	521	494	476	157	50	
			kg/kkg	53.4	42.1	37.6	37.6	37.6	53.4	42.1	11.3	3.6	
			(lb/t)	(106.7)	(84.1)	(75.2)	(75.2)	(75.2)	(106.7)	(84.1)	(22.6)	(7.2)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	72.1	72.1
		(kgal/ton)	(17.3)	(17.3)
	BOD5	mg/l	217	15
		kg/kkg	15.7	1.1
		(lb/t)	(31.3)	(2.2)
	TSS	mg/l	521	15
		kg/kkg	37.6	1.1
		(lb/t)	(75.2)	(2.2)

TABLE VIII-5
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 015 - ALKALINE UNBLEACHED - LINERBOARD

Discharge Type & Parameter				Raw Waste Load Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	46.7	36.3	35.5	35.5	35.5	46.7	36.3	35.5	35.5	35.5
			(kgal/ton)	(11.2)	(8.7)	(8.5)	(8.5)	(8.5)	(11.2)	(8.7)	(8.5)	(8.5)	(8.5)
		BOD5	mg/l	303	280	286	286	286	30	30	30	15	5
			kg/kkg	14.2	10.2	10.2	10.2	10.2	1.4	1.1	1.1	0.5	0.2
			(lb/t)	(28.3)	(20.3)	(20.3)	(20.3)	(20.3)	(2.8)	(2.2)	(2.1)	(1.1)	(0.4)
		TSS	mg/l	348	427	334	334	334	50	50	50	15	7
			kg/kkg	16.3	15.5	11.9	11.9	11.9	2.3	1.8	1.8	0.5	0.2
			(lb/t)	(32.5)	(31.0)	(23.7)	(23.7)	(23.7)	(4.7)	(3.6)	(3.5)	(1.1)	(0.5)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	35.5	35.5
		(kgal/ton)	(8.5)	(8.5)
	BOD5	mg/l	286	15
		kg/kkg	10.2	0.5
		(lb/t)	(20.3)	(1.1)
	TSS	mg/l	334	15
		kg/kkg	11.9	0.5
		(lb/t)	(23.7)	(1.1)

TABLE V[illegible]6
PREDICTED EFFLUENT QUAL[illegible] OF PURE MILLS
SUBCATEGORY 015 - ALKALINE UNBLEACHED - BAG

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	70.5	54.6	53.4	53.4	53.4	70.5	54.6	53.4	53.4	53.4
			(kgal/ton)	(16.9)	(13.1)	(12.8)	(12.8)	(12.8)	(16.9)	(13.1)	(12.8)	(12.8)	(12.8)
		BOD5	mg/l	268	247	253	253	253	30	30	30	15	5
			kg/kkg	18.9	13.5	13.5	13.5	13.5	2.1	1.6	1.6	0.8	0.3
			(lb/t)	(37.7)	(27.0)	(27.0)	(27.0)	(27.0)	(4.2)	(3.3)	(3.2)	(1.6)	(0.5)
		TSS	mg/l	294	362	350	350	350	50	50	50	15	7
			kg/kkg	20.7	19.8	18.7	18.7	18.7	3.5	2.7	2.7	0.8	0.4
			(lb/t)	(41.4)	(39.5)	(37.4)	(37.4)	(37.4)	(7.0)	(5.5)	(5.5)	(1.6)	(0.8)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	53.4	53.4
		(kgal/ton)	(12.8)	(12.8)
	BOD5	mg/l	253	15
		kg/kkg	13.5	0.8
		(lb/t)	(27.0)	(1.6)
	TSS	mg/l	350	15
		kg/kkg	18.7	0.8
		(lb/t)	(37.4)	(1.6)

TABLE VIII-7
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 016 - SEMI-CHEMICAL (80%)

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	32.5	29.2	21.7	21.7	21.7	32.5	29.2	21.7	21.7	21.7
			(kgal/ton	(7.8)	(7.0)	(5.2)	(5.2)	(5.2)	(7.8)	(7.0)	(5.2)	(5.2)	(5.2)
		BOD5	mg/l	567	567	719	719	719	30	30	30	15	5
			kg/kkg	18.5	16.6	15.6	15.6	15.6	1.0	0.9	0.6	0.3	0.1
			(lb/t)	(36.9)	(33.1)	(31.2)	(31.2)	(31.2)	(2.0)	(1.8)	(1.3)	(0.7)	(0.2)
		TSS	mg/l	662	738	666	666	666	50	50	50	15	7
			kg/kkg	21.6	21.6	14.5	14.5	14.5	1.6	1.5	1.1	0.3	0.2
			(lb/t)	(43.1)	(43.1)	(28.9)	(28.9)	(28.9)	(3.3)	(2.9)	(2.2)	(0.7)	(0.3)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	21.7	21.7
		(kgal/ton)	(5.2)	(5.2)
	BOD5	mg/l	719	15
		kg/kkg	15.6	0.3
		(lb/t)	(31.2)	(0.7)
	TSS	mg/l	666	15
		kg/kkg	14.5	0.3
		(lb/t)	(28.9)	(0.7)

TABLE VII[illegible]
PREDICTED EFFLUENT QUAL[illegible]OF PURE MILLS
SUBCATEGORY 016 - SEMI-CHEMICAL (100%)

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	48.4	43.4	32.1	32.1	32.1	48.4	43.4	32.1	32.1	32.1
			(kgal/ton)	(11.6)	(10.4)	(7.7)	(7.7)	(7.7)	(11.6)	(10.4)	(7.7)	(7.7)	(7.7)
		BOD5	mg/l	399	399	508	508	508	30	30	30	15	5
			kg/kkg	19.3	17.3	16.3	16.3	16.3	1.5	1.3	1.0	0.5	0.2
			(lb/t)	(38.6)	(34.6)	(32.6)	(32.6)	(32.6)	(2.9)	(2.6)	(1.9)	(1.0)	(0.3)
		TSS	mg/l	795	887	804	804	804	50	50	50	15	7
			kg/kkg	38.5	38.5	25.8	25.8	25.8	2.4	2.2	1.6	0.5	0.2
			(lb/t)	(76.9)	(76.9)	(51.6)	(51.6)	(51.6)	(4.8)	(4.3)	(3.2)	(1.0)	(0.4)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	32.1	32.1
		(kgal/ton)	(7.7)	(7.7)
	BOD5	mg/l	508	15
		kg/kkg	16.3	0.5
		(lb/t)	(32.6)	(1.0)
	TSS	mg/l	804	15
		kg/kkg	25.8	0.5
		(lb/t)	(51.6)	(1.0)

TABLE VIII-9
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 017 - ALKALINE UNBLEACHED & SEMI-CHEMICAL

Discharge Type & Parameter				Existing Levels	Raw Waste Load Levels				Existing Levels	Final Effluent Levels			
				0	1	2	3	4	0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	55.9	35.5	35.5	35.5	35.5	55.9	35.5	35.5	35.5	35.5
			(kgal/ton)	(13.4)	(8.5)	(8.5)	(8.5)	(8.5)	(13.4)	(8.5)	(8.5)	(8.5.)	(8.5)
		BOD5	mg/l	334	380	380	380	380	30	30	30	15	5
			kg/kkg	8.7	13.5	13.5	13.5	13.5	1.7	1.1	1.1	0.5	0.2
			(lb/t)	(37.3)	(26.9)	(26.9)	(26.9)	(26.9)	(3.4)	(2.1)	(2.1)	(1.1)	(0.4)
		TSS	mg/l	421	508	480	480	480	50	50	50	15	7
			kg/kkg	23.5	18.0	17.0	17.0	17.0	2.8	1.8	1.8	0.5	0.2
			(lb/t)	(47.0)	(36.0)	(34.0)	(34.0)	(34.0)	(5.6)	(3.5)	(3.5)	(1.1)	(0.5)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	35.5	35.5
		(kgal/ton)	(8.5)	(8.5)
	BOD5	mg/l	380	15
		kg/kkg	13.5	0.5
		(lb/t)	(26.9)	(1.1)
	TSS	mg/l	480	15
		kg/kkg	17.0	0.5
		(lb/t)	(34.0)	(1.1)

TABLE VIII-[illegible]
PREDICTED EFFLUENT QUAL[illegible]F PURE MILLS
SUBCATEGORY 019 - ALKA[illegible]NE-NEWSPRINT

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	93.8	68.0	57.5	57.5	57.5	93.8	68.0	57.5	57.5	57.5
			(kgal/ton)	(22.5)	(16.3)	(13.8)	(13.8)	(13.8)	(22.5)	(16.3)	(13.8)	(13.8)	(13.8)
		BOD5	mg/l	225	217	256	256	256	30	30	30	15	5
			kg/kkg	21.1	14.8	14.8	14.8	14.8	2.8	2.0	1.7	0.9	0.3
			(lb/t)	(42.2)	(29.5)	(29.5)	(29.5)	(29.5)	(5.6)	(4.1)	(3.4)	(1.7)	(0.6)
		TSS	mg/l	604	675	677	677	677	50	50	50	15	7
			kg/kkg	56.7	45.9	39.0	39.0	39.0	4.7	3.4	2.9	0.9	0.4
			(lb/t)	(113.3)	(91.8)	(77.9)	(77.9)	(77.9)	(9.4)	(6.8)	(5.8)	(1.7)	(0.8)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	57.5	57.5
		(kgal/ton)	(13.8)	(13.8)
	BOD5	mg/l	256	15
		kg/kkg	14.8	0.9
		(lb/t)	(29.5)	(1.7)
	TSS	mg/l	677	15
		kg/kkg	39.0	0.9
		(lb/t)	(77.9)	(1.7)

TABLE VIII-11
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 012 - SULFITE-DISSOLVING

Discharge Type & Parameter				Raw Waste Load: Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent: Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	266.4	204.7	183.9	183.9	183.9	266.4	204.7	183.9	183.9	183.9
			(kgal/ton)	(63.9)	(49.1)	(44.1)	(44.1)	(44.1)	(63.9)	(49.1)	(44.1)	(44.1)	(44.1)
		BOD5	mg/l	632	504	555	555	555	30	30	30	15	5
			kg/kkg	168.5	103.2	102.1	102.1	102.1	8.0	6.2	5.5	2.8	0.9
			(lb/t)	(336.9)	(206.4)	(204.2)	(204.2)	(204.2)	(16.0)	(12.3)	(11.0)	(5.5)	(1.8)
		TSS	mg/l	376	453	474	474	474	50	50	50	15	7
			kg/kkg	100.1	92.7	87.2	87.2	87.2	13.3	10.2	9.2	2.8	1.3
			(lb/t)	(200.2)	(185.5)	(174.4)	(174.4)	(174.4)	(26.6)	(20.5)	(18.3)	(5.5)	(2.6)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	183.9	183.9
		(kgal/ton)	(44.1)	(44.1)
	BOD5	mg/l	555	15
		kg/kkg	102.1	2.8
		(lb/t)	(204.2)	(5.5)
	TSS	mg/l	474	15
		kg/kkg	87.2	2.8
		(lb/t)	(174.4)	(5.5)

TABLE VII[illegible]

PREDICTED EFFLUENT QUAL[illegible]OF PURE MILLS

SUBCATEGORY 022 - SULFITE-PAPERGRADE (67%)

Discharge Type & Parameter				Existing Levels	Raw Waste Load Levels				Existing Levels	Final Effluent Levels			
				0	1	2	3	4	0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	152.6	90.1	87.6	87.6	87.6	152.6	90.1	87.6	87.6	87.6
			(kgal/ton)	(36.6)	(21.6)	(21.0)	(21.0)	(21.0)	(36.6)	(21.6)	(21.0)	(21.0)	(21.0)
		BOD5	mg/l	319	310	319	319	319	30	30	30	15	15
			kg/kkg	48.7	28.0	28.0	28.0	28.0	4.6	2.7	2.6	1.3	0.4
			(lb/t)	(97.3)	(55.9)	(55.9)	(55.9)	(55.9)	(9.2)	(5.4)	(5.1)	(2.6)	(0.9
		TSS	mg/l	217	350	334	334	334	50	50	50	15	7
			kg/kkg	33.1	31.5	29.3	29.3	29.3	7.6	4.5	4.4	1.3	0.6
			(lb/t)	(66.2)	(63.0)	(58.6)	(58.6)	(58.6)	(15.3)	(9.0)	(8.8)	(2.6)	(1.2)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	87.6	87.6
		(kgal/ton)	(21.1)	(21.0)
	BOD5	mg/l	319	15
		kg/kkg	28.0	1.3
		(lb/t)	(55.9)	(2.6)
	TSS	mg/l	334	15
		kg/kkg	29.3	1.3
		(lb/t)	(58.6)	(2.6)

TABLE VIII-13
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 022 - SULFITE-PAPERGRADE (100%)

Discharge Type & Parameter				Existing Levels	Raw Waste Load Levels				Existing Levels	Final Effluent Levels			
				0	1	2	3	4	0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	203.9	120.5	117.2	117.2	117.2	203.9	120.5	117.2	117.2	117.2
			(kgal/ton)	(48.9)	(28.9)	(28.1)	(28.1)	(28.1)	(48.9)	(28.9)	(28.1)	(28.1	(28.1)
		BOD5	mg/l	336	326	336	336	336	30	30	30	15	5
			kg/kkg	68.5	39.4	39.4	39.4	39.4	6.1	3.6	3.5	1.8	0.6
			(lb/t)	(136.9)	(78.7)	(78.7)	(78.7)	(78.7)	(12.2)	(7.2)	(7.0)	(3.5)	(1.2)
		TSS	mg/l	170	274	262	262	262	50	50	50	15	7
			kg/kkg	34.7	33.0	30.7	30.7	30.7	10.2	6.0	5.8	1.8	0.8
			(lb/t)	(69.3)	(66.0)	(61.4)	(61.4)	(61.4)	(20.4)	(12.0)	(11.7)	(3.5)	(1.6)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	117.2	117.2
		(kgal/ton)	(28.1)	(28.1)
	BOD5	mg/l	336	15
		kg/kkg	39.4	1.8
		(lb/t)	(78.7)	(3.5)
	TSS	mg/l	262	15
		kg/kkg	30.7	1.8
		(lb/t)	(61.4)	(3.5)

TABLE VI[illegible]
PREDICTED EFFLUENT QUAL[illegible] OF PURE MILLS
SUBCATEGORY 032 - THERMO-MECHANICAL PULP

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	60.0	42.5	42.5	42.5	42.5	60.0	42.5	42.5	42.5	42.5
			(kgal/ton)	(14.4)	(10.2)	(10.2)	(10.2)	(10.2)	(14.4)	(10.2)	(10.2)	(10.2)	(10.2)
		BOD5	mg/l	304	368	368	368	368	30	30	30	15	5
			kg/kkg	18.3	15.7	15.7	15.7	15.7	1.8	1.3	1.3	0.6	0.2
			(lb/t)	(36.5)	(31.3)	(31.3)	(31.3)	(31.3)	(3.6)	(2.5)	(2.5)	(1.3)	(0.4)
		TSS	mg/l	644	618	618	618	618	50	50	50	15	7
			kg/kkg	38.7	26.3	26.3	26.3	26.3	3.0	2.1	2.1	0.6	0.3
			(lb/t)	(77.4)	(52.6)	(52.6)	(52.6)	(52.6)	(6.0)	(4.3)	(4.3)	(1.3)	(0.6)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	42.5	52.5
		(kgal/ton)	(10.2)	(10.2)
	BOD5	mg/l	368	15
		kg/kkg	15.7	0.6
		(lb/t)	(31.3)	(1.3)
	TSS	mg/l	618	15
		kg/kkg	26.3	0.6
		(lb/t)	(52.6)	(1.3)

TABLE VIII-15
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 033 - GROUNDWOOD-CMN (74%)

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	88.4	54.6	54.6	54.6	54.6	88.4	54.6	54.6	54.6	54.6
			(kgal/ton)	(21.2)	(13.1)	(13.1)	(13.1)	(13.1)	(21.2)	(13.1)	(13.1)	(13.1)	(13.1)
		BOD5	mg/l	210	212	212	212	212	30	30	30	15	5
			kg/kkg	18.6	11.6	11.6	11.6	11.6	2.6	1.6	1.6	0.8	0.3
			(lb/t)	(37.1)	(23.2)	(23.2)	(23.2)	(23.2)	(5.3)	(3.3)	(3.3)	(1.6)	(0.5)
		TSS	mg/l	549	650	531	531	531	50	50	50	15	7
			kg/kkg	43.5	35.5	29.0	29.0	29.0	4.4	2.7	2.7	0.8	0.4
			(lb/t)	(97.0)	(71.0)	(58.0)	(58.0)	(58.0)	(8.8)	(5.5)	(5.5)	(1.6)	(0.8)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	54.6	54.6
		(kgal/ton)	(13.1)	(13.1)
	BOD5	mg/l	212	15
		kg/kkg	11.6	0.8
		(lb/t)	(23.2)	(1.6)
	TSS	mg/l	531	15
		kg/kkg	29.0	0.8
		(lb/t)	(58.0)	(1.6)

TABLE V[illegible]6
PREDICTED EFFLUENT QUA[illegible] OF PURE MILLS
SUBCATEGORY 033 - GROUNDWOOD-CMN (100%)

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	134.3	83.0	83.0	83.0	83.0	134.3	83.0	83.0	83.0	83.0
			(kgal/ton)	(32.2)	(19.9)	(19.9)	(19.9)	(19.9)	(32.2)	(19.9)	(19.9)	(19.9)	(19.9)
		BOD5	mg/l	170	172	172	172	172	30	30	30	15	5
			kg/kkg	22.9	14.3	14.3	14.3	14.3	4.0	2.5	2.5	1.2	0.4
			(lb/t)	(45.8)	(28.6)	(28.6)	(28.6)	(28.6)	(8.1)	(5.0)	(5.0)	(2.5)	(0.8)
		TSS	mg/l	577	684	558	558	558	50	50	50	15	7
			kg/kkg	77.6	56.8	46.4	46.4	46.4	6.7	4.1	4.1	1.2	0.6
			(lb/t)	(155.1)	(113.5)	(92.7)	(92.7)	(92.7)	(13.4)	(8.3)	(8.3)	(2.5)	(1.2)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	83.0	83.0
		(kgal/ton)	(19.9)	(19.9)
	BOD5	mg/l	172	15
		kg/kkg	14.3	1.2
		(lb/t)	(28.6)	(2.5)
	TSS	mg/l	558	15
		kg/kkg	46.4	1.2
		(lb/t)	(92.7)	(2.5)

TABLE VIII-17
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 034 - GROUNDWOOD-FINE (59%)

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	68.4	54.2	43.8	43.8	43.8	68.4	54.2	43.8	43.8	43.8
			(kgal/ton)	(16.4)	(13.0)	(10.5)	(10.5)	(10.5)	(16.4)	(13.0)	(10.5)	(10.5)	.(10.5)
		BOD5	mg/l	257	239	279	279	279	30	30	30	15	5
			kg/kkg	17.6	13.0	12.2	12.2	12.2	2.0	1.6	1.3	0.7	0.2
			(lb/t)	(35.2)	(25.9)	(24.4)	(24.4)	(24.4)	(4.1)	(3.3)	(2.6)	(1.3)	(0.4)
		TSS	mg/l	789	699	776	776	776	50	50	50	15	7
			kg/kkg	53.9	37.9	34.0	34.0	34.0	3.4	2.7	2.2	0.7	0.3
			(lb/t)	(107.9)	(75.8)	(68.0)	(68.0)	(68.0)	(6.8)	(5.4)	(4.4)	(1.3)	(0.6)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	43.8	43.8
		(kgal/ton)	(10.5)	(10.5)
	BOD5	mg/l	279	15
		kg/kkg	12.2	0.7
		(lb/t)	(24.4)	(1.3)
	TSS	mg/l	776	15
		kg/kkg	34.0	0.7
		(lb/t)	(68.0)	(1.3)

TABLE VI[illegible]18
PREDICTED EFFLUENT QUA[illegible] OF PURE MILLS
SUBCATEGORY 034 - GROUNDWOOD-FINE (100%)

Discharge Type & Parameter				Raw Waste Load Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	110.9	88.0	71.9	71.9	71.9	110.9	88.0	71.9	71.9	71.9
			(kgal/ton)	(26.6)	(21.1)	(17.0)	(17.0)	(17.0)	(26.6)	(21.1)	(17.0)	(17.0)	(17.0)
		BOD5	mg/l	168	156	182	182	182	30	30	30	15	5
			kg/kkg	18.6	13.7	12.9	12.9	12.9	3.4	2.6	2.1	1.1	0.4
			(lb/t)	(37.2)	(27.4)	(25.8)	(25.8)	(25.8)	(6.7)	(5.3)	(4.2)	(2.1)	(0.7)
		TSS	mg/l	498	441	491	491	491	50	50	50	15	7
			kg/kkg	55.2	38.8	34.8	34.8	34.8	5.5	4.4	3.5	1.1	0.5
			(lb/t)	(110.4)	(77.6)	(69.6)	(69.6)	(69.6)	(11.1)	(8.8)	(7.1)	(2.1)	(1.0)
	Indirect	Flow	kl/kkg										
			(kgal/ton)										
		BOD5	mg/l										
			kg/kkg										
			(lb/t)										
		TSS	mg/l										
			kg/kkg										
			(lb/t)										

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	71.9	71.9
		(kgal/ton)	(17.0)	(17.0)
	BOD5	mg/l	182	15
		kg/kkg	12.9	1.1
		(lb/t)	(25.8)	(2.1)
	TSS	mg/l	491	15
		kg/kkg	34.8	1.1
		(lb/t)	(69.6)	(2.1)

TABLE VIII-19
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 101 - DEINK FINE AND TISSUE - PURE TISSUE

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	81.3	58.4	55.3	55.3	55.3	81.3	58.4	55.3	55.3	55.3
			(kgal/ton)	(19.5)	(14.0)	(13.3)	(13.3)	(13.3)	(19.5)	(14.0)	(13.3)	(13.3)	(13.3)
		BOD5	mg/l	599	696	733	733	733	30	30	30	15	5
			kg/kkg	48.7	40.7	40.7	40.7	40.7	2.4	1.7	1.7	0.8	0.3
			(lb/t)	(97.4)	(81.3)	(81.3)	(81.3)	(81.3)	(4.9)	(3.3)	(3.3)	(1.7)	(0.6)
		TSS	mg/l	1,759	2,231	2,312	2,312	2,312	100	100	100	15	7
			kg/kkg	143.0	130.3	128.3	128.3	128.3	8.2	5.8	5.6	0.8	0.4
			(lb/t)	(286.0)	(260.5)	(256.5)	(256.5)	(256.5)	(16.3)	(11.7)	(11.1)	(1.7)	(0.8)
	Indirect	Flow	kl/kkg	81.3	58.4	55.3	55.3	55.3	81.3	58.4	55.3	55.3	
			(kgal/ton)	(19.5)	(14.0)	(13.3)	(13.3)	(13.3)	(19.5)	(14.0)	(13.3)	(13.3)	
		BOD5	mg/l	599	696	733	733	733	599	696	366	30	
			kg/kkg	48.7	40.7	40.7	40.7	40.7	48.7	40.7	20.3	1.7	
			(lb/t)	(97.4)	(81.3)	(81.3)	(81.3)	(81.3)	(97.4)	(81.3)	(40.6)	(3.3)	
		TSS	mg/l	1,759	2,231	2,312	2,312	2,312	1,759	2,231	462	50	
			kg/kkg	143.0	130.3	128.3	128.3	128.3	143.0	130.2	25.2	2.8	
			(lb/t)	(286.0)	(260.5)	(256.5)	(256.5)	(256.5)	(286.0)	(260.5)	(51.3)	(5.6)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	55.3	55.3
		(kgal/ton)	(13.3)	(13.3)
	BOD5	mg/l	733	15
		kg/kkg	40.7	0.8
		(lb/t)	(81.3)	(1.7)
	TSS	mg/l	2,312	15
		kg/kkg	128.3	0.8
		(lb/t)	(256.5)	(1.7)

TABLE VII[illegible]
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 101 - DEINK FINE AND TISSUE - PURE FINE

Discharge Type & Parameter				Raw Waste Load: Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent: Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	107.2	77.2	73.4	73.4	73.4	107.2	77.2	73.4	73.4	73.4
			(kgal/ton)	(25.7)	(18.5)	(17.6)	(17.6)	(17.6)	(25.7)	(18.5)	(17.6)	(17.6)	(17.6)
		BOD5	mg/l	466	540	568	568	568	30	30	30	15	5
			kg/kkg	50.0	41.7	41.7	41.7	41.7	3.2	2.3	2.2	1.1	0.4
			(lb/t)	(99.9)	(83.4)	(83.4)	(83.4)	(83.4)	(6.4)	(4.6)	(4.4)	(2.2)	(0.7)
		TSS	mg/l	2,012	2,546	2,635	2,635	2,635	100	100	100	15	7
			kg/kkg	215.7	196.4	193.4	193.4	193.4	10.7	7.7	7.3	1.1	0.5
			(lb/t)	(431.3)	(392.8)	(386.8)	(386.8)	(386.8)	(21.4)	(15.4)	(14.7)	(2.2)	(1.0)
	Indirect	Flow	kl/kkg	107.2	77.2	73.4	73.4	73.4	107.2	77.2	73.4	73.4	
			(kgal/ton)	(25.7)	(18.5)	(17.6)	(17.6)	(17.6)	(25.7)	(18.5)	(17.6)	(17.6)	
		BOD5	mg/l	466	540	568	568	568	466	540	284	30	
			kg/kkg	50.0	41.7	41.7	41.7	41.7	50.0	41.7	20.8	2.2	
			(lb/t)	(99.9)	(83.4)	(83.4)	(83.4)	(83.4)	(99.9)	(83.4)	(41.7)	(4.4)	
		TSS	mg/l	2,012	2,546	2,635	2,635	2,635	2,012	2,546	527	50	
			kg/kkg	215.7	196.4	193.4	193.4	193.4	215.7	196.4	38.7	3.7	
			(lb/t)	(431.3)	(392.8)	(386.8)	(386.8)	(386.8)	(431.3)	(392.8)	(77.4)	(7.3)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	73.4	73.4
		(kgal/ton)	(17.6)	(17.6)
	BOD5	mg/l	568	15
		kg/kkg	41.7	1.1
		(lb/t)	(83.4)	(2.2)
	TSS	mg/l	2,635	15
		kg/kkg	193.4	1.1
		(lb/t)	(386.8)	(2.2)

TABLE VIII-21
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 102 - DEINK NEWSPRINT

Discharge Type & Parameter				Raw Waste Load: Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent: Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	67.6	57.5	55.5	55.5	55.5	67.6	57.5	55.5	55.5	55.5
			(kgal/ton)	(16.2)	(13.8)	(13.3)	(13.3)	(13.3)	(16.2)	(13.8)	(13.3)	(13.3)	(13.3)
		BOD5	mg/l	234	232	241	241	241	30	30	30	15	5
			kg/kkg	15.9	13.4	13.4	13.4	13.4	2.0	1.7	1.7	0.8	0.3
			(lb/t)	(31.7)	(26.7)	(26.7)	(26.7)	(26.7)	(4.0)	(3.4)	(3.4)	(1.7)	(0.6)
		TSS	mg/l	1,821	2,050	1,857	1,857	1,857	100	100	100	15	7
			kg/kkg	123.0	118.0	103.0	103.0	103.0	6.8	5.8	5.5	0.8	0.4
			(lb/t)	(246.0)	(236.0)	(206.0)	(206.0)	(206.0)	(13.5)	(11.5)	(11.1)	(1.7)	(0.8)
	Indirect	Flow	kl/kkg	67.6	57.5	55.5	55.5	55.5	67.6	57.5	55.5	55.5	
			(kgal/ton)	(16.2)	(13.8)	(13.3)	(13.3)	(13.3)	(16.2)	(13.8)	(13.3)	(13.3)	
		BOD5	mg/l	234	232	241	241	241	234	232	120	30	
			kg/kkg	15.9	13.4	13.4	13.4	13.4	15.9	13.4	6.7	1.7	
			(lb/t)	(31.7)	(26.7)	(26.7)	(26.7)	(26.7)	(31.7)	(26.7)	(13.4)	(3.3)	
		TSS	mg/l	1,821	2,050	1,857	1,857	1,857	1,821	2,050	371	50	
			kg/kkg	123.0	118.0	103.0	103.0	103.0	123.0	118.0	20.6	2.8	
			(lb/t)	(246.0)	(236.0)	(206.0)	(206.0)	(206.0)	(246.0)	(236.0)	(41.2)	(5.6)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	55.5	55.5
		(kgal/ton)	(13.3)	(13.3)
	BOD5	mg/l	241	15
		kg/kkg	13.4	0.8
		(lb/t)	(26.7)	(1.7)
	TSS	mg/l	1,857	15
		kg/kkg	103.0	0.8
		(lb/t)	(206.0)	(1.7)

TABLE VIII-22
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY III - WASTEPAPER TISSUE-100% INDUSTRIAL

Discharge Type & Parameter				Raw Waste Load Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	56.7	48.4	48.4	48.4	48.4	56.7	48.4	48.4	48.4	48.4
			(kgal/ton)	(13.6)	(11.6)	(11.6)	(11.6)	(11.6)	(13.6)	(11.6)	(11.6)	(11.6)	(11.6)
		BOD5	mg/l	232	231	231	231	231	116	116	116	25	5
			kg/kkg	13.2	11.2	11.2	11.2	11.2	6.6	5.6	5.6	1.2	0.2
			(lb/t)	(26.3)	(22.4)	(22.4)	(22.4)	(22.4)	(13.1)	(11.2)	(11.2)	(2.4)	(0.5)
		TSS	mg/l	714	713	713	713	713	141	143	143	12	7
			kg/kkg	40.5	34.5	34.5	34.5	34.5	8.0	6.9	6.9	0.6	0.3
			(lb/t)	(81.0)	(69.0)	(69.0)	(69.0)	(69.0)	(16.0)	(13.8)	(13.8)	(1.2)	(0.7)
	Indirect	Flow	kl/kkg	56.7	48.4	48.4	48.4	48.4	56.7	48.4	48.4	48.4	
			(kgal/ton)	(13.6)	(11.6)	(11.6)	(11.6)	(11.6)	(13.6)	(11.6)	(11.6)	(11.6)	
		BOD5	mg/l	232	231	231	231	231	232	231	116	5	
			kg/kkg	13.2	11.2	11.2	11.2	11.2	13.2	11.2	5.6	0.2	
			(lb/t)	(26.3)	(22.4)	(22.4)	(22.4)	(22.4)	(26.3)	(22.4)	(11.2)	(0.5)	
		TSS	mg/l	714	713	713	713	713	714	713	143	7	
			kg/kkg	40.5	34.5	34.5	34.5	34.5	40.5	34.5	6.9	0.3	
			(lb/t)	(81.0)	(69.0)	(69.0)	(69.0)	(69.0)	(81.0)	(69.0)	(13.8)	(0.7)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	48.4	
		(kgal/ton)	(11.6)	
	BOD5	mg/l	231	Zero
		kg/kkg	11.2	
		(lb/t)	(22.4)	Discharge
	TSS	mg/l	713	
		kg/kkg	34.5	
		(lb/t)	(69.0)	

TABLE VIII-23
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 112 - WASTEPAPER BOARD - BOARD

Discharge Type & Parameter				Existing Levels	Raw Waste Load Levels				Existing Levels	Final Effluent Levels			
				0	1	2	3	4	0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	15.4	8.3	8.3	8.3	8.3	15.4	8.3	8.3	8.3	8.3
			(kgal/ton)	(3.7)	(2.0)	(2.0)	(2.0)	(2.0)	(3.7)	(2.0)	(2.0)	(2.0)	(2.0)
		BOD_5	mg/l	687	522	522	522	522	30	30	30	15	5
			kg/kkg	10.6	4.4	4.4	4.4	4.4	0.4	0.2	0.2	0.1	0.04
			(lb/t)	(21.2)	(8.7)	(8.7)	(8.7)	(8.7)	(0.9)	(0.5)	(0.5)	(0.3)	(0.08)
		TSS	mg/l	638	294	294	294	294	50	50	50	15	7
			kg/kkg	9.9	2.5	2.5	2.5	2.5	0.8	0.4	0.4	0.1	0.06
			(lb/t)	(19.7)	(4.9)	(4.9)	(4.9)	(4.9)	(1.5)	(0.8)	(0.8)	(0.3)	(0.12)
	Indirect	Flow	kl/kkg	15.4	8.3	8.3	8.3	8.3	15.4	8.3	8.3	8.3	
			(kgal/ton)	(3.7)	(2.0)	(2.0)	(2.0)	(2.0)	(3.7)	(2.0)	(2.0)	(2.0)	
		BOD_5	mg/l	687	522	522	522	522	687	522	260	5	
			kg/kkg	10.6	4.4	4.4	4.4	4.4	10.6	4.4	2.2	0.04	
			(lb/t)	(21.2)	(8.7)	(8.7)	(8.7)	(8.7)	(21.2)	(8.7)	(4.3)	(0.08)	
		TSS	mg/l	638	294	294	294	294	638	294	59	7	
			kg/kkg	9.9	2.5	2.5	2.5	2.5	9.9	2.5	0.5	0.06	
			(lb/t)	(19.7)	(4.9)	(4.9)	(4.9)	(4.9)	(19.7)	(4.9)	(1.0)	(0.12)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	8.3	Zero Discharge
		(kgal/ton)	(2.0)	
	BOD_5	mg/l	522	
		kg/kkg	4.4	
		(lb/t)	(8.7)	
	TSS	mg/l	294	
		kg/kkg	2.5	
		(lb/t)	(4.9)	

TABLE V[illegible]4
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 112 - WASTEPAPER BOARD - LINERBOARD

	Discharge Type & Parameter			Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	27.9	15.0	15.0	15.0	15.0	27.9	15.0	15.0	15.0	15.0
			(kgal/ton)	(6.7)	(3.6)	(3.6)	(3.6)	(3.6)	(6.7)	(3.6)	(3.6)	(3.6)	(3.6)
		BOD5	mg/l	319	243	243	243	243	30	30	30	15	5
			kg/kkg	8.9	3.7	3.7	3.7	3.7	0.8	0.4	0.4	0.2	0.1
			(lb/t)	(17.8)	(7.3)	(7.3)	(7.3)	(7.3)	(1.7)	(0.9)	(0.9)	(0.5)	(0.2)
		TSS	mg/l	385	176	176	176	176	50	50	50	15	7
			kg/kkg	10.8	2.7	2.7	2.7	2.7	1.4	0.8	0.8	0.2	0.1
			(lb/t)	(21.5)	(5.3)	(5.3)	(5.3)	(5.3)	(2.8)	(1.5)	(1.5)	(0.5)	(0.2)
	Indirect	Flow	kl/kkg	27.9	15.0	15.0	15.0	15.0	27.9	15.0	15.0	15.0	
			(kgal/ton)	(6.7)	(3.6)	(3.6)	(3.6)	(3.6)	(6.7)	(3.6)	(3.6)	(3.6)	
		BOD5	mg/l	319	243	243	243	243	319	243	122	5	
			kg/kkg	8.9	3.7	3.7	3.7	3.7	8.9	3.7	1.8	0.1	
			(lb/t)	(17.8)	(7.3)	(7.3)	(7.3)	(7.3)	(17.8)	(7.3)	(3.7)	(0.2)	
		TSS	mg/l	385	176	176	176	176	385	176	35	7	
			kg/kkg	10.8	2.7	2.7	2.7	2.7	10.8	2.7	0.5	0.1	
			(lb/t)	(21.5)	(5.3)	(5.3)	(5.3)	(5.3)	(21.5)	(5.3)	(1.1)	(0.2)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	15.0	Zero Discharge
		(kgal/ton)	(3.6)	
	BOD5	mg/l	243	
		kg/kkg	3.7	
		(lb/t)	(7.3)	
	TSS	mg/l	176	
		kg/kkg	2.7	
		(lb/t)	(5.3)	

TABLE VIII-25
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 112 - WASTEPAPER BOARD - CORRUGATED

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	4.2	2.1	2.1	2.1	2.1	4.2	2.1	2.1	2.1	2.1
			(kgal/ton)	(1.0)	(0.5)	(0.5)	(0.5)	(0.5)	(1.0)	(0.5)	(0.5)	(0.5)	(0.5)
		BOD5	mg/l	1,283	1,055	1,055	1,055	1,055	30	30	30	15	5
			kg/kkg	5.3	2.2	2.2	2.2	2.2	0.1	0.06	0.06	0.03	0.01
			(lb/t)	(10.7)	(4.4)	(4.4)	(4.4)	(4.4)	(0.3)	(0.12)	(0.12)	(0.06)	(0.02)
		TSS	mg/l	947	480	480	480	480	50	50	50	15	7
			kg/kkg	4.0	1.0	1.0	1.0	1.0	0.2	0.1	0.1	0.03	0.01
			(lb/t)	(7.9)	(2.0)	(2.0)	(2.0)	(2.0)	(0.4)	(0.2)	(0.2)	(0.06)	(0.03)
	Indirect	Flow	kl/kkg	4.2	2.1	2.1	2.1	2.1	4.2	2.1	2.1	2.1	
			(kgal/ton)	(1.0)	(0.5)	(0.5)	(0.5)	(0.5)	(1.0)	(0.5)	(0.5)	(0.5)	
		BOD5	mg/l	1,283	1,055	1,055	1,055	1,055	1,283	1,055	528	5	
			kg/kkg	5.3	2.2	2.2	2.2	2.2	5.3	2.2	1.1	0.01	
			(lb/t)	(10.7)	(4.4)	(4.4)	(4.4)	(4.4)	(10.7)	(4.4)	(2.2)	(0.02)	
		TSS	mg/l	947	480	480	480	480	947	480	96	7	
			kg/kkg	4.0	1.0	1.0	1.0	1.0	4.0	1.0	0.2	0.01	
			(lb/t)	(7.9)	(2.0)	(2.0)	(2.0)	(2.0)	(7.9)	(2.0)	(0.4)	(0.03)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	2.1	
		(kgal/ton)	(0.5)	
	BOD5	mg/l	1,055	Zero
		kg/kkg	2.2	
		(lb/t)	(4.4)	Discharge
	TSS	mg/l	480	
		kg/kkg	1.0	
		(lb/t)	(2.0)	

TABLE VI[illegible]6
PREDICTED EFFLUENT QUA[illegible] OF PURE MILLS
SUBCATEGORY 112 - WASTEPAPER BOARD - CHIP & FILLER

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	10.0	5.4	5.4	5.4	5.4	10.0	5.4	5.4	5.4	5.4
			(kgal/ton)	(2.4)	(1.3)	(1.3)	(1.3)	(1.3)	(2.4)	(1.3)	(1.3)	(1.3)	(1.3)
		BOD5	mg/l	345	258	258	258	258	30	30	30	15	5
			kg/kkg	3.5	1.4	1.4	1.4	1.4	0.3	0.2	0.2	0.1	0.03
			(lb/t)	(6.9)	(2.8)	(2.8)	(2.8)	(2.8)	(0.6)	(0.3)	(0.3)	(0.2)	(0.06)
		TSS	mg/l	445	203	203	203	203	50	50	50	15	7
			kg/kkg	4.5	1.1	1.1	1.1	1.1	0.5	0.3	0.3	0.1	0.04
			(lb/t)	(8.9)	(2.2)	(2.2)	(2.2)	(2.2)	(1.0)	(0.5)	(0.5)	(0.2)	(0.08)
	Indirect	Flow	kl/kkg	10.0	5.4	5.4	5.4	5.4	10.0	5.4	5.4	5.4	
			(kgal/ton)	(2.4)	(1.3)	(1.3)	(1.3)	(1.3)	(2.4)	(1.3)	(1.3)	(1.3)	
		BOD5	mg/l	345	258	258	258	258	345	258	129	5	
			kg/kkg	3.5	1.4	1.4	1.4	1.4	3.5	1.4	0.7	0.03	
			(lb/t)	(6.9)	(2.8)	(2.8)	(2.8)	(2.8)	(6.9)	(2.8)	(1.4)	(0.06)	
		TSS	mg/l	445	203	203	203	203	445	203	41	7	
			kg/kkg	4.5	1.1	1.1	1.1	1.1	4.5	1.1	0.2	0.04	
			(lb/t)	(8.9)	(2.2)	(2.2)	(2.2)	(2.2)	(8.9)	(2.2)	(0.4)	(0.08)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	5.4	
		(kgal/ton)	(1.3)	
	BOD5	mg/l	258	Zero Discharge
		kg/kkg	1.4	
		(lb/t)	(2.8)	
	TSS	mg/l	203	
		kg/kkg	1.1	
		(lb/t)	(2.2)	

TABLE VIII-27
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 112 - WASTEPAPER BOARD - FOLDING BOX

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	16.3	8.8	8.8	8.8	8.8	16.3	8.8	8.8	8.8	8.8
			(kgal/ton)	(3.9)	(2.1)	(2.1)	(2.1)	(2.1)	(3.9)	(2.1)	(2.1)	(2.1)	(2.1)
		BOD5	mg/l	372	285	285	285	285	30	30	30	15	5
			kg/kkg	6.1	2.5	2.5	2.5	2.5	0.5	0.3	0.3	0.1	0.04
			(lb/t)	(12.1)	(5.0)	(5.0)	(5.0)	(5.0)	(1.0)	(0.5)	(0.5)	(0.3)	(0.08)
		TSS	mg/l	434	200	200	200	200	50	50	50	15	7
			kg/kkg	7.1	1.8	1.8	1.8	1.8	0.8	0.4	0.4	0.1	0.06
			(lb/t)	(14.1)	(3.5)	(3.5)	(3.5)	(3.5)	(1.6)	(0.9)	(0.9)	(0.3)	(0.12)
	Indirect	Flow	kl/kkg	16.3	8.8	8.8	8.8	8.8	16.3	8.8	8.8	8.8	
			(kgal/ton)	(3.9)	(2.1)	(2.1)	(2.1)	(2.1)	(3.9)	(2.1)	(2.1)	(2.1)	
		BOD5	mg/l	372	285	285	285	285	372	285	143	5	
			kg/kkg	6.1	2.5	2.5	2.5	2.5	6.1	2.5	1.2	0.04	
			(lb/t)	(12.1)	(5.0)	(5.0)	(5.0)	(5.0)	(12.1)	(5.0)	(2.5)	(0.08)	
		TSS	mg/l	434	200	200	200	200	434	200	40	7	
			kg/kkg	7.1	1.8	1.8	1.8	1.8	7.1	1.8	0.4	0.06	
			(lb/t)	(14.1)	(3.5)	(3.5)	(3.5)	(3.5)	(14.1)	(3.5)	(0.7)	(0.12)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	8.8	Zero Discharge
		(kgal/ton)	(2.1)	
	BOD5	mg/l	285	
		kg/kkg	2.5	
		(lb/t)	(5.0)	
	TSS	mg/l	200	
		kg/kkg	1.8	
		(lb/t)	(3.5)	

TABLE VI[illegible]8
PREDICTED EFFLUENT QUA[illegible] OF PURE MILLS
SUBCATEGORY 112 - WASTEPAPER BOARD - SETUP BOX

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	20.4	10.8	10.8	10.8	10.8	20.4	10.8	10.8	10.8	10.8
			(kgal/ton)	(4.9)	(2.6)	(2.6)	(2.6)	(2.6)	(4.9)	(2.6)	(2.6)	(2.6)	(2.6)
		BOD5	mg/l	360	277	277	277	277	30	30	30	15	5
			kg/kkg	7.3	3.0	3.0	3.0	3.0	0.6	0.3	0.3	0.2	0.05
			(lb/t)	(14.7)	(6.0)	(6.0)	(6.0)	(6.0)	(1.2)	(0.7)	(0.7)	(0.3)	(0.1)
		TSS	mg/l	279	129	129	129	129	50	50	50	15	7
			kg/kkg	5.7	1.4	1.4	1.4	1.4	1.0	0.5	0.5	0.2	0.1
			(lb/t)	(11.4)	(2.8)	(2.8)	(2.8)	(2.8)	(2.0)	(1.1)	(1.1)	(0.3)	(0.2)
	Indirect	Flow	kl/kkg	20.4	10.8	10.8	10.8	10.8	20.4	10.8	10.8	10.8	
			(kgal/ton)	(4.9)	(2.6)	(2.6)	(2.6)	(2.6)	(4.9)	(2.6)	(2.6)	(2.6)	
		BOD5	mg/l	360	277	277	277	277	360	277	138	5	
			kg/kkg	7.3	3.0	3.0	3.0	3.0	7.3	3.0	1.5	0.05	
			(lb/t)	(14.7)	(6.0)	(6.0)	(6.0)	(6.0)	(14.7)	(6.0)	(3.0)	(0.1)	
		TSS	mg/l	279	129	129	129	129	279	129	26	7	
			kg/kkg	5.7	1.4	1.4	1.4	1.4	5.7	1.4	0.3	0.1	
			(lb/t)	(11.4)	(2.8)	(2.8)	(2.8)	(2.8)	(11.4)	(2.8)	(0.6)	(0.2)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	10.8	
		(kgal/ton)	(2.6)	
	BOD5	mg/l	277	Zero
		kg/kkg	3.0	
		(lb/t)	(6.0)	Discharge
	TSS	mg/l	129	
		kg/kkg	1.4	
		(lb/t)	(2.8)	

TABLE VIII-29
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 112 - WASTEPAPER BOARD - GYPSUM

Discharge Type & Parameter				Raw Waste Load Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	11.7	6.3	6.3	6.3	6.3	11.7	6.3	6.3	6.3	6.3
			(kgal/ton)	(2.8)	(1.5)	(1.5)	(1.5)	(1.5)	(2.8)	(1.5)	(1.5)	(1.5)	(1.5)
		BOD5	mg/l	497	384	384	384	384	30	30	30	15	5
			kg/kkg	5.8	2.4	2.4	2.4	2.4	0.4	0.2	0.2	0.1	0.03
			(lb/t)	(11.6)	(4.8)	(4.8)	(4.8)	(4.8)	(0.7)	(0.4)	(0.4)	(0.2)	(0.06)
		TSS	mg/l	1,362	1,103	1,103	1,103	1,103	50	50	50	15	7
			kg/kkg	15.9	6.9	6.9	6.9	6.9	0.6	0.3	0.3	0.1	0.04
			(lb/t)	(31.8)	(13.8)	(13.8)	(13.8)	(13.8)	(1.2)	(0.6)	(0.6)	(0.2)	(0.08)
	Indirect	Flow	kl/kkg	11.7	6.3	6.3	6.3	6.3	11.7	6.3	6.3	6.3	
			(kgal/ton)	(2.8)	(1.5)	(1.5)	(1.5)	(1.5)	(2.8)	(1.5)	(1.5)	(1.5)	
		BOD5	mg/l	497	384	384	384	384	497	384	192	5	
			kg/kkg	5.8	2.4	2.4	2.4	2.4	5.8	2.4	1.2	0.03	
			(lb/t)	(11.6)	(4.8)	(4.8)	(4.8)	(4.8)	(11.6)	(4.8)	(2.4)	(0.06)	
		TSS	mg/l	1,362	1,103	1,103	1,103	1,103	1,362	1,103	221	7	
			kg/kkg	15.9	6.9	6.9	6.9	6.9	15.9	6.9	1.4	0.04	
			(lb/t)	(31.8)	(13.8)	(13.8)	(13.8)	(13.8)	(31.8)	(13.8)	(2.8)	(0.08)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	6.3	Zero Discharge
		(kgal/ton)	(1.5)	
	BOD5	mg/l	384	
		kg/kkg	2.4	
		(lb/t)	(4.8)	
	TSS	mg/l	1,103	
		kg/kkg	6.9	
		(lb/t)	(13.8)	

TABLE VIII-30
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 113 - WASTEPAPER - MOLDED PRODUCTS

	Discharge Type & Parameter			Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	52.5	41.3	41.3	41.3	41.3	52.5	41.3	41.3	41.3	41.3
			(kgal/ton)	(12.6)	(9.9)	(9.9)	(9.9)	(9.9)	(12.6)	(9.9)	(9.9)	(9.9)	(9.9)
		BOD_5	mg/l	124	119	119	119	119	30	30	30	15	5
			kg/kkg	6.5	4.9	4.9	4.9	4.9	1.6	1.2	1.2	0.6	0.2
			(lb/t)	(13.0)	(9.8)	(9.8)	(9.8)	(9.8)	(3.2)	(2.5)	(2.5)	(1.2)	(0.4)
		TSS	mg/l	216	130	130	130	130	50	50	50	15	7
			kg/kkg	11.4	5.4	5.4	5.4	5.4	2.6	2.1	2.1	0.6	0.3
			(lb/t)	(22.7)	(10.7)	(10.7)	(10.7)	(10.7)	(5.3)	(4.1)	(4.1)	(1.2)	(0.6)
	Indirect	Flow	kl/kkg	52.5	41.3	41.3	41.3	41.3	52.5	41.3	41.3	41.3	
			(kgal/ton)	(12.6)	(9.9)	(9.9)	(9.9)	(9.9)	(12.6)	(9.9)	(9.9)	(9.9)	
		BOD_5	mg/l	124	119	119	119	119	124	119	59	5	
			kg/kkg	6.5	4.9	4.9	4.9	4.9	6.5	4.9	2.4	0.2	
			(lb/t)	(13.0)	(9.8)	(9.8)	(9.8)	(9.8)	(13.0)	(9.8)	(4.9)	(0.4)	
		TSS	mg/l	216	130	130	130	130	216	130	26	7	
			kg/kkg	11.4	5.4	5.4	5.4	5.4	11.4	5.4	1.1	0.3	
			(lb/t)	(22.7)	(10.7)	(10.7)	(10.7)	(10.7)	(22.7)	(10.7)	(2.1)	(0.6)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	41.3	41.3
		(kgal/ton)	(9.9)	(9.9)
	BOD_5	mg/l	119	15
		kg/kkg	4.9	0.6
		(lb/t)	(9.8)	(1.2)
	TSS	mg/l	130	15
		kg/kkg	5.4	0.6
		(lb/t)	(10.7)	(1.2)

TABLE VIII-31
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 114 - WASTEPAPER CONSTRUCTION PRODUCTS - 100% WASTEPAPER

Discharge Type & Parameter				Raw Waste Load: Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent: Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	14.6	6.7	6.7	6.7	6.7	14.6	6.7	6.7	6.7	6.7
			(kgal/ton)	(3.5)	(1.6)	(1.6)	(1.6)	(1.6)	(3.5)	(1.6)	(1.6)	(1.6)	(1.6)
		BOD5	mg/l	521	187	187	187	187	30	30	30	15	5
			kg/kkg	7.6	1.3	1.3	1.3	1.3	0.4	0.2	0.2	0.1	0.03
			(lb/t)	(15.2)	(2.5)	(2.5)	(2.5)	(2.5)	(0.9)	(0.4)	(0.4)	(0.2)	(0.06)
		TSS	mg/l	1,326	180	180	180	180	50	50	50	15	7
			kg/kkg	19.4	1.2	1.2	1.2	1.2	0.8	0.3	0.3	0.1	0.04
			(lb/t)	(38.7)	(2.4)	(2.4)	(2.4)	(2.4)	(1.5)	(0.7)	(0.7)	(0.2)	(0.08)
	Indirect	Flow	kl/kkg	14.6	6.7	6.7	6.7	6.7	14.6	6.7	6.7	6.7	
			(kgal/ton)	(3.5)	(1.6)	(1.6)	(1.6)	(1.6)	(3.5)	(1.6)	(1.6)	(1.6)	
		BOD5	mg/l	521	187	187	187	187	521	187	93	5	
			kg/kkg	7.6	1.3	1.3	1.3	1.3	7.6	1.3	0.6	0.03	
			(lb/t)	(15.2)	(2.5)	(2.5)	(2.5)	(2.5)	(15.2)	(2.5)	(1.2)	(0.06)	
		TSS	mg/l	1,326	180	180	180	180	1,326	180	36	7	
			kg/kkg	19.4	1.2	1.2	1.2	1.2	19.4	1.2	0.2	0.04	
			(lb/t)	(38.7)	(2.4)	(2.4)	(2.4)	(2.4)	(38.7)	(2.4)	(0.5)	(0.08)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	6.7	
		(kgal/ton)	(1.6)	
	BOD5	mg/l	187	Zero
		kg/kkg	1.3	
		(lb/t)	(2.5)	Discharge
	TSS	mg/l	180	
		kg/kkg	1.2	
		(lb/t)	(2.4)	

TABLE VI[illegible]2
PREDICTED EFFLUENT QUA[illegible] OF PURE MILLS
SUBCATEGORY 114 - WASTEPAP[illegible] CONSTRUCTION PRODUCTS
50% WP AND 50% TMP

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	12.5	5.8	5.8	5.8	5.8	12.5	5.8	5.8	5.8	5.8
			(kgal/ton)	(3.0)	(1.4)	(1.4)	(1.4)	(1.4)	(3.0)	(1.4)	(1.4)	(1.4)	(1.4)
		BOD5	mg/l	1,111	394	394	394	394	30	30	30	15	5
			kg/kkg	13.9	2.3	2.3	2.3	2.3	0.4	0.2	0.2	0.1	0.03
			(lb/t)	(27.8)	(4.6)	(4.6)	(4.6)	(4.6)	(0.8)	(0.4)	(0.4)	(0.2)	(0.06)
		TSS	mg/l	815	111	111	111	111	50	50	50	15	7
			kg/kkg	10.2	0.7	0.7	0.7	0.7	0.6	0.3	0.3	0.1	0.04
			(lb/t)	(20.4)	(1.3)	(1.3)	(1.3)	(1.3)	(1.3)	(0.6)	(0.6)	(0.2)	(0.08)
	Indirect	Flow	kl/kkg	12.5	5.8	5.8	5.8	5.8	12.5	5.8	5.8	5.8	
			(kgal/ton)	(3.0)	(1.4)	(1.4)	(1.4)	(1.4)	(3.0)	(1.4)	(1.4)	(1.4)	
		BOD5	mg/l	1,111	394	394	394	394	1,111	394	197	5	
			kg/kkg	13.9	2.3	2.3	2.3	2.3	13.9	2.3	1.2	0.03	
			(lb/t)	(27.8)	(4.6)	(4.6)	(4.6)	(4.6)	(27.8)	(4.6)	(2.3)	(0.06)	
		TSS	mg/l	815	111	111	111	111	815	111	22	7	
			kg/kkg	10.2	0.7	0.7	0.7	0.7	10.2	0.7	0.1	0.04	
			(lb/t)	(20.4)	(1.3)	(1.3)	(1.3)	(1.3)	(20.4)	(1.3)	(0.3)	(0.08)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	5.8	
		(kgal/ton)	(1.4)	
	BOD5	mg/l	394	Zero
		kg/kkg	2.3	
		(lb/t)	(4.6)	Discharge
	TSS	mg/l	111	
		kg/kkg	0.7	
		(lb/t)	(1.3)	

TABLE VIII-33
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 201 - NONINTEGRATED-FINE

Discharge Type & Parameter			Existing Levels	Raw Waste Load Levels				Existing Levels	Final Effluent Levels			
			0	1	2	3	4	0	1	2	3	4
Existing Source Mills — Direct	Flow	kl/kkg	48.4	34.2	32.5	32.5	32.5	48.4	34.2	32.5	32.5	32.5
		(kgal/ton)	(11.6)	(8.2)	(7.8)	(7.8)	(7.8)	(11.6)	(8.2)	(7.8)	(7.8)	(7.8)
	BOD5	mg/l	175	161	169	169	169	30	30	30	15	5
		kg/kkg	8.5	5.5	5.5	5.5	5.5	1.4	1.0	1.4	0.5	0.2
		(lb/t)	(17.0)	(11.0)	(11.0)	(11.0)	(11.0)	(2.9)	(2.0)	(2.8)	(1.0)	(0.3)
	TSS	mg/l	621	670	573	573	573	50	50	50	15	7
		kg/kkg	30.1	22.9	18.7	18.7	18.7	2.4	1.7	1.6	0.5	0.2
		(lb/t)	(60.1)	(45.8)	(37.3)	(37.3)	(37.3)	(4.8)	(3.4)	(3.2)	(1.0)	(0.5)
Existing Source Mills — Indirect	Flow	kl/kkg	48.4	34.2	32.5	32.5	32.5	48.4	34.2	32.5	32.5	
		(kgal/ton)	(11.6)	(8.2)	(7.8)	(7.8)	(7.8)	(11.6)	(8.2)	(7.8)	(7.8)	
	BOD5	mg/l	175	161	169	169	169	175	161	85	5	
		kg/kkg	8.5	5.5	5.5	5.5	5.5	8.5	5.5	2.8	0.2	
		(lb/t)	(17.0)	(11.0)	(11.0)	(11.0)	(11.0)	(17.0)	(11.0)	(5.5)	(0.3)	
	TSS	mg/l	621	670	573	573	573	621	670	115	7	
		kg/kkg	30.1	22.9	18.7	18.7	18.7	30.1	22.9	3.7	0.2	
		(lb/t)	(60.1)	(45.8)	(37.3)	(37.3)	(37.3)	(60.1)	(45.8)	(7.5)	(0.5)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	32.5	32.5
		(kgal/ton)	(7.8)	(7.8)
	BOD5	mg/l	169	15
		kg/kkg	5.5	0.5
		(lb/t)	(11.0)	(1.0)
	TSS	mg/l	573	15
		kg/kkg	18.7	0.5
		(lb/t)	(37.3)	(1.0)

TABLE VI[illegible]
PREDICTED EFFLUENT QUAL[illegible] OF PURE MILLS
SUBCATEGORY 202 - NONINTEGRATED-TISSUE

Discharge Type & Parameter				Raw Waste Load Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	73.4	36.3	34.2	34.2	34.2	73.4	36.3	34.2	34.2	34.2
			(kgal/ton)	(17.6)	(8.7)	(8.2)	(8.2)	(8.2)	(17.6)	(8.7)	(8.2)	(8.2)	(8.2)
		BOD5	mg/l	181	152	161	161	161	91	76	80	25	5
			kg/kkg	13.3	5.5	5.5	5.5	5.5	6.7	2.8	2.8	0.9	0.2
			(lb/t)	(26.5)	(11.0)	(11.0)	(11.0)	(11.0)	(13.3)	(5.5)	(5.5)	(1.7)	(0.3)
		TSS	mg/l	531	677	477	477	477	106	135	95	12	7
			kg/kkg	39.0	24.6	16.3	16.3	16.3	7.8	4.9	3.3	0.4	0.2
			(lb/t)	(77.9)	(49.1)	(32.6)	(32.6)	(32.6)	(15.6)	(9.8)	(6.5)	(0.8)	(0.5)
	Indirect	Flow	kl/kkg	73.4	36.3	34.2	34.2	34.2	73.4	36.3	34.2	34.2	
			(kgal/ton)	(17.6)	(8.7)	(8.2)	(8.2)	(8.2)	(17.6)	(8.7)	(8.2)	(8.2)	
		BOD5	mg/l	181	152	161	161	161	181	152	80	5	
			kg/kkg	13.3	5.5	5.5	5.5	5.5	13.3	5.5	2.8	0.2	
			(lb/t)	(26.5)	(11.0)	(11.0)	(11.0)	(11.0)	(26.5)	(11.0)	(5.5)	(0.3)	
		TSS	mg/l	531	677	477	477	477	531	677	95	7	
			kg/kkg	39.0	24.6	16.3	16.3	16.3	39.0	24.6	3.3	0.2	
			(lb/t)	(77.9)	(49.1)	(32.6)	(32.6)	(32.6)	(77.9)	(49.1)	(6.5)	(0.5)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	34.2	34.2
		(kgal/ton)	(8.2)	(8.2)
	BOD5	mg/l	161	25
		kg/kkg	5.5	0.9
		(lb/t)	(11.0)	(1.7)
	TSS	mg/l	477	12
		kg/kkg	16.3	0.4
		(lb/t)	(32.6)	(0.8)

TABLE VIII-35
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 204 - NONINTEGRATED-LIGHTWEIGHT

Discharge Type & Parameter				Raw Waste Load: Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Final Effluent: Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	266.5	213.5	209.3	209.3	209.3	266.5	213.5	209.3	209.3	209.3
			(kgal/ton)	(63.9)	(51.2)	(50.2)	(50.2)	(50.2)	(63.9)	(51.2)	(50.2)	(50.2)	(50.2)
		BOD5	mg/l	57	48	49	49	49	29	24	25	25	5
			kg/kkg	15.3	10.4	10.4	10.4	10.4	7.6	5.2	5.2	5.2	1.0
			(lb/t)	(30.6)	(20.7)	(20.7)	(20.7)	(20.7)	(15.3)	(10.4)	(10.5)	(10.5)	(2.1)
		TSS	mg/l	171	133	96	96	96	86	27	19	12	7
			kg/kkg	45.6	28.5	20.2	20.2	20.2	22.8	5.7	4.0	2.5	1.5
			(lb/t)	(91.2)	(56.9)	(40.4)	(40.4)	(40.4)	(45.6)	(11.4)	(8.1)	(5.0)	(3.0)
	Indirect	Flow	kl/kkg	266.5	213.5	209.3	209.3	209.3	266.5	213.5	209.3	209.3	
			(kgal/ton)	(63.9)	(51.2)	(50.2)	(50.2)	(50.2)	(63.9)	(51.2)	(50.2)	(50.2)	
		BOD5	mg/l	57	48	49	49	49	57	48	25	5	
			kg/kkg	15.3	10.4	10.4	10.4	10.4	15.3	10.4	5.2	1.0	
			(lb/t)	(30.6)	(20.7)	(20.7)	(20.7)	(20.7)	(30.6)	(20.7)	(10.5)	(2.1)	
		TSS	mg/l	171	133	96	96	96	171	133	19	7	
			kg/kkg	45.6	28.5	20.2	20.2	20.2	45.6	28.5	4.0	1.5	
			(lb/t)	(91.2)	(56.9)	(40.4)	(40.4)	(40.4)	(91.2)	(56.9)	(8.1)	(3.0)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	209.3	209.3
		(kgal/ton)	(50.2)	(50.2)
	BOD5	mg/l	49	25
		kg/kkg	10.4	5.2
		(lb/t)	(20.7)	(10.5)
	TSS	mg/l	96	12
		kg/kkg	20.2	2.5
		(lb/t)	(40.4)	(5.0)

TABLE VII[illegible]
PREDICTED EFFLUENT QUAL[illegible]OF PURE MILLS
SUBCATEGORY 204 - NONINTEGRATED-LIGHTWEIGHT ELECTRICAL

	Discharge Type & Parameter			Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	407.0	326.1	319.8	319.8	319.8	407.0	326.1	319.8	319.8	319.8
			(kgal/ton)	(97.6)	(78.2)	(76.7)	(76.7)	(76.7)	(97.6)	(78.2)	(76.7)	(76.7)	(76.7)
		BOD_5	mg/l	28	9	9	9	9	14	9	9	8	5
			kg/kkg	11.6	2.8	2.8	2.8	2.8	5.8	2.8	2.8	2.5	1.6
			(lb/t)	(23.1)	(5.6)	(5.6)	(5.6)	(5.6)	(11.6)	(5.6)	(5.6)	(5.1)	(3.2)
		TSS	mg/l	93	72	52	52	52	46.3	72	52	12	7
			kg/kkg	37.7	23.5	16.7	16.7	16.7	18.8	23.5	16.7	3.8	2.2
			(lb/t)	(75.3)	(47.0)	(33.4)	(33.4)	(33.4)	(37.7)	(47.0)	(33.4)	(7.7)	(4.5)
	Indirect	Flow	kl/kkg	407.0	326.1	319.8	319.8	319.8	407.0	326.1	319.8	319.8	
			(kgal/ton)	(97.6)	(78.2)	(76.7)	(76.7)	(76.7)	(97.6)	(78.2)	(76.7)	(76.7)	
		BOD_5	mg/l	28	9	9	9	9	28	9	9	5	
			kg/kkg	11.6	2.8	2.8	2.8	2.8	11.6	2.8	2.8	1.6	
			(lb/t)	(23.1)	(5.6)	(5.6)	(5.6)	(5.6)	(23.1)	(5.6)	(5.6)	(3.2)	
		TSS	mg/l	93	72	52	52	52	93	72	10	7	
			kg/kkg	37.7	23.5	16.7	16.7	16.7	37.7	23.5	3.3	2.2	
			(lb/t)	(75.3)	(47.0)	(33.4)	(33.4)	(33.4)	(75.3)	(47.0)	(6.7)	(4.4)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	319.8	319.8
		(kgal/ton)	(76.7)	(76.7)
	BOD_5	mg/l	9	8
		kg/kkg	2.8	2.5
		(lb/t)	(5.6)	(5.1)
	TSS	mg/l	52	12
		kg/kkg	16.7	3.8
		(lb/t)	(33.4)	(7.7)

TABLE VIII-37
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 205 - NONINTEGRATED-FILTER AND NONWOVEN

Discharge Type & Parameter				Existing Levels 0	Raw Waste Load Levels 1	2	3	4	Existing Levels 0	Final Effluent Levels 1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	171.8	125.9	125.9	125.9	125.9	171.8	125.9	125.9	125.9	125.9
			(kgal/ton)	(41.2)	(30.2)	(30.2)	(30.2)	(30.2)	(41.2)	(30.2)	(30.2)	(30.2)	(30.2)
		BOD5	mg/l	57	54	54	54	54	28	27	27	12	5
			kg/kkg	9.8	6.9	6.9	6.9	6.9	4.9	3.4	3.4	1.5	0.6
			(lb/t)	(19.6)	(13.7)	(13.7)	(13.7)	(13.7)	(9.8)	(6.9)	(6.9)	(3.0)	(1.2)
		TSS	mg/l	227	183	183	183	183	45	37	37	12	7
			kg/kkg	39.1	23.1	23.1	23.1	23.1	7.8	4.6	4.6	1.5	0.9
			(lb/t)	(78.1)	(46.1)	(46.1)	(46.1)	(46.1)	(15.6)	(9.2)	(9.2)	(3.0)	(1.8)
	Indirect	Flow	kl/kkg	171.8	125.9	125.9	125.9	125.9	171.8	125.9	125.9	125.9	
			(kgal/ton)	(41.2)	(30.2)	(30.2)	(30.2)	(30.2)	(41.2)	(30.2)	(30.2)	(30.2)	
		BOD5	mg/l	57	54	54	54	54	57	54	27	5	
			kg/kkg	9.8	6.9	6.9	6.9	6.9	9.8	6.9	3.4	0.6	
			(lb/t)	(19.6)	(13.7)	(13.7)	(13.7)	(13.7)	(19.6)	(13.7)	(6.9)	(1.2)	
		TSS	mg/l	227	183	183	183	183	227	183	37	7	
			kg/kkg	39.1	23.1	23.1	23.1	23.1	39.1	23.1	4.6	0.9	
			(lb/t)	(78.1)	(46.1)	(46.1)	(46.1)	(46.1)	(78.1)	(46.1)	(9.2)	(1.8)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	125.9	125.9
		(kgal/ton)	(30.2)	(30.2)
	BOD5	mg/l	54	12
		kg/kkg	6.9	1.5
		(lb/t)	(13.7)	(3.0)
	TSS	mg/l	183	12
		kg/kkg	23.1	1.5
		(lb/t)	(46.1)	(3.0)

TABLE VII[illegible]
PREDICTED EFFLUENT QUAL[illegible] OF PURE MILLS
SUBCATEGORY 211 - NONINTEGRATED-BOARD

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	102.6	62.6	62.6	62.6	62.6	102.6	62.6	62.6	62.6	62.6
			(kgal/ton)	(24.6)	(15.0)	(15.0)	(15.0)	(15.0)	(24.6)	(15.0)	(15.0)	(15.0)	(15.0)
		BOD5	mg/l	98	104	104	104	104	49	52	52	25	5
			kg/kkg	10.0	6.5	6.5	6.5	6.5	5.0	3.2	3.2	1.6	0.3
			(lb/t)	(20.0)	(13.0)	(13.0)	(13.0)	(13.0)	(10.0)	(6.5)	(6.5)	(3.1)	(0.6)
		TSS	mg/l	412	412	412	412	412	82	82	82	12	7
			kg/kkg	42.3	25.8	25.8	25.8	25.8	8.4	5.2	5.2	0.8	0.4
			(lb/t)	(84.5)	(51.5)	(51.5)	(51.5)	(51.5)	(16.9)	(10.3)	(10.3)	(1.5)	(0.9)
	Indirect	Flow	kl/kkg	102.2	62.6	62.6	62.6	62.6	102.6	62.6	62.6	62.6	
			(kgal/ton)	(24.6)	(15.0)	(15.0)	(15.0)	(15.0)	(24.6)	(15.0)	(15.0)	(15.0)	
		BOD5	mg/l	98	104	104	104	104	98	104	52	5	
			kg/kkg	10.0	6.5	6.5	6.5	6.5	10.0	6.5	3.2	0.3	
			(lb/t)	(20.0)	(13.0)	(13.0)	(13.0)	(13.0)	(20.0)	(13.0)	(6.5)	(0.6)	
		TSS	mg/l	412	412	412	412	412	412	412	82	7	
			kg/kkg	42.3	25.8	25.8	25.8	25.8	42.3	25.8	5.2	0.4	
			(lb/t)	(84.5)	(51.5)	(51.5)	(51.5)	(51.5)	(84.5)	(51.5)	(10.3)	(0.9)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	62.6	62.6
		(kgal/ton)	(15.0)	(15.0)
	BOD5	mg/l	104	25
		kg/kkg	6.5	1.6
		(lb/t)	(13.0)	(3.1)
	TSS	mg/l	412	12
		kg/kkg	25.8	0.8
		(lb/t)	(51.5)	(1.5)

TABLE VIII-39
PREDICTED EFFLUENT QUALITY OF PURE MILLS
SUBCATEGORY 211 - NONINTEGRATED BOARD-ELECTRICAL

Discharge Type & Parameter				Raw Waste Load Levels: Existing Levels 0	1	2	3	4	Final Effluent Levels: Existing Levels 0	1	2	3	4
Existing Source Mills	Direct	Flow	kl/kkg	247.3	151.0	151.0	151.0	151.0	247.3	151.0	151.0	151.0	151.0
			(kgal/ton)	(59.3)	(36.2)	(36.2)	(36.2)	(36.2)	(59.3)	(36.2)	(36.2)	(36.2)	(36.2)
		BOD5	mg/l	40	43	43	43	43	20	22	22	15	5
			kg/kkg	10.0	6.5	6.5	6.5	6.5	5.0	3.2	3.2	2.8	0.7
			(lb/t)	(20.0)	(13.0)	(13.0)	(13.0)	(13.0)	(10.0)	(6.5)	(6.5)	(4.5)	(1.5)
		TSS	mg/l	171	171	171	171	171	34	34	34	12	7
			kg/kkg	42.3	25.8	25.8	25.8	25.8	8.4	5.2	5.2	1.8	1.0
			(lb/t)	(84.5)	(51.5)	(51.5)	(51.5)	(51.5)	(16.9)	(10.3)	(10.3)	(3.6)	(2.1)
	Indirect	Flow	kl/kkg	247.3	151.0	151.0	151.0	151.0	247.3	151.0	151.0	151.0	
			(kgal/ton)	(59.3)	(36.2)	(36.2)	(36.2)	(36.2)	(59.3)	(36.2)	(36.2)	(36.2)	
		BOD5	mg/l	40	43	43	43	43	40	43	22	5	
			kg/kkg	10.0	6.5	6.5	6.5	6.5	10.0	6.5	3.2	0.8	
			(lb/t)	(20.0)	(13.0)	(13.0)	(13.0)	(13.0)	(20.0)	(13.0)	(6.5)	(1.5)	
		TSS	mg/l	171	171	171	171	171	171	171	34	7	
			kg/kkg	42.3	25.8	25.8	25.8	25.8	42.3	25.8	5.2	1.0	
			(lb/t)	(84.5)	(51.5)	(51.5)	(51.5)	(51.5)	(84.5)	(51.5)	(10.3)	(2.1)	

			Raw Waste Load	Final Effluent
New Source Mills	Flow	kl/kkg	151.0	151.0
		(kgal/ton)	(36.2)	(36.2)
	BOD5	mg/l	43	15
		kg/kkg	6.5	2.8
		(lb/t)	(13.0)	(4.5)
	TSS	mg/l	171	12
		kg/kkg	25.8	1.8
		(lb/t)	(51.5)	(3.6)

SECTION IX

COST, ENERGY AND NON-WATER-QUALITY ASPECTS

INTRODUCTION

As part of the Effluent Limitations Guidelines Review Program for the Pulp, Paper, and Paperboard Industry, the E.C. Jordan Co. is addressing the cost, energy, and non-water-quality aspects of the technologies available to achieve the various levels of control. Previous sections have described production process controls and effluent treatment technologies available for implementation. Levels of control have been developed and associated effluent quality has been determined for each control and treatment option. This section summarizes the cost, energy, and non-water-quality impacts of the various control and treatment options. The non-water-quality aspects to be addressed are:

1. air pollution;

2. noise pollution;

3. solid waste;

4. byproduct recovery; and

5. implementation.

DEVELOPMENT OF COSTS

Introduction

Compliance with effluent limitations guidelines and standards requires the implementation of production process controls and effluent treatment technologies. This section will describe how representative cost data has been developed relative to the implementation of various control and treatment options.

Full assessment of the cost of implementing each control and treatment option at each of over 700 pulp, paper or paperboard mills would require numerous detailed engineering studies that would be extremely costly and beyond the scope of this investigation. The actual cost of implementing production process controls and effluent treatment options can vary at each individual facility, depending on the design and operation of the production facilities. Local conditions and effluent treatment costs reported by the industry vary greatly from one installation to another, depending, in part, upon bookkeeping procedures. To provide a representative estimate of implementation costs, the cost analyses in this document are based on the model mill concept, thus reflecting raw waste characteristics and control and treatment methods that are representative of each subcategory of the pulp, paper and paperboard industry.

In order to assess the overall impact of future effluent regulations on the pulp, paper and paperboard industry, three discharge characteristics have been studied: 1) direct discharge; 2) indirect discharge; and 3) new point source mills.

Model Mills

As a result of current subcategorization investigations, the pulp, paper and paperboard industry has been divided into 24 discreet subcategories, plus miscellaneous mill groupings. Previous sections of the report have summarized the development of representative model mills for each subcategory. In-place production process control and effluent treatment technology have been summarized, including raw waste and final effluent characteristics. Estimates have been made of the resulting raw waste and final effluent characteristics after implementation of the various levels of controls at a model mill. These waste characteristics are summarized in Table IX-1.

As noted earlier, the purpose of establishing a model mill for each subcategory has been to develop representative cost data as presented in this section of the report. In order to assess the variability of the costs, factors affecting costs are also presented in this section. Model mills have been developed for several production capacities within the size range found in each subcategory. The model mills, therefore, reflect the significance of size (economies of scale) affecting the cost of implementing the technology. The selected mill sizes for each subcategory are shown in Tables IX-2, 3, and 4.

The miscellaneous mill groupings are not addressed by the model mill concept. Mills in these groupings generally employ several processes at one site, and therefore cannot be represented by a single model mill. In order to assess the cost of control technology implementation at these mills, a methodology has been developed and is discussed subsequently in this section. Mills in the nonwood pulping group of the integrated miscellaneous mill grouping are not included in the cost data development.

Cost Criteria

In order to develop cost estimates for the various control and treatment options under consideration, criteria have been developed relating to capital costs, operating/maintenance costs and energy expenditures. These criteria are shown in Table IX-5. The pre-engineering cost estimates developed for this study are considered to have a variability of plus or minus 30 percent. Information on which these criteria are based is summarized in the following discussions.

Capital Cost Criteria

All costs presented in this section except as noted are in terms of first quarter 1978 dollars. Since construction costs escalate, this may be adjusted

TABLE IX-1

MODEL MILL RAW WASTE LOADS RESULTING FROM LEVEL 1 AND 2 PRODUCTION PROCESS CONTROL MODIFICATIONS

Subcategory No.	Name	Raw Waste Load (RWL) Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
011	Alkaline-Dissolving						
	Model Mill RWL	198.1	(47.5)	53.8	(107.6)	76.8	(153.7)
	Level 1 Reduction	12.9	(3.1)	21.2	(42.3)	12.3	(24.5)
	Level 1 RWL	185.2	(44.4)	32.6	(65.3)	64.5	(129.2)
	Level 2 Reduction	8.0	(1.9)	0.6	(1.3)	4.3	(8.6)
	Level 2 RWL	177.2	(42.5)	32.0	(64.0)	60.2	(120.6)
012	Alkaline-Market						
	Model Mill RWL	178.2	(42.8)	41.5	(83.0)	31.8	(63.6)
	Level 1 Reduction	29.1	(7.0)	13.2	(26.4)	1.5	(3.0)
	Level 1 RWL	149.1	(35.8)	28.3	(56.6)	30.3	(60.6)
	Level 2 Reduction	15.9	(3.8)	0.4	(0.8)	3.5	(7.0)
	Level 2 RWL	133.2	(32.0)	27.9	(55.8)	26.8	(53.6)
013	Alkaline-BCT						
	Model Mill RWL	152.2	(36.5)	45.7	(91.3)	42.5	(85.0)
	Level 1 Reduction	26.3	(6.3)	19.9	(39.7)	3.6	(7.3)
	Level 1 RWL	125.9	(30.2)	25.8	(51.6)	38.9	(77.7)
	Level 2 Reduction	23.7	(5.7)	-	-	2.6	(5.2)
	Level 2 RWL	102.2	(24.5)	25.8	(51.6)	36.3	(72.5)
014	Alkaline-Fine						
	Model Mill RWL	110.5	(26.5)	30.5	(61.0)	66.2	(132.3)
	Level 1 Reduction	20.0	(4.8)	13.8	(27.7)	14.0	(28.0)
	Level 1 RWL	90.5	(21.7)	16.7	(33.3)	52.2	(104.3)
	Level 2 Reduction	16.7	(4.0)	-	-	5.5	(11.0)
	Level 2 RWL	73.8	(17.7)	16.7	(33.3)	46.7	(93.3)
015	Alkaline-Unbleached						
	Model Mill RWL	46.6	(11.2)	14.2	(28.3)	16.3	(32.5)
	Level 1 Reduction	10.4	(2.5)	4.0	(8.0)	0.8	(1.5)
	Level 1 RWL	36.2	(8.7)	10.2	(20.3)	15.5	(31.0)
	Level 2 Reduction	0.9	(0.2)	-	-	3.6	(7.3)
	Level 2 RWL	35.3	(8.5)	10.2	(20.3)	11.9	(23.7)
016	Semi-Chemical						
	Model Mill RWL	32.5	(7.8)	18.5	(36.9)	21.6	(43.1)
	Level 1 Reduction	3.3	(0.8)	1.9	(3.8)	-	-
	Level 1 RWL	29.2	(7.0)	16.6	(33.1)	21.6	(43.1)
	Level 2 Reduction	7.5	(1.8)	1.0	(1.9)	7.1	(14.2)
	Level 2 RWL	21.7	(5.2)	15.6	(31.2)	14.5	(28.9)

TABLE IX-1 (Continued)

Subcategory		Raw Waste Load (RWL)					
		Flow		BOD5		TSS	
No.	Name	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
017	Alkaline-Unbleached and Semi-Chemical						
	Model Mill RWL	55.8	(13.4)	18.7	(37.3)	23.5	(47.0)
	Level 1 Reduction	20.4	(4.9)	5.2	(10.4)	5.5	(11.0)
	Level 1 RWL	35.4	(8.5)	13.5	(26.9)	18.0	(36.0)
	Level 2 Reduction	-	-	-	-	1.0	(2.0)
	Level 2 RWL	35.4	(8.5)	13.5	(26.9)	17.0	(34.0)
019	Alkaline Newsprint						
	Model Mill RWL	93.8	(22.5)	21.1	(42.2)	56.7	(113.3)
	Level 1 Reduction	25.9	(6.2)	6.3	(12.7)	10.8	(21.5)
	Level 1 RWL	67.9	(16.3)	14.8	(29.5)	45.9	(91.8)
	Level 2 Reduction	10.4	(2.5)	-	-	7.0	(13.9)
	Level 2 RWL	57.5	(13.8)	14.8	(29.5)	38.9	(77.9)
021	Sulfite-Dissolving						
	Model Mill RWL	256.9	(61.6)	153.0	(306.0)	90.3	(180.6)
	Level 1 Reduction	59.7	(14.3)	59.3	(118.6)	6.6	(13.3)
	Level 1 RWL	197.2	(47.3)	93.7	(187.4)	83.7	(167.3)
	Level 2 Reduction	20.0	(4.8)	1.0	(2.0)	5.0	(10.0)
	Level 2 RWL	177.2	(42.5)	92.7	(185.4)	78.7	(157.3)
022	Sulfite-Papergrade						
	Model Mill RWL	152.6	(36.6)	48.7	(97.3)	33.1	(66.2)
	Level 1 Reduction	62.6	(15.0)	20.7	(41.4)	1.6	(3.2)
	Level 1 RWL	90.0	(21.6)	28.0	(55.9)	31.5	(63.0)
	Level 2 Reduction	2.4	(0.6)	-	-	2.2	(4.4)
	Level 2 RWL	87.6	(21.0)	28.0	(55.9)	29.3	(58.6)
032	Thermo-Mechanical Pulp						
	Model Mill RWL	60.0	(14.4)	18.3	(36.5)	38.7	(77.4)
	Level 1 Reduction	17.5	(4.2)	2.6	(5.2)	12.4	(24.8)
	Level 1 RWL	42.5	(10.2)	15.7	(31.3)	26.3	(52.6)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	42.5	(10.2)	15.7	(31.3)	26.3	(52.6)
033	Groundwood-CMN						
	Model Mill RWL	88.4	(21.2)	18.6	(37.1)	48.5	(97.0)
	Level 1 Reduction	33.8	(8.1)	7.0	(13.9)	13.0	(26.0)
	Level 1 RWL	54.6	(13.1)	11.6	(23.2)	35.5	(71.0)
	Level 2 Reduction	--	(--)	--	(--)	6.5	(13.0)
	Level 2 RWL	54.6	(13.1)	11.6	(23.2)	29.0	(58.0)
034	Groundwood-Fine						
	Model Mill RWL	68.4	(16.4)	17.6	(35.2)	53.9	(107.9)
	Level 1 Reduction	14.2	(3.4)	4.6	(9.3)	16.0	(32.1)

TABLE IX-1 (Continued)

Subcategory No.	Name	Raw Waste Load (RWL): Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
	Level 1 RWL	54.2	(13.0)	13.0	(25.9)	37.9	(75.8)
	Level 2 Reduction	10.4	(2.5)	0.8	(1.5)	3.9	(7.8)
	Level 2 RWL	43.8	(10.5)	12.2	(24.4)	34.0	(68.0)
101	Deink-Fine and Tissue						
	Model Mill RWL	81.3	(19.5)	48.7	(97.4)	143.0	(286.0)
	Level 1 Reduction	22.9	(5.5)	8.0	(16.1)	12.8	(25.5)
	Level 1 RWL	58.4	(14.0)	40.7	(81.3)	130.2	(260.5)
	Level 2 Reduction	2.9	(0.7)	-	-	2.0	(4.0)
	Level 2 RWL	55.5	(13.3)	40.7	(81.3)	128.2	(256.5)
102	Deink-Newsprint						
	Model Mill RWL	67.6	(16.2)	15.9	(31.7)	123.0	(246.0)
	Level 1 Reducton	10.1	(2.4)	2.5	(5.0)	5.0	(10.0)
	Level 1 RWL	57.5	(13.8)	13.4	(26.7)	118.0	(236.0)
	Level 2 Reduction	2.0	(0.5)	-	-	15.0	(30.0)
	Level 2 RWL	55.5	(13.3)	13.4	(26.7)	103.0	(206.0)
111	Wastepaper-Tissue						
	Model Mill RWL	39.2	(9.4)	8.8	(17.5)	27.0	(54.0)
	Level 1 Reduction	5.8	(1.4)	1.3	(2.6)	4.0	(8.0)
	Level 1 RWL	33.4	(8.0)	7.5	(14.9)	23.0	(46.0)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	33.4	(8.0)	7.5	(14.9)	23.0	(46.0)
112	Wastepaper-Board						
	Model Mill RWL	15.4	(3.7)	6.5	(12.9)	7.7	(15.3)
	Level 1 Reduction	7.1	(1.7)	3.8	(7.6)	5.8	(11.5)
	Level 1 RWL	8.3	(2.0)	2.7	(5.3)	1.9	(3.8)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	8.3	(2.0)	2.7	(5.3)	1.9	(3.8)
113	Wastepaper-Molded Products						
	Model Mill RWL	47.1	(11.3)	5.7	(11.4)	10.7	(21.3)
	Level 1 Reduction	10.0	(2.4)	1.4	(2.8)	5.7	(11.3)
	Level 1 RWL	37.1	(8.9)	4.3	(8.6)	5.0	(10.0)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	37.1	(8.9)	4.3	(8.6)	5.0	(10.0)
114	Wastepaper-Construction Products						
	Model Mill RWL	9.2	(2.2)	5.8	(11.5)	8.2	(16.3)
	Level 1 Reduction	5.01	(1.2)	4.8	(9.6)	7.7	(15.3)
	Level 1 RWL	4.2	(1.0)	1.0	(1.9)	0.5	(1.0)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	4.2	(1.0)	1.0	(1.9)	0.5	(1.0)

TABLE IX-1 (Continued)

Subcategory No.	Name	Raw Waste Load (RWL) Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
201	Nonintegrated-Fine						
	Model Mill RWL	48.5	(11.6)	8.5	(17.0)	30.1	(60.1)
	Level 1 Reduction	14.2	(3.4)	3.0	(6.0)	7.2	(14.3)
	Level 1 RWL	34.3	(8.2)	5.5	(11.0)	22.9	(45.8)
	Level 2 Reduction	1.7	(0.4)	-	-	4.2	(8.5)
	Level 2 RWL	32.6	(7.8)	5.5	(11.0)	18.7	(37.3)
202	Nonintegrated-Tissue						
	Model Mill RWL	73.4	(17.6)	13.3	(26.5)	39.0	(77.9)
	Level 1 Reduction	37.1	(8.9)	7.8	(15.5)	14.4	(28.8)
	Level 1 RWL	36.3	(8.7)	5.5	(11.0)	24.6	(49.1)
	Level 2 Reduction	2.1	(0.5)	-	(--)	8.3	(16.5)
	Level 2 RWL	34.2	(8.2)	5.5	(11.0)	16.3	(32.6)
204	Nonintegrated-Lightweight						
	Model Mill RWL	266.5	(63.9)	15.3	(30.6)	45.6	(91.2)
	Level 1 Reduction	52.9	(12.7)	5.0	(9.9)	17.1	(34.3)
	Level 1 RWL	213.6	(51.2)	10.3	(20.7)	28.5	(56.9)
	Level 2 Reduction	4.2	(1.0)	-	-	8.3	(16.5)
	Level 2 RWL	209.4	(50.2)	10.3	(20.7)	20.2	(40.4)
205	Nonintegrated-Filter						
	Model Mill RWL	171.8	(41.2)	5.0	(10.0)	25.0	(50.0)
	Level 1 Reduction	45.9	(11.0)	1.5	(3.0)	10.2	(20.5)
	Level 1 RWL	125.9	(30.2)	3.5	(7.0)	14.8	(29.5)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	125.9	(30.2)	3.5	(7.0)	14.8	(29.5)
211	Nonintegrated-Paperboard						
	Model Mill RWL	102.4	(24.6)	10.0	(20.0)	42.3	(84.5)
	Level 1 Reduction	40.0	(9.6)	3.5	(7.0)	16.5	(33.0)
	Level 1 RWL	62.4	(15.0)	6.5	(13.0)	25.8	(51.5)
	Level 2 Reduction	-	-	-	-	-	-
	Level 2 RWL	62.4	(15.0)	6.5	(13.0)	25.8	(51.5)

TABLE IX-2

MODEL MILL SIZES
DIRECT DISCHARGE MILLS

Subcategory	Model Mill Size: Small kkg/day	(t/d)	Medium kkg/d	(t/d)	Large kkg/d	(t/d)
011 Alkaline-Dissolving	--	--	907	(1,000)	--	--
012 Alkaline-Market	318	(350)	544	(600)	1,452	(1,600)
013 Alkaline-BCT	272	(300)	726	(800)	1,180	(1,300)
014 Alkaline-Fine	181	(200)	726	(800)	1,089	(1,200)
015 Alkaline-Unbleached	408	(450)	907	(1,000)	1,361	(1,500)
016 Semi-Chemical	181	(200)	386	(425)	544	(600)
017 Alkaline-Unbleached and Semi-Chemical	635	(700)	1,361	(1,500)	2,359	(2,600)
019 Alkaline-Newsprint	--	--	907	(1,000)	1,270	(1,400)
021 Sulfite-Dissolving	408	(450)	544	(600)	681	(750)
022 Sulfite-Papergrade	91	(100)	408	(450)	907	(1,000)
032 Thermo-Mechanical Pulp	--	--	318	(350)	--	--
033 Groundwood-CMN	45	(50)	544	(600)	907	(1,000)
034 Groundwood-Fine	68	(75)	454	(500)	681	(750)
101 Deink-Fine and Tissue	45	(50)	163	(180)	726	(800)
111 Wastepaper-Tissue	9	(10)	41	(45)	--	--
112 Wastepaper-Board	45	(50)	145	(160)	635	(700)
113 Wastepaper-Molded Products	18	(20)	45	(50)	136	(150)
114 Wastepaper-Construction Products	91	(100)	205	(225)	318	(350)
201 Nonintegrated-Fine	32	(35)	125	(215)	907	(1,000)
202 Nonintegrated-Tissue	32	(35)	163	(180)	907	(1,000)
204 Nonintegrated-Lightweight	9	(10)	54	(60)	181	(200)
205 Nonintegrated-Filter and Nonwoven	4	(5)	18	(20)	41	(45)
211 Nonintegrated-Paperboard	9	(10)	36	(40)	68	(75)

TABLE IX-3

MODEL MILL SIZES
INDIRECT DISCHARGE MILLS

Subcategory	Model Mill Size					
	Small		Medium		Large	
	kkg/day	(t/d)	kkg/d	(t/d)	kkg/d	(t/d)
014 Alkaline-Fine	336	(370)	726	(800)	1,070	(1,180)
101 Deink-Fine and Tissue	68	(75)	163	(180)	345	(380)
102 Deink-Newsprint	-	-	363	(400)	-	-
111 Wastepaper-Tissue	9	(10)	32	(35)	77	(85)
112 Wastepaper-Board	45	(50)	127	(140)	372	(410)
113 Wastepaper-Molded Products	18	(20)	50	(55)	168	(185)
114 Wastepaper-Construction Products	91	(100)	204	(225)	318	(350)
201 Nonintegrated-Fine	14	(15)	104	(115)	531	(585)
202 Nonintegrated-Tissue	9	(10)	82	(90)	263	(290)
204 Nonintegrated-Lightweight	23	(25)	27	(30)	32	(35)
205 Nonintegrated-Filter and Nonwoven	5	(5)	14	(15)	41	(45)
211 Nonintegrated-Paperboard	9	(10)	23	(25)	45	(50)

TABLE IX-4

MODEL MILL SIZES
NEW POINT SOURCE MILLS

Subcategory	Model Mill Size: Small kkg/day	Small (t/d)	Medium kkg/d	Medium (t/d)	Large kkg/d	Large (t/d)
011 Alkaline-Dissolving	--	--	907	(1,000)	--	--
012 Alkaline-Market	318	(350)	544	(600)	1,451	(1,600)
013 Alkaline-BCT	272	(300)	726	(800)	1,179	(1,300)
014 Alkaline-Fine	181	(200)	726	(800)	1,089	(1,200)
015 Alkaline-Unbleached	408	(450)	907	(1,000)	1,361	(1,500)
016 Semi-Chemical	181	(200)	386	(425)	544	(600)
017 Alkaline-Unbleached and Semi-Chemical	635	(700)	1,361	(1,500)	2,359	(2,600)
019 Alkaline-Newsprint	907	(1,000)	1,270	(1,400)	--	--
021 Sulfite-Dissolving	408	(450)	544	(600)	680	(750)
022 Sulfite-Papergrade	91	(100)	408	(450)	907	(1,000)
032 Thermo-Mechanical Pulp	--	--	318	(350)	--	--
033 Groundwood-CMN	45	(50)	544	(600)	907	(1,000)
034 Groundwood-Fine	68	(75)	454	(500)	680	(750)
101 Deink-Fine and Tissue	45	(50)	171	(189)	726	(800)
102 Deink-Newsprint	--	--	363	(400)	--	--
111 Wastepaper-Tissue	9	(10)	41	(45)	--	--
112 Wastepaper-Board	45	(50)	145	(160)	635	(700)
113 Wastepaper-Molded Products	18	(20)	45	(50)	136	(150)
114 Wastepaper-Construction Products	91	(100)	204	(225)	318	(350)
201 Nonintegrated-Fine	32	(35)	195	(215)	907	(1,000)
202 Nonintegrated-Tissue	32	(35)	163	(180)	907	(1,000)
204 Nonintegrated-Lightweight	9	(10)	54	(60)	181	(200)
205 Nonintegrated-Filter and Nonwoven	5	(5)	18	(20)	41	(45)
211 Nonintegrated-Paperboard	9	(10)	36	(40)	68	(75)

TABLE IX-5

COST CRITERIA(38, 196, 197, 198, 199, 200, 201)

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1. Capital costs - February, 1978; ENR = 2,683

2. Annual fixed costs:
   General 15 percent of capital expenditures.
   Solids disposal 24 percent of capital expenditures for solids disposal.

3. Energy:

Electrical	3.25 cents per kWh
Fuel	$12.00/barrel

4. Operation/maintenance:

Labor:

General	$10.00/hr
Solids disposal	$ 8.00/hr

Chemicals:

Alum	$100/ton, dry basis
Polymer	$2.50/lb
Phosphoric Acid	$0.20/lb - 85%
Anhydrous ammonia	$1.40/ton, dry basis
Sodium hydroxide	$150/ton - 50%
Granular Activated Carbon	$0.40/lb

by appropriate cost indices to represent the time reference necessary. The most accepted and used cost index in the engineering field is the Engineering News-Record (ENR) construction cost index. The ENR index value of 2,683 used in this report was taken from the "U.S. - 20 Cities Average" for February, 1978.(197)

Equipment costs were based upon supplier quotes, published literature, engineering experience and data request program mill responses. Capital costs include allowances for lost production during construction or for additional power facilities as warranted. Additional costs such as engineering and contingencies are based on a percentage of capital and vary from 15 to 25 percent depending on the technology.

A total labor rate of $23.00 per hour was used for installation of production process controls. This wage rate is based upon a $19.00 national average wage rate including fringe benefits plus a net supervision rate of $4 per laborer hour.(202) Construction and installation cost estimates for effluent treatment were based on a varying percentage of capital items.

The cost for land may vary from $500 per acre to $10,000 per acre, depending on the particular location of a facility. The U.S. pulp, paper and paperboard mills vary in location from densely populated areas to isolated mills located several miles from neighboring communities. Consequently, the costs associated with land acquisition may vary significantly from mill to mill. Therefore, in developing the cost estimates, the cost of land acquisition has not been included except as noted.

Annual Fixed Charges. The annual fixed charges are those operating costs which are directly related to the construction of the pollution abatement facilities. These charges commonly include such items as depreciation of the control equipment and the interest on the capital borrowed for construction. In addition, such costs as maintenance materials, spare parts, insurance and taxes are expressed as a percentage of initial capital expenditures.

The useful life of each structure and mechanical unit varies depending on the physical wear or duty of it. Such pieces of mechanical equipment which experience high service wear may have a useful life of 5 to 10 years as compared to a structure (such as a building) which will have a useful life of 40 to 50 years. Depreciation costs are those accounting charges for the eventual replacement of a given asset (equipment or structure) at the end of its useful life.

The depreciation rate will vary depending on the complexities of the system. A system with large quantities of earthwork and structures may have a depreciation rate of 6 percent, as compared to a system with complex mechanical equipment having a useful life of 10 to 15 years, which may have a depreciation rate of 8 percent.

Depreciation of the capital assets may be by accumulation of digits (rapid depreciation) or method of averages (straight-line). Recent tax regulations allow for the rapid 60-month depreciation of capital assets for pollution abatement. Review of data from private communications indicates that this is not a widely used method in this industry. This is confirmed by a NCASI report which showed an average depreciation rate of 16.5 years.(203)

Interest is that annual charge for financing the capital expenditures for construction of a facility. Such financing may be through corporate bonds, conventional lending markets, or tax-exempt municipal revenue bonds. Municipal revenue bonds have lower interest rates compared to corporate bonds. A NCASI report states that 44 percent of the pollution abatement expenditures in 1976 were financed through tax-exempt municipal bonds; the average annual interest rate reported was 7.1 percent(203).

The annual interest rate on tax-exempt municipal bonds is currently between 6 and 7 percent. For some mills it may be required that facilities be financed through either corporate bonds or conventional lending markets. Such bonds are likely to have interest rates of 10.5 to 11 percent. Based on the above data, a depreciation period of 15 years and an interest of 9 percent have been utilized for the cost data development. This results in a capital recovery factor of approximately 12.5 percent.

NCASI (203) reported the average 1976 taxes for pollution abatement in the pulp and paper industry to be 0.42 percent of the capital spent for that purpose from 1967 to 1976. This low rate reflects the large percentage of environmental protection expenditures claimed for property and/or sales tax relief. Therefore, a tax rate of 0.50 percent has been assumed for this analysis.

Costs for insurance, spare parts, and maintenance materials are often expressed as a percentage of the capital investment. Although these costs may vary, factors of 1.5 percent for insurance and 0.5 percent for spare parts are considered reasonable. For the purposes of calculating annual costs, an average fixed charge of 15 percent of the capital expenditure was used which includes all of the above items. It is realized that these charges may vary and are dependent upon several items, such as the complexities of the system installed, financing availability, insurance coverage, property tax credits, spare parts inventory, and maintenance materials.

Energy Costs. An average national electric power cost for large industrial users (200,000 kWh, 1,000 kW demand) was estimated at 3.66 cents per kilowatt-hour (kWh). This figure is derived from average cost information by state, which is based on electric rates from approximately 200 public and private utilities.(198) Information concerning actual revenues from approximately 200 public and private utilities indicates a cost of 2.81 cents/kWh.(198) Energy costs are estimated at 3.25 cents per kWh, an average of the two figures.

Fuel for steam generation was estimated at $12 per barrel(38).

Operating and Maintenance Labor. The average nonsupervisory labor rate in the pulp and paper industry was reported to be $7.14 per hour in February

1978.(199) Average total benefits for the pulp, paper, lumber and furniture industry for the year 1977 are reported as 34 percent of wages.(200) Although no industry-wide data concerning supervisory costs was available, the proposed technologies under consideration are anticipated to require only minimal supervisory labor.

A supervisory and benefits cost of 45 percent of the labor rate has been assumed. This results in a total labor rate of $10.00/hr or approximately $21,000 per man-year, which is assumed in all cases except in estimating solids disposal costs. The total labor rate for solids disposal is estimated at $8.00/hr and reflects the lower level of skill required of operating personnel.

Chemicals. Many of the technologies under evaluation include the use of chemicals. These chemicals include alum, polymer, phosphoric acid, anhydrous ammonia and sodium hydroxide which are required for optimizing the technology processes. Make-up carbon is also required for activated carbon adsorption.

Based on quotes from chemical suppliers and chemical marketing reports, the following chemical costs have been assumed:(201)

Alum	$100/ton, dry basis
Polymer	$2.50/lb
Phosphoric Acid	$0.20/lb - 85%
Anhydrous Ammonia	$1.40/ton, dry basis
Sodium Hydroxide	$150/ton - 50%
Granular Activated Carbon	$0.40/lb

Production Process Control Costs

Previous sections of the report have detailed the production process controls being considered in the development of technology options applicable at mills in the various subcategories of the pulp, paper and paperboard industry. As outlined, these production process controls have been classified as technology Levels 1 or 2. The Level 1 controls are those that result in significant reductions in BOD_5 and flow. The Level 2 items are those that result in significant reductions of TSS in addition to reductions in flow and/or BOD_5. Table IX-6 presents a summary of the production process controls being considered in the development of the technology options.

Costs for the production process controls are based on flow schematics presented previously. Costs are based on the application or technology at a representative model mill of the typical sizes and configuration of mills that have been placed in each respective subcategory. Table IX-7 presents the number of pulp lines, bleach lines, and papermachines used, where appropriate, as a basis for production process control development.

Capital costs were prepared for each technology. Equipment manufacturers were contacted for cost estimates in February 1978 dollars. These estimates were supplemented by the use of standard cost estimating procedures for pipelines and small equipment items. Other factors such as freight, engineering and contingencies are included in the total capital costs.

TABLE 1

PRODUCTION PROCESS CONTROLS
LEVEL 1 AND 2

	011	012	013	014	015	016	017	019	021	022	032	033	034	101	102	111	112	113	114	201	202	204	205	211
<u>Woodroom</u>																								
Close up or dry operation									1				1											
Segregate cooling water	1	1	1	1	1	1	1	1	1	1	1	1	1											
<u>Pulp Mill Digester</u>																								
Dispose relief and blow condensate	1	1	1	1	1			1																
<u>Grinder</u>																								
Reduce thick overflow													2											
<u>Washer</u>																								
Add 3rd or 4th stage or press	1	1	1	1	1	1	1	1		1							1							
<u>Screen</u>																								
Recycle more decker filtrate		1	1	1				1	1															
Cleaner reject landfill								2		2		2	2				1							
Eliminate side hill screens	1																							
<u>Spill Collection</u>																								
Brownstock area and waste paper	1	1	1	1				1	1	1		1	1	1										
Pulp mill liquor storage	1	1	1	1				1																
<u>Bleaching</u>																								
C.C. or jump stage wash	2	2	2					2	1	1														
Evap. caustic extract filtrate									1															
<u>Evaporation and Recovery</u>																								
Recycle cond.		1				1		1																
Replace barometric condensor	2																							
Boil out tank		2																						
Neutralize SSL									1	1														
Segregate cooling water						1																		
<u>Spill Collection</u>																								
Evap. and recov.	1	1	1				1	1																
Liquor preparation	1		1	1				1	1	1														
Spare liquor tank	1	1	1	1			1	1																

TABLE 1 (Continued)

	011	012	013	014	015	016	017	019	021	022	032	033	034	101	102	111	112	113	114	201	202	204	205	211
Liquid Preparation-Caustic																								
Green liquor dregs filter	2	2	2	2	2		2	2																
Lime mud pond				2	2			2																
Spill Collection																								
Paper machine and bleached pulp	1	1	1	1				1	1	1	1	1	1							1	1	1	1	
Color plant				1						1										1				
Paper Machine or Dryer																								
Improve saveall					1	2	1	1		1	1	1			1		1		1	1	1	1	1	
High pressure fr. water shower	1				1				2					1						1		1	1	
W.W. to vacuum pump	1		1	1	1	2	1	1	2	1		1	2	1	1					1		1		1
W.W. showers					1	2									1				1				1	1
W.W. storage and/or to pulp mill			1	1				1	2	1		1		1			1					1		
Recycle press water	1				1	2		1		1		1	2											1
Recycle vacuum pump water					1	1	1		2	1		1	2							1				1
Broke storage																						1		
Wet lap machine				1						1			1	1										
Segregate cooling water																				1	1	1		
Cleaner rejects to land fill	2	2	2	2	2			2		2		2	2	2	1	1				2	2	2		
Steam Plant and Utility																								
Segregate cooling water	1							1	1	1			1	1									1	1
Improve recycle of effluent																1		1	1			1	1	1
Lagoon for boiler blow-down & backwash waters	2	2	2	2				2		2				2				1		2	2	2		

C.C. - Counter-current
W.W. - White water
S.S.L. - Spent sulfite liquor

TABLE IX-7

SUMMARY OF PULP LINES, BLEACH LINES, AND PAPERMACHINES IN MODEL MILLS

Subcategory		Small	Model	Large
011	Alkaline-Dissolving	-	2 Pulp Lines	-
012	Alkaline-Market	1 Pulp Line	1 Pulp Line	3 Pulp Lines (washer, bleaching & dryers)
013	Alkaline-BCT	1 Pulp & Bleach Line 3 Papermachines	2 Pulp & Bleach Lines 3 Papermachines	2 Pulp Lines 3 Bleach Lines 4 Papermachines
014	Alkaline-Fine	1 Pulp & Bleach Line 3 Papermachines	2 Pulp & Bleach Lines 4 Papermachines	2 Pulp & Bleach Lines 8 Papermachines
015	Alkaline-Unbleached	1 Pulp Line 1 Papermachine	2 Pulp Lines 1 Papermachine	2 Pulp Lines 2 Papermachines
016	Semi-Chemical	1 Line 1 Papermachine	1 Line 1 Papermachine	2 Lines 3 Papermachines (1 extra washer)
017	Alkaline-Unbleached & Semi-Chemical	2 Pulp Lines & 1 Semi-Chemical 2 Papermachines	2 Pulp Lines & 1 Semi-Chemical 3 Papermachines	3 Pulp Lines & 1 Semi-Chemical 4 Papermachines
019	Alkaline-Newsprint	1 Pulp Line & GWD 4 Papermachines	1 Pulp Line & GWD 4 Papermachines	-

TABLE IX-7 (continued)

SUMMARY OF PULP LINES, BLEACH LINES, AND PAPERMACHINES
IN MODEL MILLS

Subcategory		Small	Model	Large
021	Sulfite-Dissolving	1 Pulp & Bleach Line	1 Pulp & Bleach Line	2 Pulp & Bleach Lines
022	Sulfite-Papergrade	1 Pulp & Bleach Line 2 Papermachines	1 Pulp & Bleach Line 4 Papermachines	2 Pulp & Bleach Lines 4 Papermachines
032	Thermo-Mechanical Pulp	-	1 Pulp Line 2 Papermachines	-
033	Groundwood-CMN	1 Pulp Line Molded	1 Pulp Line 2 Papermachines	1 Pulp Line 6 Papermachines
034	Groundwood-Fine	1 Pulp & Bleach Line 1 Papermachine	1 Pulp & Bleach Line 3 Papermachines	1 Pulp & Bleach Line 4 Papermachines
101	Deink-Fine & Tissue	1 Deink Line 2 Papermachines	1 Deink Line 3 Papermachines	1 Deink Line 9 Papermachines
102	Deink-Newsprint	-	1 Deink Line 1 Papermachine	-
111	Wastepaper-Tissue	1 Papermachine	1 Papermachine	-
112	Wastepaper-Board	1 Board Machine	1 Board Machine	6 Board Machines (2 new Savealls) (2 relocated Saveealls)

TABLE IX-7 (continued)

SUMMARY OF PULP LINES, BLEACH LINES, AND PAPERMACHINES
IN MODEL MILLS

Subcategory		Small	Model	Large
113	Wastepaper Molded Products	2 Molding Machines	8 Molding Machines	20 Molding Machines
114	Wastepaper-Construction	1 Machine	1 Machine	3 Machines
201	Nonintegrated-Fine	2 Papermachines	2 Papermachines	8 Papermachines
202	Nonintegrated-Tissue	1 Papermachine	2 Papermachines	11 Papermachines
204	Nonintegrated-Lightweight	2 Papermachines (1 Saveall)	3 Papermachines	6 Papermachines
204	Nonintegrated-Filter & Nonwoven	1 Papermachine	1 Papermachine	3 Papermachines
211	Nonintegrated-Paperboard	1 Board Machine	1 Board Machine	3 Board Machines

The costs developed for the model mill were then adjusted for mills and subcategories of different size or type from that used for the base estimate. The exponent-based technique of estimating was utilized in adjusting the costs. The appropriate exponent factors were used in development of estimates for each type of equipment or construction. Such methodology provides a reliable technique for preliminary evaluations such as those required in assessing the economic impact of implementation of each level of technology.(204)

Net operating and maintenance (materials, power, chemicals, labor) costs were estimated for each technology option and compared with expected savings in power, fiber, heat, and chemicals resulting from application of each technology option. Maintenance costs are assumed to range from 3 to 5 percent of the capital costs as appropriate. The operating and maintenance costs presented reflect net costs. Gross savings and costs for operating, maintenance, and energy are presented separately for comparative purposes. In cases where savings are equal to or greater than the associated operation, maintenance, and energy costs, net costs are assumed to be zero.

Table IX-8 presents a sample cost summary for a 726 kkg/day (800 ton/day) Alkaline-Fine mill.

Effluent Treatment Costs

As part of the data analysis efforts, effluent treatment system design criteria and operating procedures have been reviewed in order to establish representative design criteria and standard operating procedures for the cost analysis. The design criteria associated with each treatment technology are discussed in Section VII. Table IX-9 presents a summary of effluent technologies considered for each level of treatment by subcategory. The technologies are generally cumulative by level (i.e., Level 4 technology also includes Level 3 technology). The only exception occurs for Level 2, primary clarification for indirect dischargers. In this case, primary treatment is modified to include the addition of chemicals (chemically assisted clarification) for Level 3, where the installation of biological treatment is not anticipated. One level of treatment has been contemplated for new point source mills; "x" is used to identify treatment type in this case. For levels where no effluent control technology is indicated, only production process controls are proposed.

Treatment technology equipment was sized based on the appropriate design criteria at various flows characteristic for the subcategory. Quantity estimates were prepared for large equipment and material items such as tanks, basins, and yard piping. Several manufacturers were contacted to obtain quotations for major pieces of process equipment.

The construction costs for these facilities are those defined as the capital expenditures required to implement the treatment technology. Included in these costs are the traditional expenditures for such items as mechanical and electrical equipment, instrumentation, yard and process piping, earthwork, unit construction, site preparation and grading, equipment installation and testing, and engineering.

TABLE IX-8

LEVEL 2 PRODUCTION PROCESS CONTROLS
SAMPLE COST CALCULATION

A. Capital Costs

Item No.		
1	Segregate cooling water in wood room	$ 31,800
2	Reuse digester relief and blow condensate	23,000
3	Fourth-stage brown stock washer	973,700
4	Recycle all screen room decker filtrate and modify heat recovery system	143,200
5	Spill collection for pulp mill brownstock area	268,500
6	Spill collection for liquor storage in digester, washer area	30,000
7	Full countercurrent washing for bleaching	2,661,000
8	Spill collection and spare liquor tank-evaporator and causticizing area	274,800
9	Green liquor dregs filter with removal to landfill	198,000
10	Lime mud pond to collect surges, spills	335,000
11	Spill collection for bleached pulp and papermachine areas including wet lap machines for stock recovery	532,800
12	Spill collection for color plants and size press	132,000
13	Pulp cleaner rejects removed to landfill	23,500
14	Machine whitewater used on vacuum pumps	65,000
15	Central whitewater chest and increased whitewater use in pulp mill	130,700
16	Machine vacuum pump water recycled to whitewater system	118,000
17	Lagoon for separate discharge of boiler blowdown and water treatment backwash	144,500
18	Lost production, added construction labor. Electric substations and power distribution	380,500
	Total Capital Cost	$6,466,000

TABLE IX-8 (continued)

B. Energy Requirements

Item No.		Increase in elect. Power kwhr/t	Reduction in Steam used - lb/t
1	Segregate cooling water in wood room	0.30	27
2	Reuse digester condensate	1.20	
3.	Fourth-stage washer	7.50	
4	Recycle decker filtrate	3.00	82
5	Spill Collection - Pulp Mill	2.40	
6	Spill Collection - Liquor Storage	2.40	
7	Full countercurrent wash - bleach	2.10	72
8	Spill collection evaporator - causticizing	1.50	10
9	Green liquor - dregs filter	0.30	
10	Lime mud pond	2.40	
11	Spill collection - bleach pulp and machine	3.00	
12	Spill collection - color plant	0.42	
13	Pulp cleaner rejects to landfill	0.15	
14	Whitewater to vacuum pumps	1.23	
15	Central whitewater chest	1.23	
16	Recycle vacuum pump water	1.23	
17	Lagoon for boiler blowdown water and water treatment plant filter backwash	0.45	
	Total	25-95	191

Cost of electric power \$.0325/kwh x 25.95 kwh/t	=	.84/t
Steam saving 191 x 1100 BTU/lb x \$1.24/million BTU	=	(.25/t)

TABLE IX-8 (Continued)

Steam cost based on \$2.4/million BTU fuel cost less \$.94/10^6 BTU net increase in electric cost because of lost back pressure power.

Net increase in cost of energy	\$.59/ton

C. Net Annual Costs

As an example of the details of the annual cost - Item 4 - recycle screen room decker filtrate - is used.

1.	Fixed cost = 15% of \$152,200 capital cost (includes Item 18 - misc. cap. costs prorated) for interest, depreciation, taxes.	\$22,800
2.	Maintenance 4.5% of capital cost	6,800
3.	Added labor	0
4.	Electric power 3.0 kwhr/ton x \$.0325/kwhr x 281,600 ton/year	27,500
5	Cost for misc. items, contracts, etc.	0
	Annual Cost	\$57,100

Savings - Items 3 and 4 are actually combined and save both salt cake with better washing and steam system.

The typical mill has a blow heat recovery system to heat fresh water for brownstock washing. When the decker filtrate is closed up by using this for brownstock washing, the temperature is sufficient for washing without heating provided warm water showers are used on the decker and cold water makeup in screening is held to a minimum. As a result, papermachine whitewater is pumped to the heat recovery system for the model mill, heated and used for both decker showers and bleach washing. The steam saved is in bleaching with 650 gpm whitewater being used and the temperature 80°F. above the typical fresh water temperature for 6 months of the year. Steam saved at a net cost of \$1.24/million BTU's.

Saving = 650 gpm x lb/hr/gpm x 80°F. x 6 mos/12 mos x \$1.24/million BTU x 24 hr/day x 35 days/yr = \$136,200

7. No savings were taken as more than the annual cost so net cost is zero.

TABLE IX-9

SUMMARY OF IDENTIFIED EFFLUENT TREATMENT TECHNOLOGY

Proposed Effluent Treatment Technology[a]	Subcategory No. 011	012	013	014	015	016	017	019	021	022	032	033	034	101	102	111	112	113	114	201	202	204	205	211
Direct																								
Wastewater Pumping	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Chemical Clarification	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Solids Dewatering	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Landfill	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Carbon Adsorption	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Indirect																								
Preliminary Screening				2										2	2	2	2	2	2	2	2	2	2	2
Wastewater Pumping				2										2	2	2	2	2	2	2	2	2	2	2
Primary Clarification				2										2	2	2	2	2	2	2	2	2	2	2
Biological Treatment				3										3	3									
Secondary Clarification				3										3	3									
Chemical Clarification																3	3	3	3	3	3	3	3	3
Solids Dewatering				2										2	2	2	2	2	2	2	2	2	2	2
Landfill				2										2	2	2	2	2	2	2	2	2	2	2
Carbon Adsorption																3	3	3	3	3	3	3	3	3
Outfall				2										2	2	2	2	2	2	2	2	2	2	2
New Point Source																								
Preliminary Screening	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x
Wastewater Pumping	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x
Primary Clarification	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									
Biological Treatment	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									
Secondary Clarification	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									
Chemical Clarification	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x
Solids Dewatering	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x
Landfill	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x
Outfall	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x
Diffuser	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x

[a] Where no numbers or "x's" are shown only production process controls are proposed. (Table indcates level to which technology is assigned (i.e., Level 2, 3 or 4); all New Point Source technologies are at the same level (designated as "x").

The sum of both the quantity estimates and process equipment estimates comprises the base capital cost. For estimates of this nature, it is not feasible to obtain detailed estimates for items such as electrical, instrumentation, process piping, and site preparation. Therefore, these items are included in the capital construction costs as a percentage of the base capital cost. These percentages vary for the different control technologies.

The annual operating costs are those associated with proper and continued operation of the facility and include:

1. operating labor;

2. maintenance labor;

3. energy requirements; and

4. chemicals.

Operating labor costs are based on the annual manhours required to perform the tasks necessary to ensure proper operation, administration, quality control, and monitoring. The maintenance costs are the annual manhours required for preventive maintenance tasks such as lubrication, equipment inspection, minor parts replacement, and painting. Major equipment repair and/or replacement and miscellaneous yard work is considered to be performed by the existing mill personnel. The cost estimates do not include major equipment repair or replacement; depreciation accounting includes costs for writeoff or replacement of the equipment.

Chemical cost estimates are based on anticipated quantities required to optimize operation of the particular technology under consideration. Chemicals are normally required to optimize the flocculation and solids dewatering processes associated with chemically assisted clarification.

The cost of a landfill is dependent on a variety of factors including sludge characteristics and hydrogeologic conditions of the disposal site. Therefore, a deviation from considering a specific technology was made in the case of sludge disposal. Several acceptable sludge landfill techniques with associated requirements and estimated costs have been outlined in a recent publication.(196) The techniques evaluated include: area fill layer, area fill mound, diked containment, narrow trench, wide trench, co-disposal with soil, and co-disposal with refuse. The range of costs for these various methods is shown in Figures IX-1 and IX-2.(196)

The fiber present in pulp and paper wastes can aid in solids dewatering, resulting in sludge with a relatively low moisture content. The presence of clay and aluminum hydroxide in alum sludge, however, would hinder dewatering and increase disposal costs. Therefore, mid-range disposal costs are assumed for primary and secondary sludge handling, while upper-range costs are assumed for alum sludge disposal.

Capital, operating and energy cost relations were developed for each treatment technology based on a standard design parameter (i.e., flow, BOD_5, TSS,).

FIGURE IX-1
TYPICAL SITE CAPITAL COST
FOR SLUDGE LANDFILLING [196]

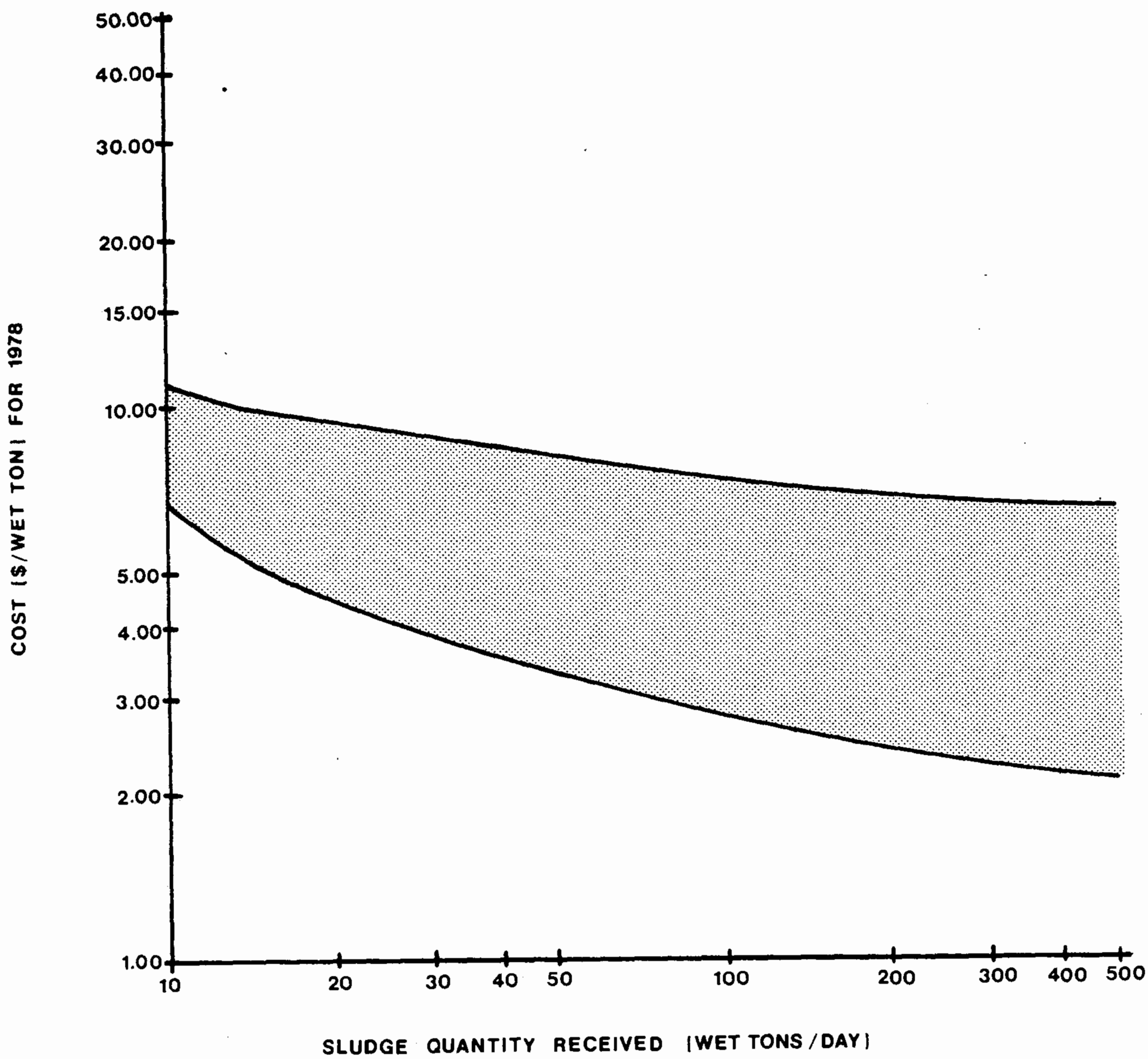
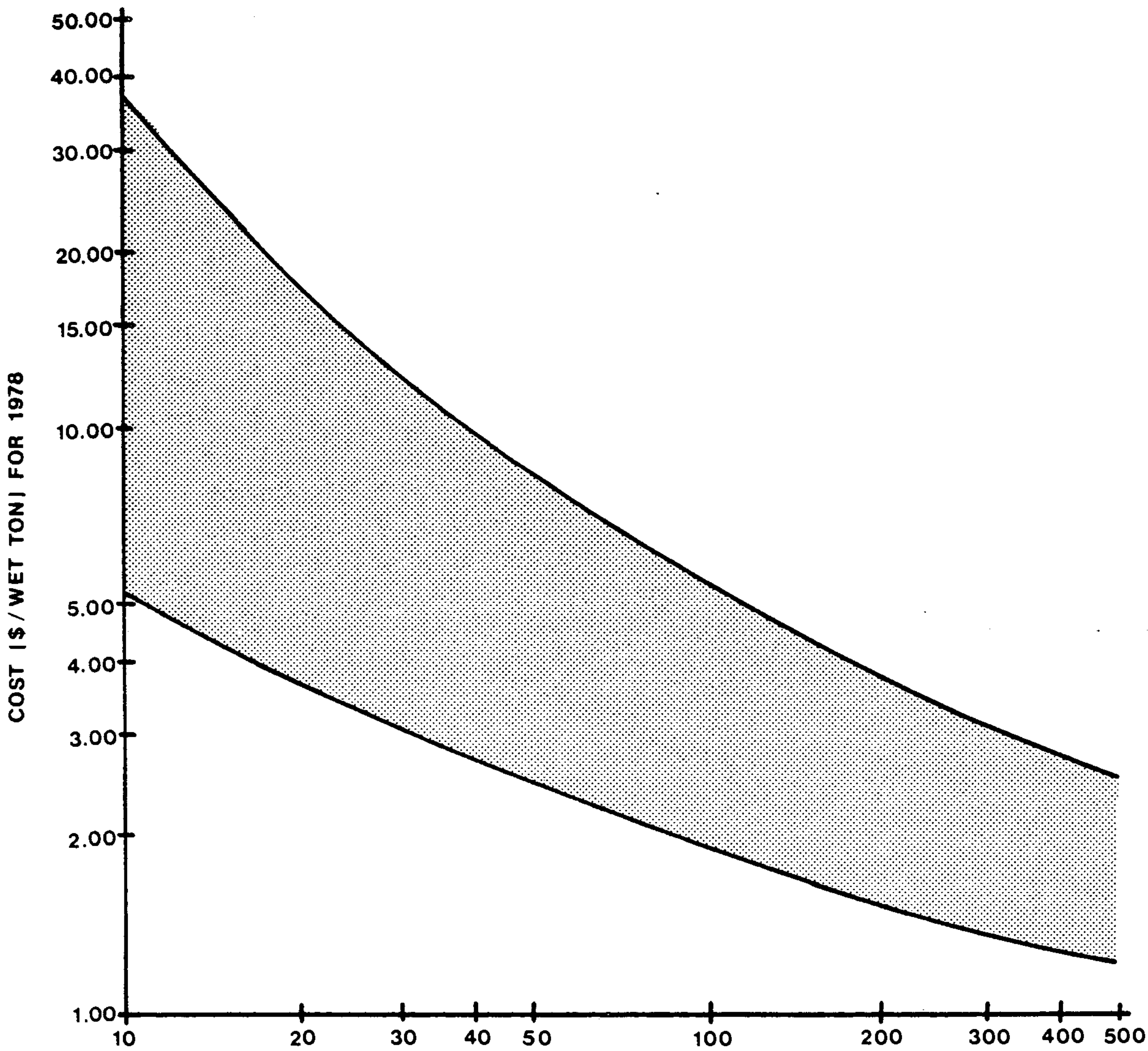


FIGURE IX-2
TYPICAL SITE OPERATING COST FOR SLUDGE LANDFILLING [196]



Based on the raw waste and final effluent characteristics developed as a result of data analysis, costs were developed for the specific model mills. The methodology utilized allows for variations of such factors as peak flows, quantity of solids generated, and BOD5 loading. An example of the calculation of design parameters from raw waste characteristics follows. Associated unit process costs for Level 4 treatment for the direct discharge Alkaline-Fine model mill is shown in Table IX-10. Design parameters used to develop the process costs for Level 4 treatment are calculated below.

SUBCATEGORY 014 - ALKALINE-FINE (800 t/d)

Raw Waste Characteristics:

Flow 17.7 kgal/t;
BOD5 33.3 lb/t; and
TSS 93.3 lb/t.

Design Parameters:

Flow:
800 t/d x 17.7 kgal/t = 14,160 kgal/d = 14.2 mgd

Raw Wastewater TSS:
800 t/d x 93.3 lb/t = 74,660 lb/day

Chemical Solids Production (Dry Basis):

	74,600 lb TSS/day x 0.1	= 7,460 lb/day
+	334 lb $Al(OH)_3$/mil.gal. x 14.1 mgd	= 4,709 lb/day
		= 12,169 lb/day

COST ESTIMATES BY SUBCATEGORY

Capital, operating, and annual fixed costs for various production and effluent control and treatment technology options are presented in this section for each subcategory of the pulp, paper and paperboard industry. The costs presented herein have been developed for the purpose of assessing the overall industry expenditure for compliance with effluent limitations.

Costs have been developed for three types of dischargers: direct dischargers, indirect dischargers, and new point source mills. Tables IX-11, 12, and 13 summarize the costs for the model mills for each respective discharge characteristic. The capital costs have been developed as discussed above. The operating and maintenance costs include operating and maintenance labor, energy requirements, and chemicals. The annual fixed charges include depreciation and interest, insurance, taxes, spare parts, and miscellaneous maintenance materials. These items are included as 15 percent of the investment costs, except as noted. Total annual costs include operating and maintenance costs plus the annual fixed charges.

TABLE IX-10
UNIT PROCESS EFFLUENT TREATMENT COST SUMMARY
LEVEL 4 TREATMENT COSTS

800 ton/day Alkaline-Fine Model Mill
Effluent Flow = 14.2 mgd
Solids (Dry Basis) = 12,169 lb/day

Treatment	Capital Cost ($1000)	Amortized Capital ($1000)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
Effluent Treatment Technology					
Wastewater Pumping (Peaking Factor = 1.3)	716.	107.	22.	31.	160.
Neutralization	43.	6.	15.	3.	24.
Chemicals for Neutralization	0.	0.	62.	0.	62.
Secondary Clarification	2995.	449.	51.	23.	522.
Chemical Coagulants	0.	0.	420.	0.	420.
Wastewater Pumping (Peaking Factor = 1.3)	716.	107.	22.	31.	160.
Carbon Adsorption	9632.	1445.	407.	180.	2031.
Make-Up Carbon for Carbon Adsorption	0.	0.	409.	0.	409.
Horizontal Belt-Filter	685.	103.	4.	28.	135.
Dewatering Polymer	0.	0.	44.	0.	44.
Alum Sludge Landfill at 20% Solids	349.	84.	126.	0.	209.
Subtotal	15135.	2302.	1582.	296.	4179.

TABLE IX-11

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		011 Alkaline Dissolving 1000t/d			
1	4,830	725	-	302	1,027
2	6,096	914	-	293	1,207
3	15,049	2,315	1,820	298	4,433
4	39,744	6,020	3,698	1,043	10,761

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		012 Alkaline Market 350 t/d			
1	1,471	221	-	73	294
2	1,940	291	-	77	368
3	5,874	898	586	145	1,629
4	15,747	2,362	1,534	246	4,141
		012 Alkaline Market 600 t/d			
1	1,856	278	-	126	404
2	2,565	385	-	132	517
3	8,713	1,307	1,075	179	2,561
4	21,139	3,197	1,937	507	5,641
		012 Alkaline Market 1600 t/d			
1	3,768	565	-	336	901
2	5,539	831	-	353	1,184
3	16,537	2,481	2,499	430	5,409
4	47,743	7,161	5,070	962	13,193

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		013 Alkaline BCT 300 t/d			
1	1,794	269	-	80	349
2	2,144	322	-	72	394
3	5,369	820	436	126	1,381
4	11,473	1,736	978	241	2,954
		013 Alkaline BCT 800 t/d			
1	3,165	475	-	213	688
2	3,951	593	-	192	785
3	9,773	1,498	936	293	2,726
4	23,135	3,503	1,985	576	6,064
		013 Alkaline BCT 1300 t/d			
1	4,356	653	-	346	999
2	5,670	851	-	312	1,163
3	13,485	2,070	1,412	454	3,936
4	33,102	5,012	2,913	895	8,820

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		014 Alkaline Fine 200 t/d			
1	1,271	191	-	35	226
2	2,690	404	-	40	444
3	4,788	729	277	77	1,083
4	8,198	1,241	629	135	2,005
		014 Alkaline Fine 800 t/d			
1	2,894	434	-	140	574
2	6,503	975	-	162	1,137
3	11,290	1,725	744	247	2,716
4	21,638	3,277	1,582	458	5,316
		014 Alkaline Fine 1200 t/d			
1	3,942	591	-	210	801
2	9,770	1,466	-	243	1,708
3	15,862	2,423	1,031	353	3,806
4	30,083	4,556	2,141	657	7,354

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		015 Alkaline Unbleached 450 t/d			
1	1,162	174	-	37	211
2	1,619	243	-	49	292
3	3,781	577	279	86	942
4	7,421	1,122	648	149	1,919
		015 Alkaline Unbleached 1000 t/d			
1	2,101	315	-	81	396
2	2,953	443	-	110	553
3	6,433	981	485	168	1,634
4	13,321	2,014	1,082	300	3,396
		015 Alkaline Unbleached 1500 t/d			
1	2,670	401	-	122	523
2	3,829	574	-	165	739
3	8,252	1,259	658	240	2,157
4	17,723	2,680	1,435	431	4,546

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		016 Semi-Chemical 200 t/d			
1	812	122	6	19	147
2	1,306	196	10	32	238
3	2,354	357	152	52	562
4	3,619	547	339	71	956
		016 Semi-Chemical 425 t/d			
1	1,113	167	2	40	209
2	1,858	279	-	69	347
3	3,504	533	213	98	844
4	5,865	887	487	137	1,511
		016 Semi-Chemical 600 t/d			
1	1,288	193	-	56	249
2	2,194	329	-	97	426
3	4,200	640	268	132	1,040
4	7,297	1,104	588	185	1,877

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		017 Alkaline Unbleached and Semi-Chemical 700 t/d			
1	2,639	396	-	85	481
2	2,837	426	-	86	512
3	5,638	860	382	135	1,377
4	10,795	1,633	858	229	2,721
		017 Alkaline Unbleached and Semi-Chemical 1500 t/d			
1	3,725	559	-	182	741
2	4,121	618	-	185	803
3	8,526	1,304	671	262	2,237
4	17,997	2,725	1,447	452	4,624
		017 Alkaline Unbleached and Semi-Chemical 2600 t/d			
1	5,153	773	-	316	1,089
2	5,797	869	-	320	1,189
3	11,929	1,828	1,049	431	3,308
4	26,627	4,033	2,194	748	6,975

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
019 Alkaline Newsprint 1000 t/d					
1	3,060	459	-	33	492
2	4,365	655	-	40	695
3	9,312	1,429	731	124	2,284
4	19,428	2,946	1,553	329	4,828
019 Alkaline Newsprint 1400 t/d					
1	3,784	568	-	47	615
2	5,437	816	-	57	872
3	11,496	1,766	958	161	2,885
4	24,696	3,746	1,996	440	6,182

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		021 Sulfite Dissolving 450 t/d			
1	14,257	2,139	286	587	3,012
2	14,948	2,242	318	534	3,094
3	20,544	3,116	1,244	635	4,995
4	33,635	5,079	2,275	911	8,265
		021 Sulfite Dissolving 600 t/d			
1	17,387	2,608	247	782	3,637
2	18,271	2,741	306	712	3,759
3	24,929	3,782	1,365	835	5,982
4	41,393	6,252	2,637	1,195	10,084
		021 Sulfite Dissolving 750 t/d			
1	20,457	3,069	237	978	4,284
2	21,552	3,233	149	890	4,272
3	29,171	4,427	1,578	1,034	7,039
4	48,837	7,377	3,083	1,476	11,936

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		022 Sulfite Papergrade 100 t/d			
1	1,883	282	-	-	282
2	1,962	294	-	-	294
3	3,468	525	197	27	749
4	5,744	866	465	64	1,395
		022 Sulfite Papergrade 450 t/d			
1	3,930	590	-	-	590
2	4,071	611	-	-	611
3	7,686	1,170	523	62	1,756
4	15,147	2,289	1,160	207	3,656
		022 Sulfite Papergrade 1000 t/d			
1	6,821	1,023	-	-	1,023
2	6,976	1,046	-	-	1,046
3	12,816	1,955	989	105	3,050
4	26,390	4,072	2,092	407	6,572

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		032 Thermo-Mechanical Pulp 350 t/d			
1	892	134	-	-	134
2	892	134	-	-	134
3	3,038	466	281	38	784
4	6,525	989	638	98	1,725

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		033 Groundwood CMN 50 t/d			
1	376	56	-	-	56
2	376	56	-	-	56
3	1,196	181	118	16	314
4	2,150	324	276	30	630
		033 Groundwood CMN 600 t/d			
1	1,813	272	-	-	272
2	1,837	276	-	-	276
3	5,176	794	472	58	1,324
IIIB	11,674	1,769	1,041	181	2,992
		033 Groundwood CMN 1000 t/d			
1	2,714	407	-	-	407
2	2,745	412	-	-	412
3	7,257	1,116	691	79	1,886
4	16,964	2,572	1,484	275	4,331

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		034 Groundwood Fine 75 t/d			
1	695	104	6	-	110
2	749	112	7	-	119
3	1,686	256	138	18	413
4	2,746	416	306	34	755
		034 Groundwood Fine 500 t/d			
1	1,943	291	-	-	291
2	2,200	330	-	-	330
3	4,971	762	368	48	1,177
4	9,708	1,472	814	134	2,420
		034 Groundwood Fine 750 t/d			
1	2,577	387	-	-	387
2	2,840	426	-	-	426
3	6,344	973	485	60	1,518
4	12,214	1,948	1,055	183	3,186

TABLE IX-11

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		101 Deink Fine & Tissue 50 t/d			
1	230	35	10	-	45
2	266	40	10	-	50
3	1,230	190	151	21	362
4	2,184	333	309	34	677
		101 Deink Fine & Tissue 180 t/d			
1	491	74	-	-	74
2	557	84	-	-	84
3	2,500	391	259	37	688
4	5,029	771	546	79	1,396
		101 Deink Fine & Tissue 800 t/d			
1	1,500	225	-	-	225
2	1,669	250	-	-	250
3	6,307	1,000	688	82	1,771
4	14,513	2,231	1,377	244	3,852

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		111 Wastepaper Tissue 10 t/d			
1	126	19	30	-	49
2	126	19	30	-	49
3	432	65	92	7	165
4	524	79	154	10	243
		111 Wastepaper Tissue 45 t/d			
1	275	41	34	-	75
2	275	41	34	-	75
3	898	136	129	13	278
4	1,511	228	253	21	502

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		112 Wastepaper Board 50 t/d			
1	286	43	31	-	74
2	286	43	31	-	74
3	597	90	93	7	196
4	689	104	155	10	269
		112 Wastepaper Board 160 t/d			
1	558	84	43	-	127
2	558	84	43	-	127
3	1,093	165	127	11	303
4	1,581	238	237	17	492
		112 Wastepaper Board 700 t/d			
1	1,284	193	86	-	279
2	1,284	193	86	-	279
3	2,428	383	241	21	645
4	4,019	631	459	47	1,137

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		113 Wastepaper Molded Products 20 t/d			
1	244	37	12	1	50
2	244	37	12	1	50
3	644	98	82	10	189
4	820	129	191	13	333
		113 Wastepaper Molded Products 50 t/d			
1	377	57	19	3	78
2	377	57	19	3	78
3	963	146	108	15	268
4	1,576	238	233	23	493
		113 Wastepaper Molded Products 150 t/d			
1	718	108	36	8	152
2	718	108	36	8	152
3	1,849	280	184	29	492
4	3,406	514	394	52	961

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
114 Wastepaper Construction Products 100 t/d					
1	363	54	25	8	87
2	363	54	25	8	87
3	665	100	87	16	203
4	758	114	149	18	281
114 Wastepaper Construction Products 225 t/d					
1	533	80	11	18	109
2	533	80	11	18	109
3	933	141	81	27	249
4	1,109	167	190	30	387
114 Wastepaper Contruction Products 350 t/d					
1	696	104	-	28	132
2	696	104	-	28	132
3	1,213	182	84	39	304
4	1,701	256	194	46	495

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		201 Non-Int. Fine 35 t/d			
1	366	55	1	-	56
2	396	59	2	-	61
3	1,187	138	86	11	235
4	1,675	211	196	17	424
		201 Non-Int. Fine 215 t/d			
1	814	122	-	-	122
2	875	131	-	-	131
3	2,278	347	183	26	555
4	4,203	636	423	56	1,115
		201 Non-Int. Fine 1000 t/d			
1	2,117	318	-	-	318
2	2,202	330	-	-	330
3	5,605	859	470	58	1,386
4	12,040	1,824	1,035	180	3,039

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		202 Non-Int. Tissue 35 t/d			
1	113	17	-	2	19
2	229	34	-	3	37
3	746	113	84	14	211
4	1,234	186	194	20	401
		202 Non-Int. Tissue 180 t/d			
1	552	83	-	8	91
2	612	92	-	15	107
3	1,900	290	168	38	496
4	3,644	551	395	65	1,011
		202 Non-Int. Tissue 1000 t/d			
1	1,313	197	-	45	242
2	1,547	232	-	82	314
3	5,015	770	482	141	1,392
4	11,710	1,775	1,065	269	3,108

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		204 Non-Integrated Lightweight 10 t/d			
1	310	47	11	-	58
2	345	52	12	-	64
3	983	149	107	13	269
4	1,714	258	243	22	523
		204 Non-Integrated Lightweight 60 t/d			
1	717	108	18	-	126
2	779	117	20	1	138
3	2,555	388	250	113	751
4	5,573	841	573	164	1,578
		204 Non-Integrated Lightweight 200 t/d			
1	874	131	25	-	156
2	1,602	243	26	-	269
3	5,242	800	555	62	1,417
4	13,078	1,975	1,218	215	3,408

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		205 Non-Int. Filter & Non-Woven 5 t/d			
1	78	12	7	-	19
2	179	27	7	-	34
3	576	88	77	9	173
4	753	114	185	12	312
		205 Non-Int. Filter & Non-Woven 20 t/d			
1	364	55	12	-	67
2	364	55	12	-	67
3	1,099	166	117	14	298
4	1,944	293	265	26	584
		205 Non-Int. Filter & Non-Woven 45 t/d			
1	637	96	19	-	115
2	637	96	19	-	115
3	1,810	274	171	21	466
4	3,460	522	390	46	958

TABLE IX-11 (Continued)

DIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		211 Non-Int. Paperboard 10 t/d			
1	114	17	5	1	23
2	152	23	5	1	29
3	454	69	67	8	144
4	547	83	129	11	223
		211 Non-Int. Paperboard 40 t/d			
1	269	40	6	1	47
2	269	40	6	1	47
3	1,028	156	115	16	287
4	1,872	283	263	28	574
		211 Non-Int. Paperboard 75 t/d			
1	412	62	7	2	71
2	412	62	7	2	71
3	1,491	227	152	22	401
4	2,855	432	346	43	821

TABLE IX-12

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		014 Alkaline Fine 370 t/d			
1	1,836	275	-	65	340
2	6,627	1,017	140	142	1,299
3 (AS)	9,626	1,471	485	230	2,186
3 (ASB)	9,042	1,379	382	288	2,049
		014 Alkaline Fine 800 t/d			
1	2,894	434	-	140	574
2	10,691	1,644	199	275	2,118
3 (AS)	15,945	2,440	814	450	3,704
3 (ASB)	14,797	2,260	650	591	3,501
		014 Alkaline Fine 1180 t/d			
1	3,888	583	-	207	790
2	14,105	2,168	239	390	2,797
3 (AS)	21,152	3,490	1,081	639	5,210
3 (ASB)	19,511	3,233	868	855	4,956

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		101 Deink Fine and Tissue 75 t/d			
1	278	42	-	-	42
2	1,655	266	118	33	417
3 (AS)	2,604	409	290	60	759
3 (ASB)	2,557	400	238	65	703
		101 Deink Fine and Tissue 180 t/d			
1	491	74	-	-	74
2	2,703	435	180	50	665
3 (AS)	4,380	690	493	104	1,287
3 (ASB)	4,276	691	408	127	1,206
		101 Deink Fine and Tissue 380 t/d			
1	828	124	-	-	124
2	4,216	682	209	71	962
3 (AS)	7,075	1,117	772	175	2,064
3 (ASB)	6,809	1,071	636	234	1,941

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		102 Deink Newsprint 400 t/d			
1	1,486	223	-	-	223
2	5,329	854	195	69	1,118
3 (AS)	7,122	1,118	677	121	1,916
3 (ASB)	6,715	1,052	564	190	1,806

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		111 Wastepaper Tissue 10 t/d			
1	127	19	30	-	49
2	410	63	61	7	131
3 (CC)	542	83	130	10	223
3 (CA)	634	97	192	13	301
		111 Wastepaper Tissue 35 t/d			
1	255	38	27	-	65
2	764	117	70	12	199
3 (CC)	1,028	159	173	18	350
3 (CA)	1,516	232	283	24	539
		111 Wastepaper Tissue 85 t/d			
1	432	65	38	-	103
2	1,237	191	97	18	306
3 (CC)	1,670	263	241	26	530
3 (CA)	2,624	406	399	39	844

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		112 Wastepaper Board 50 t/d			
1	274	41	30	2	73
2	515	78	58	8	144
3 (CC)	642	96	120	11	227
3 (CA)	734	110	182	13	305
		112 Wastepaper Board 140 t/d			
1	514	77	25	6	108
2	911	138	61	14	213
3 (CC)	1,173	176	151	20	347
3 (CA)	1,661	249	262	26	537
		112 Wastepaper Board 410 t/d			
1	945	142	-	18	160
2	1,652	251	49	31	331
3 (CC)	2,085	313	182	39	534
3 (CA)	3,145	472	350	55	877

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
113 Wastepaper Molded Products 20 t/d					
1	300	45	12	1	58
2	530	81	44	7	132
3 (CC)	708	106	113	11	230
3 (CA)	884	133	222	14	369
113 Wastepaper Molded Products 55 t/d					
1	400	60	20	3	83
2	857	130	60	12	201
3 (CC)	1,199	183	163	19	365
3 (CA)	1,930	293	300	29	622
113 Wastepaper Molded Products 185 t/d					
1	800	120	40	10	170
2	1,722	262	98	27	386
3 (CC)	2,322	356	270	38	664
3 (CA)	4,157	631	503	66	1,201

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
114 Wastepaper Construction Products 100 t/d					
1	363	54	25	8	87
2	560	84	51	13	148
2 (CC)	685	103	107	16	226
3 (CA)	777	117	169	18	304
114 Wastepaper Construction Products 225 t/d					
1	553	83	10	18	111
2	839	127	36	24	187
3 (CC)	1,045	157	111	29	297
3 (CA)	1,222	183	219	32	434
114 Wastepaper Construction Products 350 t/d					
1	698	105	-	28	133
2	1,053	159	35	36	230
3 (CC)	1,297	195	119	41	355
3 (CA)	1,785	268	230	47	545

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		114 Wastepaper Construction Products 100 t/d			
1	363	54	25	8	87
2	560	84	51	13	148
2 (CC)	685	103	107	16	226
3 (CA)	777	117	169	18	304
		114 Wastepaper Construction Products 225 t/d			
1	553	83	10	18	111
2	839	127	36	24	187
3 (CC)	1,045	157	111	29	297
3 (CA)	1,222	183	219	32	434
		114 Wastepaper Construction Products 350 t/d			
1	698	105	-	28	133
2	1,053	159	35	36	230
3 (CC)	1,297	195	119	41	355
3 (CA)	1,785	268	230	47	545

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		201 Non-Integrated Fine 15 t/d			
1	252	38	5	-	43
2	553	84	37	7	128
3 (CC)	705	108	110	11	229
3 (CA)	797	122	171	14	307
		201 Non-Integrated Fine 115 t/d			
1	618	93	-	-	93
2	1,538	237	62	19	318
3 (CC)	2,033	319	219	28	566
3 (CA)	3,197	493	396	45	934
		201 Non-Integrated Fine 585 t/d			
1	1,514	227	-	-	227
2	3,793	587	118	44	749
3 (CC)	5,042	805	502	60	1,367
3 (CA)	9,276	1,441	913	136	2,490

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		202 Non-Integrated Tissue 10 t/d			
1	97	15	-	1	16
2	366	56	29	8	93
3 (CC)	495	76	95	11	182
3 (CA)	588	90	157	13	260
		202 Non-Integrated Tissue 90 t/d			
1	364	55	-	4	59
2	1,146	176	55	24	255
3 (CC)	1,571	246	193	32	470
3 (CA)	2,525	389	351	45	785
		202 Non-Integrated Tissue 290 t/d			
1	704	106	-	13	119
2	2,257	348	86	53	487
3 (CC)	3,084	487	334	66	887
3 (CA)	5,613	866	621	107	1,594

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
204 Non-Integrated Lightweight 25 t/d					
1	475	71	15	-	86
2	1,267	192	67	13	272
3 (CC)	1,800	275	225	23	523
3 (CA)	3,357	509	436	47	992
204 Non-Integrated Lightweight 30 t/d					
1	518	78	16	-	94
2	1,389	211	71	14	296
3 (CC)	1,895	301	233	25	559
3 (CA)	3,638	563	459	52	1,074
204 Non-Integrated Lightweight 35 t/d					
1	557	84	10	-	94
2	1,513	229	71	15	315
3 (CC)	2,155	329	249	28	606
3 (CA)	4,169	632	497	59	1,188

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
205 Non-Integrated Filter and Non-Woven 5 t/d					
1	188	28	7	-	35
2	429	65	37	5	107
3 (CC)	643	98	108	10	216
3 (CA)	819	124	217	13	354
205 Non-Integrated Filter and Non-Woven 15 t/d					
1	300	45	10	-	55
2	771	117	49	9	175
3 (CC)	1,063	162	147	15	324
3 (CA)	1,794	272	284	25	580
205 Non-Integrated Filter and Non-Woven 45 t/d					
1	637	96	19	-	115
2	1,467	223	73	14	310
3 (CC)	2,014	308	230	25	563
3 (CA)	3,665	556	448	50	1,055

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-12 (Continued)

INDIRECT DISCHARGE TREATMENT COSTS

Level of Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
211 Non-Integrated Paperboard 10 t/d					
1	153	23	4	-	27
2	432	66	35	8	109
3 (CC)	584	90	108	11	209
3 (CA)	676	104	170	14	288
211 Non-Integrated Paperboard 25 t/d					
1	221	33	4	1	38
2	730	112	49	12	173
3 (CC)	1,037	160	156	19	335
3 (CA)	1,650	252	280	27	559
211 Non-Integrated Paperboard 50 t/d					
1	307	46	2	3	51
2	1,028	158	58	18	234
3 (CC)	1,442	225	194	25	444
3 (CA)	2,396	368	352	39	759

CC = Chemical Clarification
CA = Carbon Adsorption

TABLE IX-13

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		011 Alkaline Dissolving 1000 t/d			
NSPS - AS	33,524	5,157	3,041	1,036	9,234
NSPS - ASB	30,404	4,675	2,709	1,470	8,854

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
012 Alkaline MKT 350 t/d					
NSPS - AS	12,970	1,984	1,039	328	3,350
NSPS - ASB	11,840	1,808	883	423	3,114
012 Alkaline MKT 600 t/d					
NSPS - AS	18,308	2,803	1,532	524	4,859
NSPS - ASB	16,554	2,531	1,324	691	4,546
012 Alkaline MKT 1600 t/d					
NSPS - AS	36,188	5,546	3,352	1,276	10,175
NSPS - ASB	32,164	4,926	2,976	1,737	9,639

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		013 Alkaline BCT 300 t/d			
NSPS - AS	10,993	1,685	855	280	2,821
NSPS - ASB	10,323	1,580	718	341	2,639
		013 Alkaline BCT 800 t/d			
NSPS - AS	20,758	3,189	1,720	659	5,568
NSPS - ASB	19,254	2,953	1,487	827	5,267
		013 Alkaline BCT 1300 t/d			
NSPS - AS	29,000	4,458	2,519	1,025	8,002
NSPS - ASB	26,720	4,102	2,204	1,302	7,608

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		014 Alkaline Fine 200 t/d			
NSPS - AS	8,474	1,299	595	163	2,057
NSPS - ASB	7,990	1,224	495	186	1,905
		014 Alkaline Fine 800 t/d			
NSPS - AS	20,366	3,134	1,496	519	5,150
NSPS - ASB	18,988	2,920	1,294	613	4,827
		014 Alkaline Fine 1200 t/d			
NSPS - AS	26,956	4,150	2,033	743	6,926
NSPS - ASB	25,030	3,850	1,776	886	6,512

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		015 Alkaline Unbleached 450 t/d			
NSPS - AS	7,568	1,158	579	184	1,920
NSPS - ASB	7,212	1,101	476	219	1,796
		015 Alkaline Unbleached 1000 t/d			
NSPS - AS	12,780	1,959	957	360	3,276
NSPS - ASB	12,165	1,860	806	442	3,107
		015 Alkaline Unbleached 1500 t/d			
NSPS - AS	16,170	2,481	1,269	514	4,263
NSPS - ASB	15,271	2,338	1,079	639	4,057

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
016 Semi-Chemical 200 t/d					
NSPS - AS	4,541	695	367	120	1,181
NSPS - ASB	4,712	718	289	145	1,152
016 Semi-Chemical 425 t/d					
NSPS - AS	7,084	1,086	537	224	1,848
NSPS - ASB	7,294	1,113	425	280	1,819
016 Semi-Chemical 600 t/d					
NSPS - AS	8,695	1,334	666	302	2,303
NSPS - ASB	8,931	1,364	532	383	2,279

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		017 Alkaline Unbl. & Semi-Chem. 700 t/d			
NSPS - AS	11,168	1,714	832	314	2,860
NSPS - ASB	10,896	1,667	689	391	2,747
		017 Alkaline Unbl. & Semi-Chem. 1500 t/d			
NSPS - AS	17,875	2,748	1,413	615	4,775
NSPS - ASB	17,231	2,642	1,193	783	4,618
		017 Alkaline Unbl. & Semi-Chem. 2600 t/d			
NSPS - AS	25,780	3,764	2,150	1,017	6,931
NSPS - ASB	24,619	3,576	1,840	1,312	6,728

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		019 Alkaline Newsprint 1000 t/d			
NSPS - AS	18,426	2,849	1,529	419	4,797
NSPS - ASB	17,363	2,680	1,322	527	4,528
		019 Alkaline Newsprint 1400 t/d			
NSPS - AS	22,959	3,551	1,974	559	6,083
NSPS - ASB	21,553	3,330	1,721	710	5,760

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		021 Sulfite Dissolving 450 t/d			
NSPS - AS	34,567	5,276	2,309	1,301	8,886
NSPS - ASB	33,855	5,153	1,977	1,669	8,799
		021 Sulfite Dissolving 600 t/d			
NSPS - AS	42,381	6,469	2,796	1,710	10,975
NSPS - ASB	41,273	6,283	2,388	2,202	10,874
		021 Sulfite Dissolving 750 t/d			
NSPS - AS	49,910	7,619	3,101	2,117	12,837
NSPS - ASB	48,381	7,367	2,732	2,734	12,833

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
			022 Sulfite Papergrade 100 t/d		
NSPS - AS	6,089	928	422	92	1,442
NSPS - ASB	5,908	899	342	113	1,353
			022 Sulfite Papergrade 450 t/d		
NSPS - AS	14,680	2,246	1,044	290	3,581
NSPS - ASB	14,062	2,147	876	395	3,418
			022 Sulfite Papergrade 1000 t/d		
NSPS - AS	25,054	3,838	1,879	575	6,292
NSPS - ASB	23,771	3,634	1,612	813	6,059

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		032 Thermo Mechanical Pulp 350 t/d			
NSPS - AS	6,152	953	633	155	1,741
NSPS - ASB	6,863	1,055	522	198	1,775

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
033 Groundwood CMN 50 t/d					
NSPS - AS	2,558	390	254	42	686
NSPS - ASB	2,364	360	205	45	610
033 Groundwood CMN 600 t/d					
NSPS - AS	11,175	1,724	956	213	2,892
NSPS - ASB	10,331	1,592	814	272	2,678
033 Groundwood CMN 1000 t/d					
NSPS - AS	15,687	2,422	1,364	318	4,104
NSPS - ASB	14,421	2,226	1,179	418	3,822

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		034 Groundwood Fine 75 t/d			
NSPS - AS	3,285	504	302	52	858
NSPS - ASB	3,126	479	246	59	783
		034 Groundwood Fine 500 t/d			
NSPS - AS	9,917	1,532	818	188	2,538
NSPS - ASB	9,485	1,463	691	231	2,385
		034 Groundwood Fine 750 t/d			
NSPS - AS	12,759	1,973	1,070	257	3,300
NSPS - ASB	12,173	1,879	912	322	3,113

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		101 Deink Fine & Tissue 50 t/d			
NSPS - AS	3,022	473	375	64	912
NSPS - ASB	2,886	451	313	68	832
		101 Deink Fine & Tissue 189 t/d			
NSPS - AS	6,245	987	744	148	1,879
NSPS - ASB	5,990	945	630	158	1,733
		101 Deink Fine & Tissue 800 t/d			
NSPS - AS	15,930	2,540	2,018	469	5,028
NSPS - ASB	15,018	2,392	1,740	503	4,635

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
102 Deink Newsprint 400 t/d					
NSPS - AS	9,823	1,550	1,040	178	2,768
NSPS - ASB	9,314	1,469	900	227	2,596

AS = Activated Sludge
ASB = Aerated Stabilization Basin

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		111 Wastepaper Tissue 10 t/d			
Self-Contained	126	19	30	-	49
		111 Wastepaper Tissue 45 t/d			
Self-Contained	275	41	34	-	75

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		112 Wastepaper Board 50 t/d			
Self-Contained	286	43	31	2	76
		112 Wastepaper Board 160 t/d			
Self-Contained	558	84	43	7	134
		112 Wastepaper Board 700 t/d			
Self-Contained	875	131	102	-	233

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
113 Wastepaper Molded Products 20 t/d					
NSPS - CC	767	117	110	11	238
113 Wastepaper Molded Products 50 t/d					
NSPS - CC	1,088	166	144	18	327
113 Wastepaper Molded Products 150 t/d					
NSPS - CC	2,062	315	237	33	585

CC = Chemical Clarification

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		114 Wastepaper Construction Products 100 t/d			
Self-Contained	363	54	25	8	87
		114 Wastepaper Construction Products 225 t/d			
Self-Contained	422	63	4	18	86
		114 Wastepaper Construction Products 350 t/d			
Self-Contained	465	70	-	28	98

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
201 Non-Int. Fine 35 t/d					
NSPS - CC	1,120	171	127	17	315
201 Non-Int. Fine 215 t/d					
NSPS - CC	2,739	425	279	37	741
201 Non-Int. Fine 1000 t/d					
NSPS - CC	6,613	1,036	718	80	1,834

CC = Chemical Clarification

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
202 Non-Int. Tissue 35 t/d					
NSPS - CC	933	143	124	19	286
202 Non-Int. Tissue 180 t/d					
NSPS - CC	2,300	357	252	48	657
202 Non-Int. Tissue 1000 t/d					
NSPS - CC	5,964	936	710	161	1,807

CC = Chemical Clarification

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
			204 Non-Int. Ltwt 10 t/d		
NSPS - CC	1,096	166	135	15	316
			204 Non-Int. Ltwt 60 t/d		
NSPS - CC	2,834	434	318	37	789
			204 Non-Int. Ltwt 200 t/d		
NSPS - CC	5,762	887	672	70	1,629

CC = Chemical Clarification

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		205 Non-Int. Filter & Non-Woven 5 t/d			
NSPS - CC	652	99	104	10	213
		205 Non-Int. Filter & Non-Woven 20 t/d			
NSPS - CC	1,225	187	156	17	360
		205 Non-Int. Filter & Non-Woven 45 t/d			
NSPS - CC	2,008	307	224	25	555

CC = Chemical Clarification

TABLE IX-13 (Continued)

NEW POINT SOURCE TREATMENT COSTS

	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual ($1000/yr)
		211 Non-Int. Paperboard 10 t/d			
NSPS - CC	658	101	99	12	212
		211 Non-Int. Paperboard 40 t/d			
NSPS - CC	1,275	197	163	23	383
		211 Non-Int. Paperboard 75 t/d			
NSPS - CC	1,816	281	220	31	532

CC = Chemical Clarification

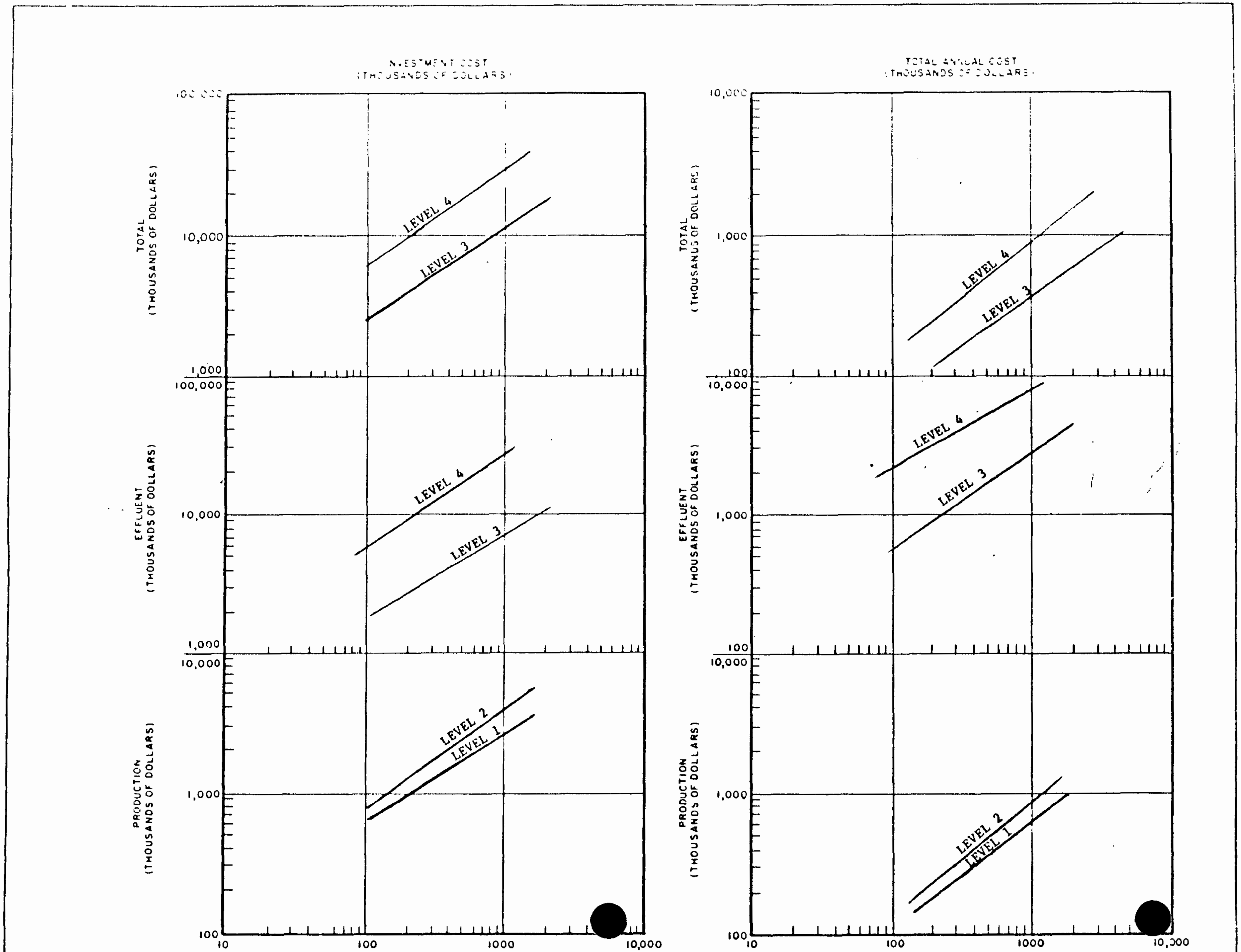
Based on the model mill costs summarized on Tables IX-11, 12, and 13 for the three discharge characteristics, production vs cost curves were developed for the capital and total annual costs for the subcategories. These costs curves are presented as Figures IX-3 through IX-35, and can be directly applied to mills that fit into one of the subcategories defined in Section IV. If a mill fits the requirements established for the subcategory, the cost of implementing the production process control or effluent treatment technology option can be obtained by using the mill's production rate and determining the cost from the curves.

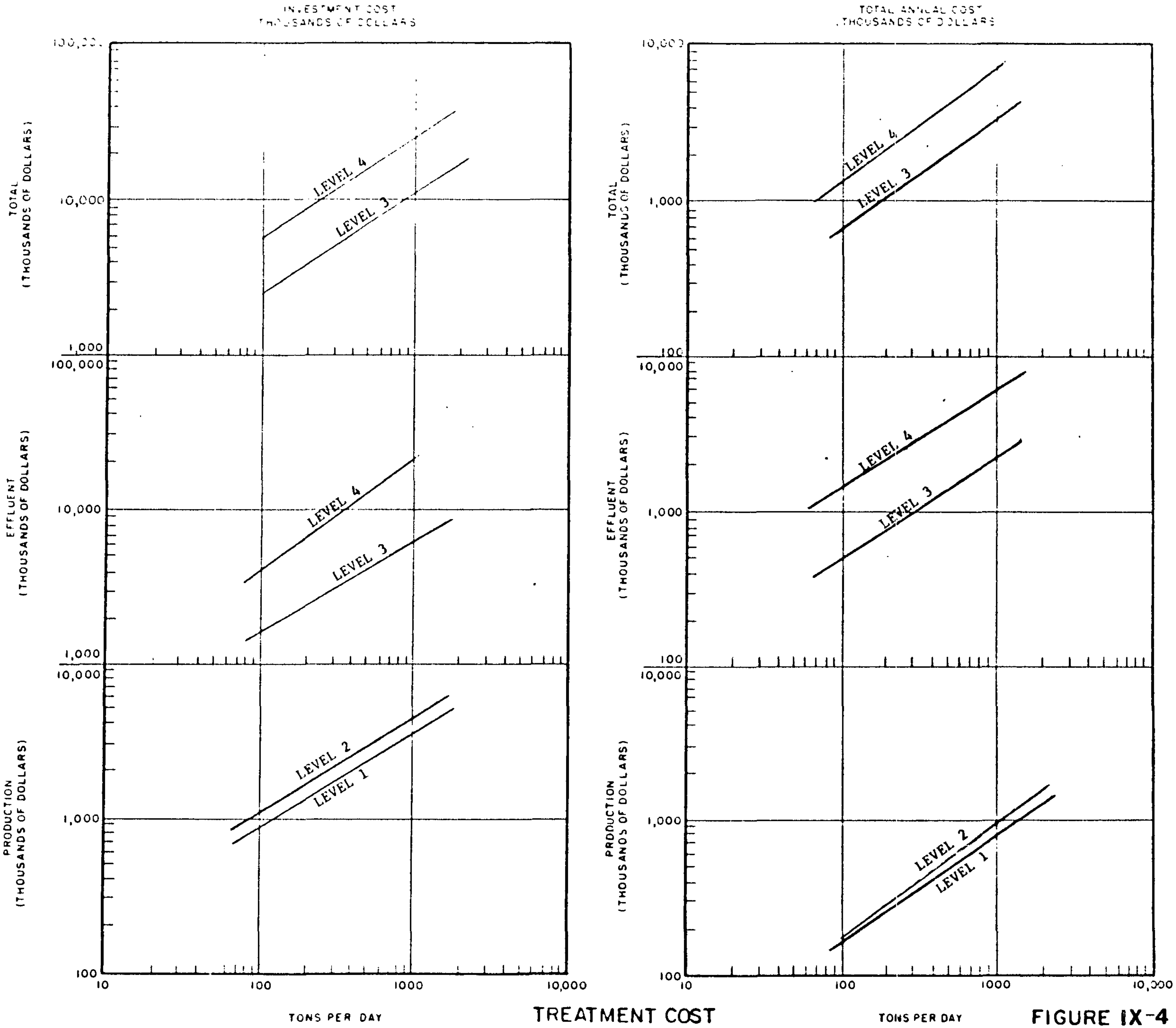
Mills with combined operations in the miscellaneous mill groupings are not represented by model mills. However, the cost curves can still be used to estimate the cost for implementing production process controls or effluent treatment technology options at these mills. Costs for production controls in one process would not be significantly affected by controls for a second process in a combined mill. Therefore, the costs associated with each production level can be determined directly from the appropriate curves, and production process control costs for the combined operations can be considered additive.

Economies of scale must be accounted for in development of effluent treatment costs. Aggregate curves relating cost to effluent flow rate are presented in Figures IX-36 through IX-41 for carbon adsorption, chemically assisted clarification and primary clarification. Actual costs for effluent treatment can be affected by factors other than flow (e.g., raw wastewater solids). However, these variations are not expected to result in a cost increase that would exceed the cost variability associated with model mill development.

Effluent treatment costs for each level of technology can be estimated for mills in the miscellaneous groupings based on representative model mill data. This requires that a flow rate be determined that is representative of effluent discharged from each miscellaneous mill. The flow rate associated with each miscellaneous mill can be estimated from Table IX-14, which provides flow information for pure mills in each subcategory. The production rate associated with each production process employed at miscellaneous mills should be multiplied by the model flow associated with that process. Addition of the respective model flows associated with each production process employed yields a total flow representative of the miscellaneous mill.

Using the methodology outlined, production process control costs and effluent treatment costs may be estimated for miscellaneous mills. The costs associated with the implementation of production process controls and effluent treatment may then be added to yield an estimate of the costs incurred at a mill in the miscellaneous grouping. The sample calculation presented subsequently illustrates this procedure.

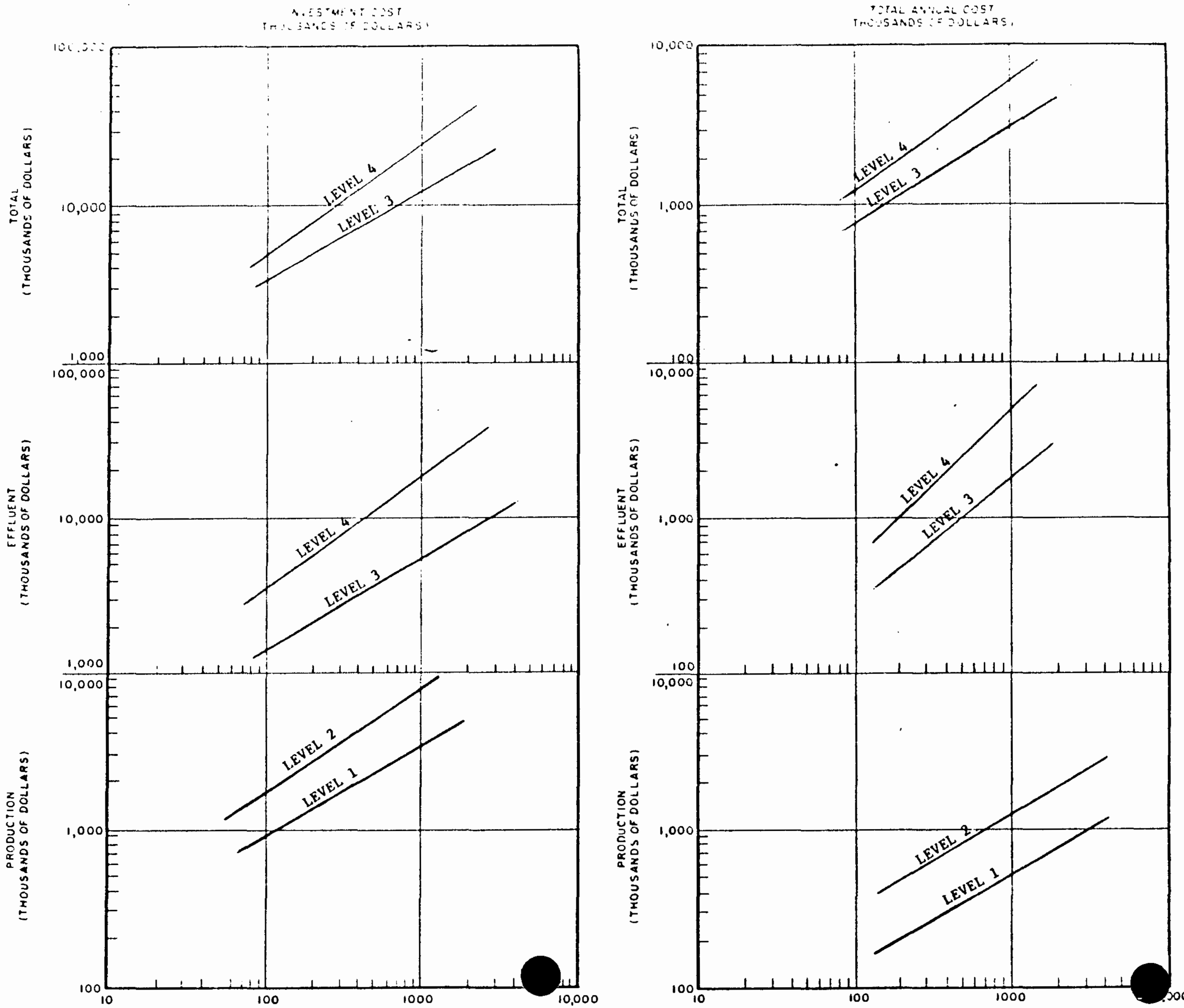

INVESTMENT COST
(THOUSANDS OF DOLLARS)
TOTAL ANNUAL COST
(THOUSANDS OF DOLLARS)
TOTAL
(THOUSANDS OF DOLLARS)
EFFLUENT
(THOUSANDS OF DOLLARS)
PRODUCTION
(THOUSANDS OF DOLLARS)
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
100,000
10,000
1,000
100
10
1000

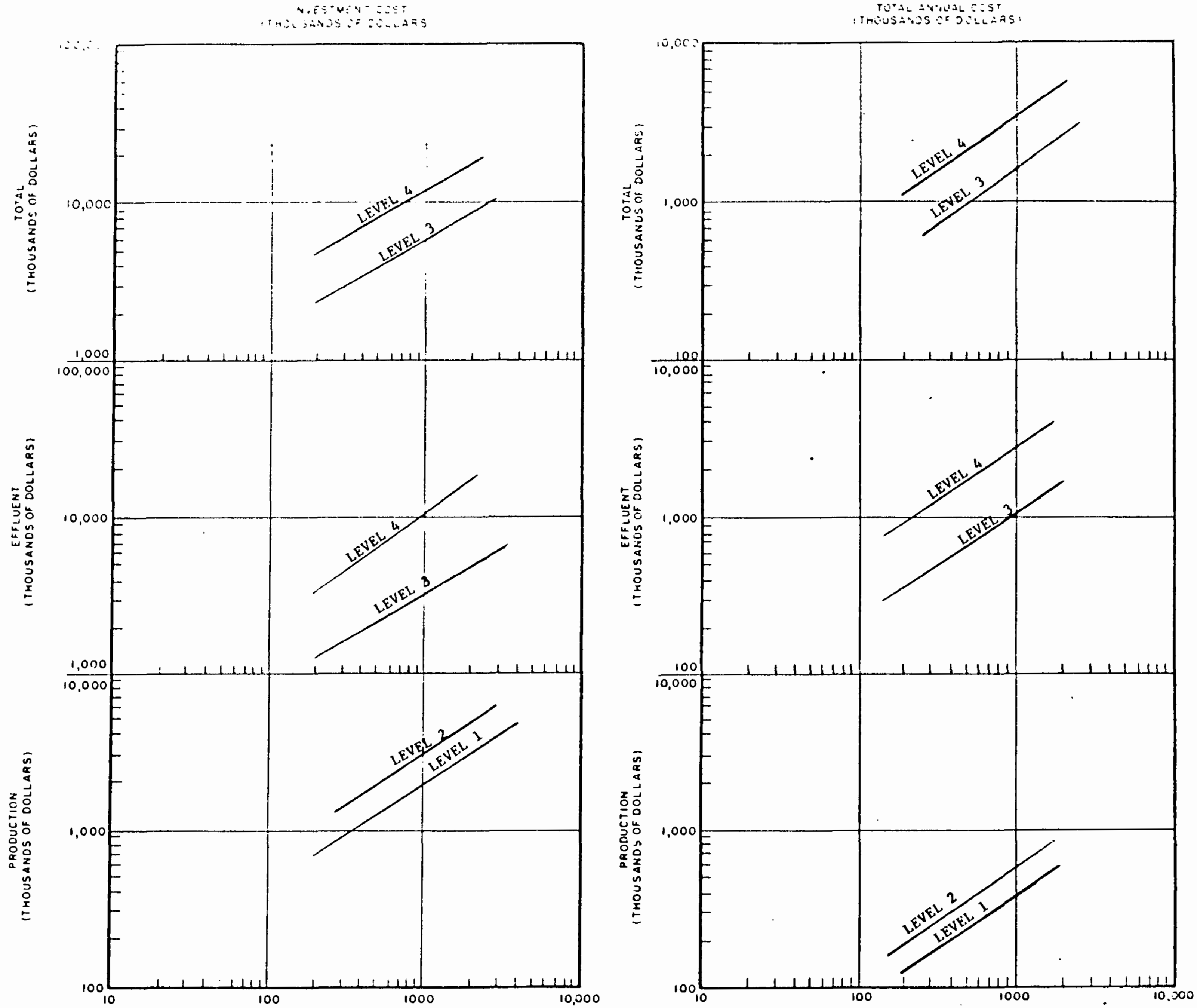


TREATMENT COST

013 ALKALINE - BCT

FIGURE IX-4

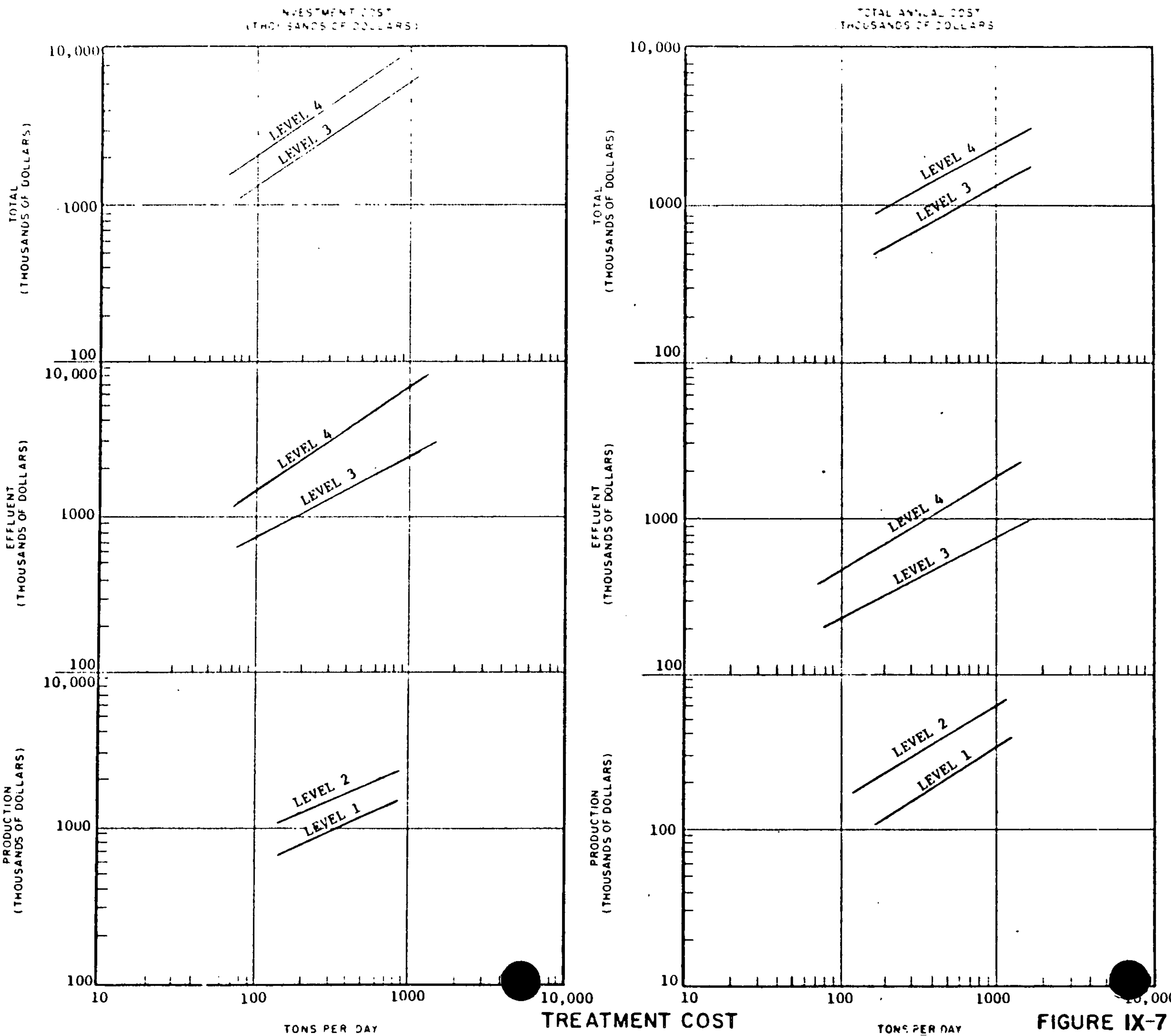

INVESTMENT COST (THOUSANDS OF DOLLARS)
TOTAL ANNUAL COST (THOUSANDS OF DOLLARS)
TOTAL (THOUSANDS OF DOLLARS)
EFFLUENT (THOUSANDS OF DOLLARS)
PRODUCTION (THOUSANDS OF DOLLARS)
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
100,000
10,000
1,000
100
10
1000



TREATMENT COST

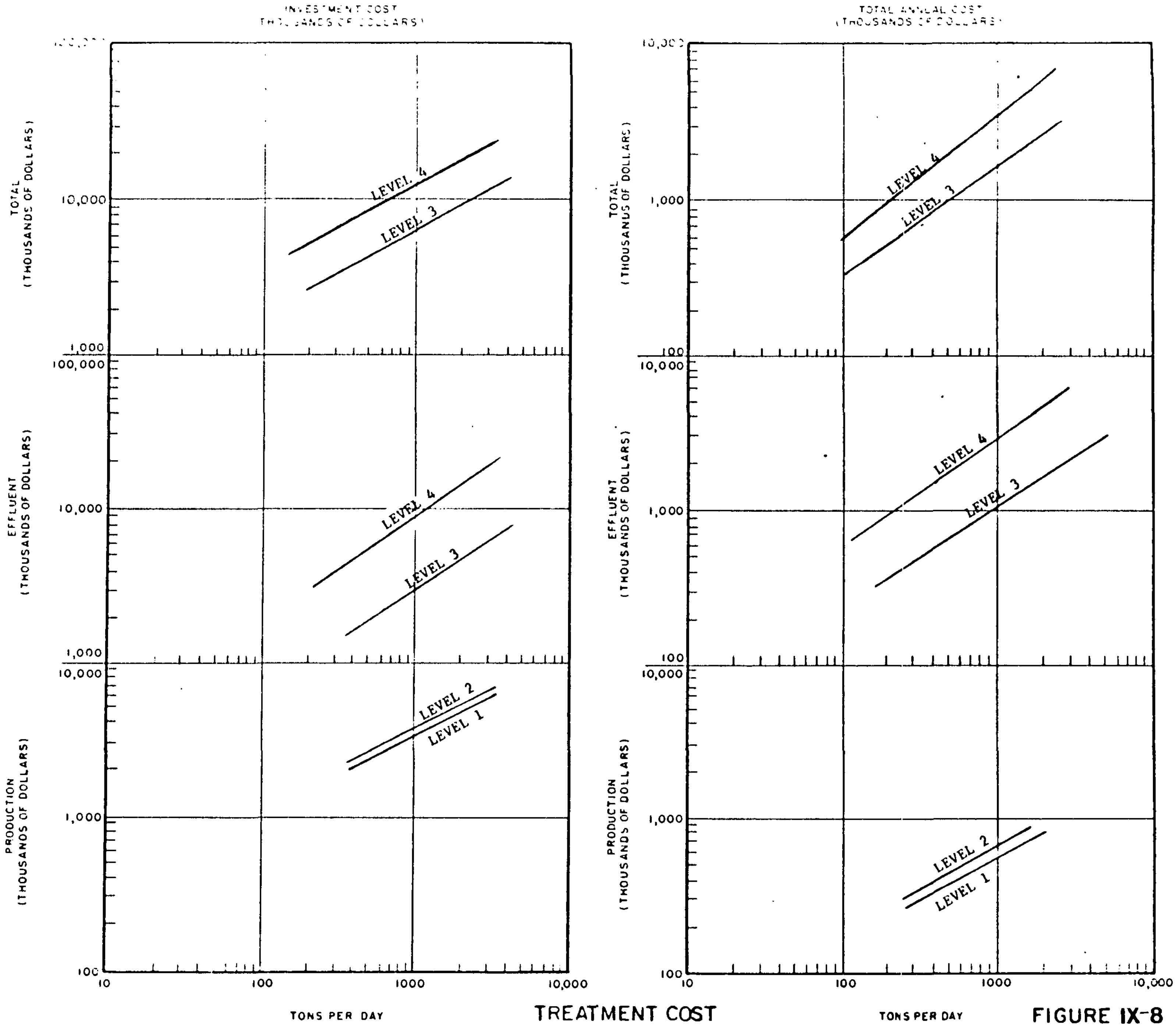
FIGURE IX-6

015 ALKALINE - UNBLEACHED



TREATMENT COST

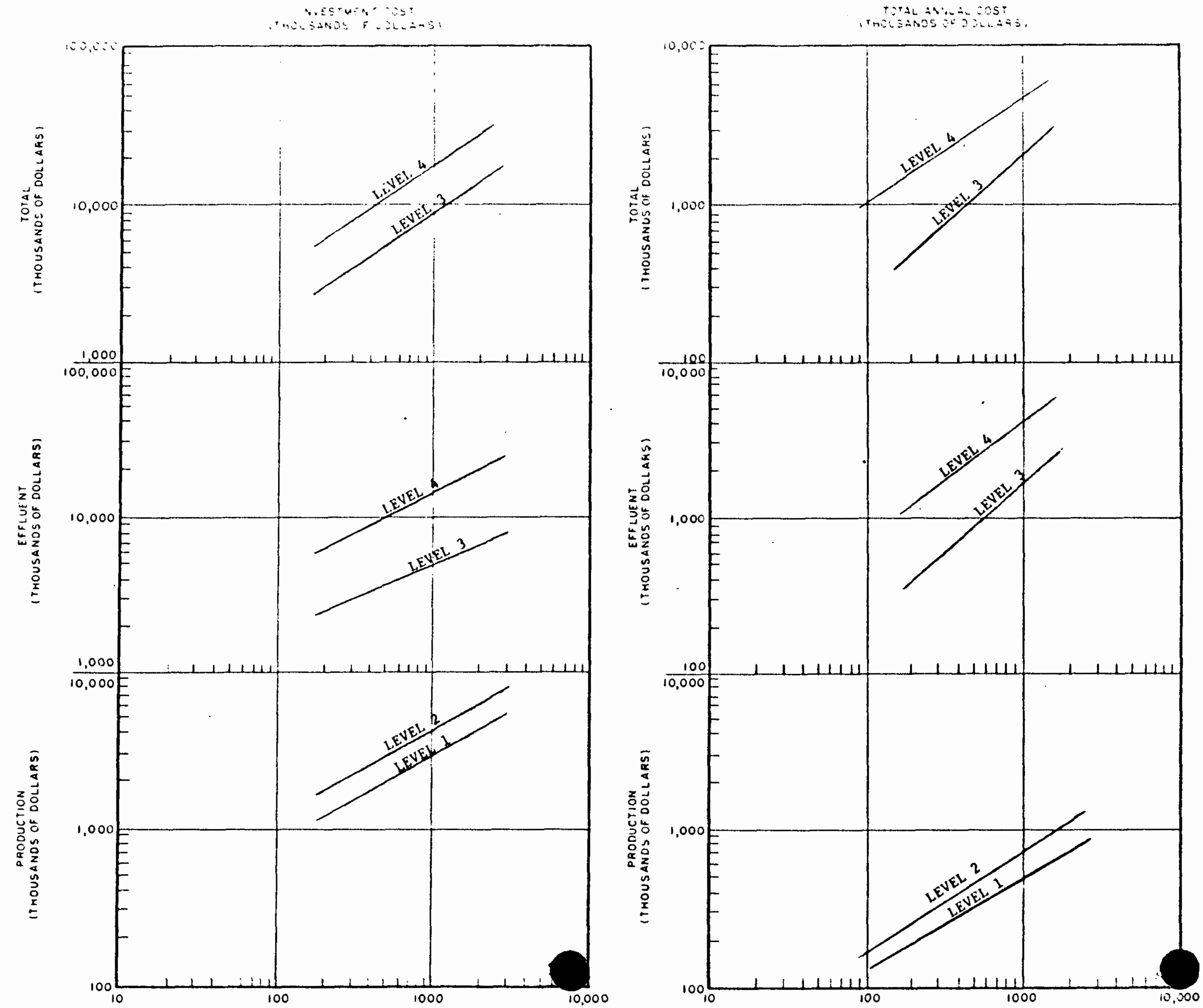
FIGURE IX-7

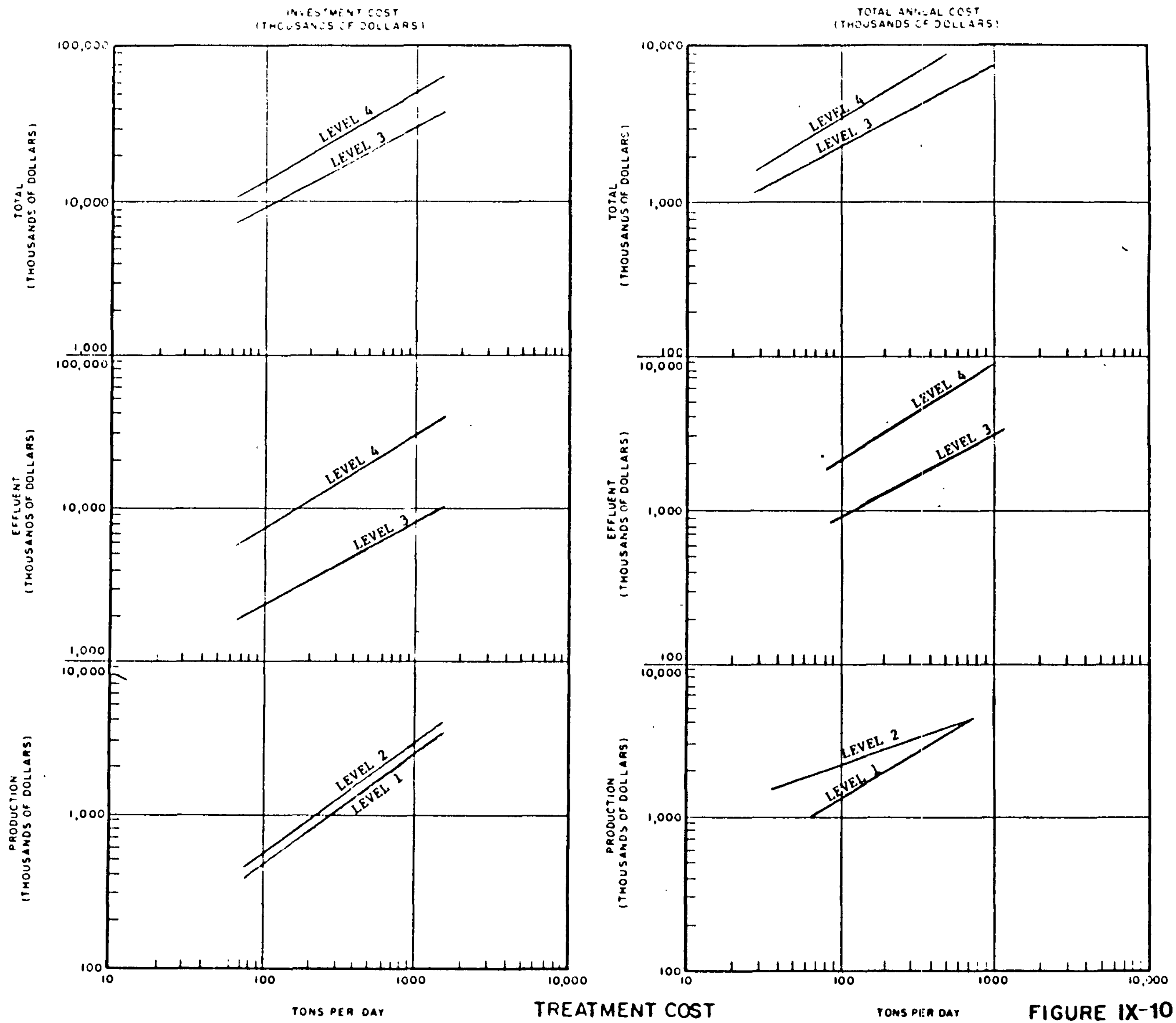


TREATMENT COST

FIGURE IX-8

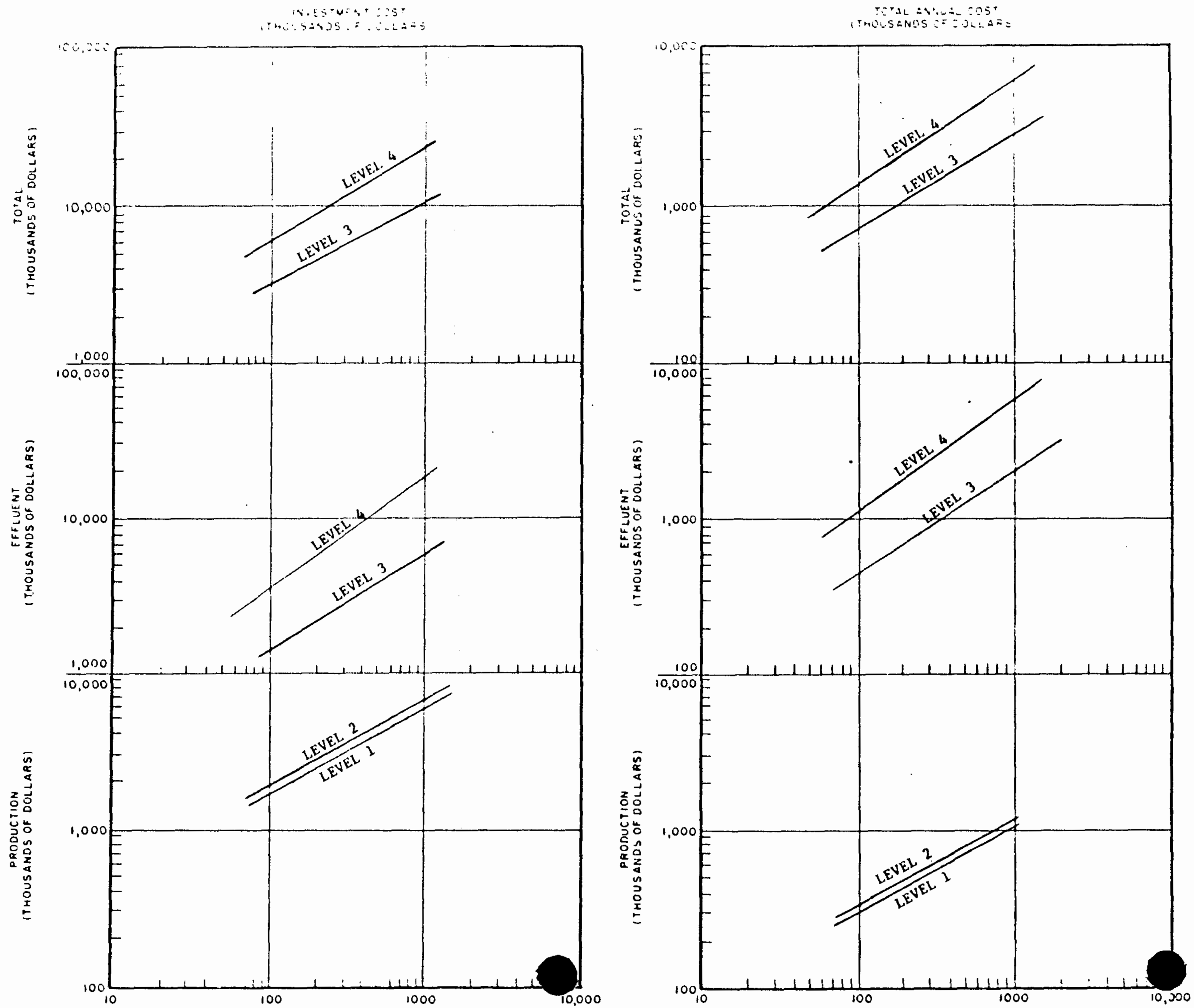
017 ALKALINE UNBLEACHED AND SEMI-CHEMICAL


INVESTMENT COST
(THOUSANDS OF DOLLARS)
TOTAL ANNUAL COST
(THOUSANDS OF DOLLARS)
TOTAL
(THOUSANDS OF DOLLARS)
EFFLUENT
(THOUSANDS OF DOLLARS)
PRODUCTION
(THOUSANDS OF DOLLARS)
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
100,000
10,000
1,000
100
10
1000

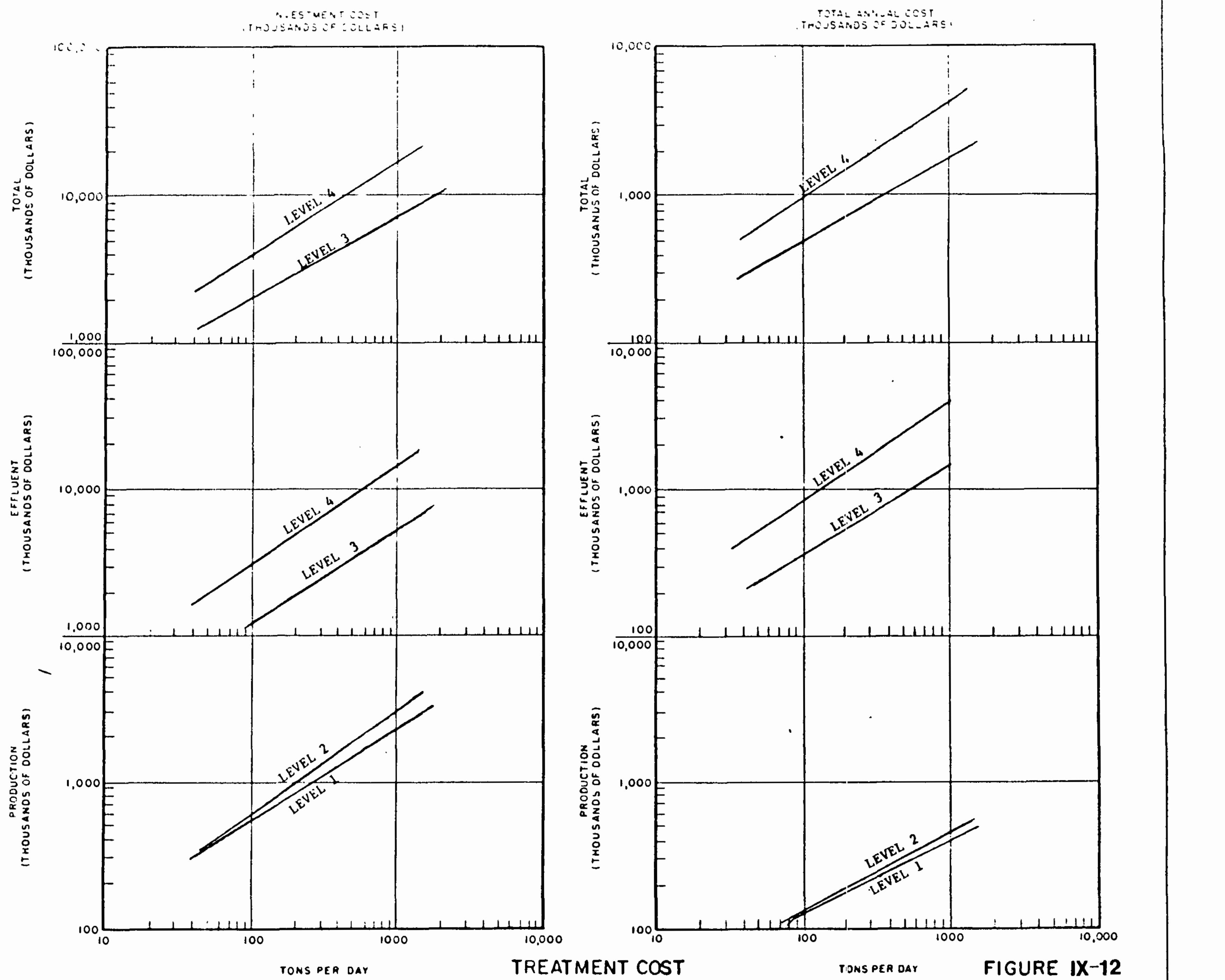


TREATMENT COST
021 SULFITE - DISSOLVING

FIGURE IX-10



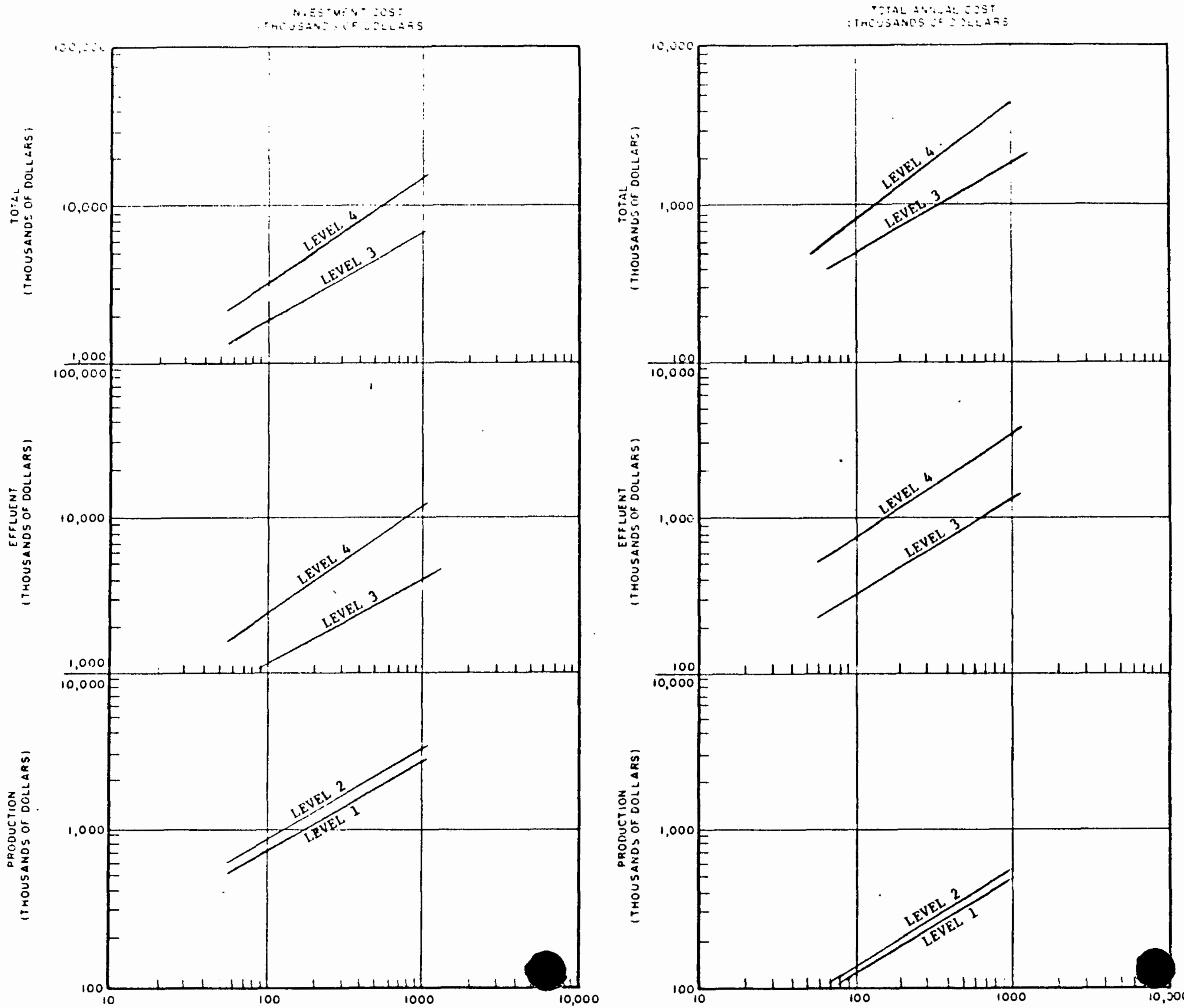
INVESTMENT COST (THOUSANDS OF DOLLARS)
TOTAL ANNUAL COST (THOUSANDS OF DOLLARS)
TOTAL (THOUSANDS OF DOLLARS)
EFFLUENT (THOUSANDS OF DOLLARS)
PRODUCTION (THOUSANDS OF DOLLARS)
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
100,000
10,000
1,000
100
10
1000

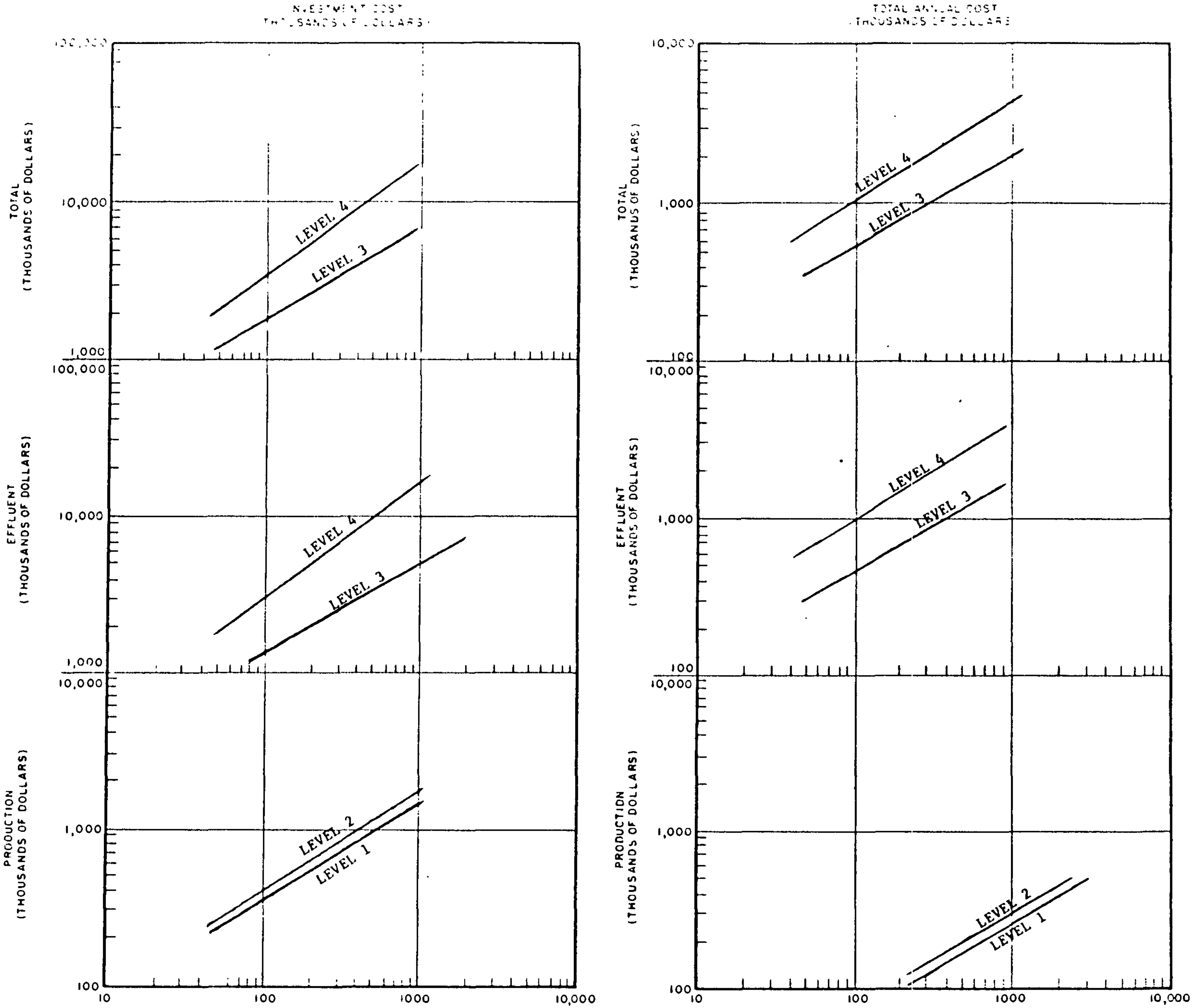


TREATMENT COST

033 GROUNDWOOD - CMN

FIGURE IX-12

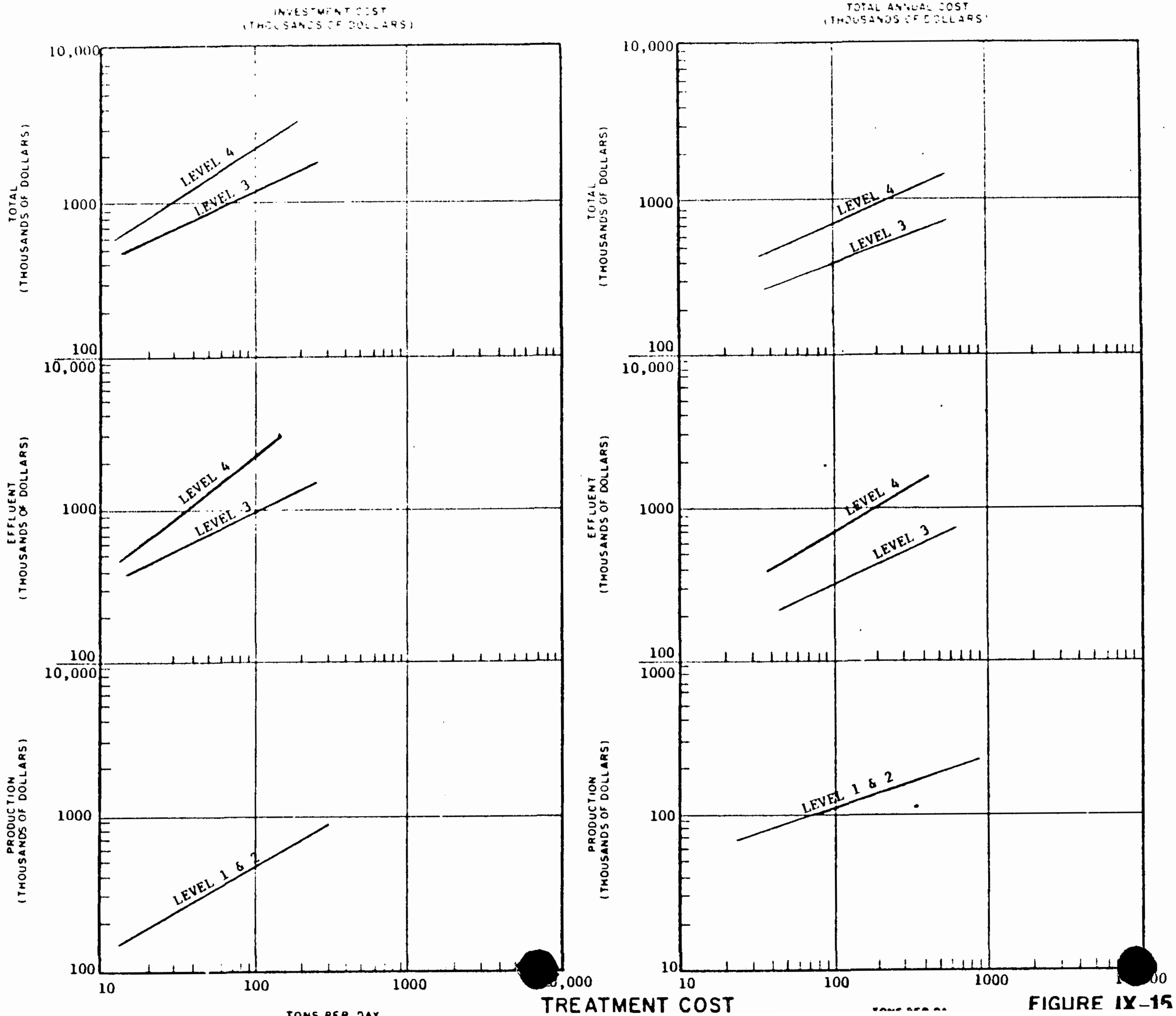

TOTAL (THOUSANDS OF DOLLARS)
EFFLUENT (THOUSANDS OF DOLLARS)
PRODUCTION (THOUSANDS OF DOLLARS)
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
100,000
10,000
1,000
100
10
100
1000
10,000



TREATMENT COST

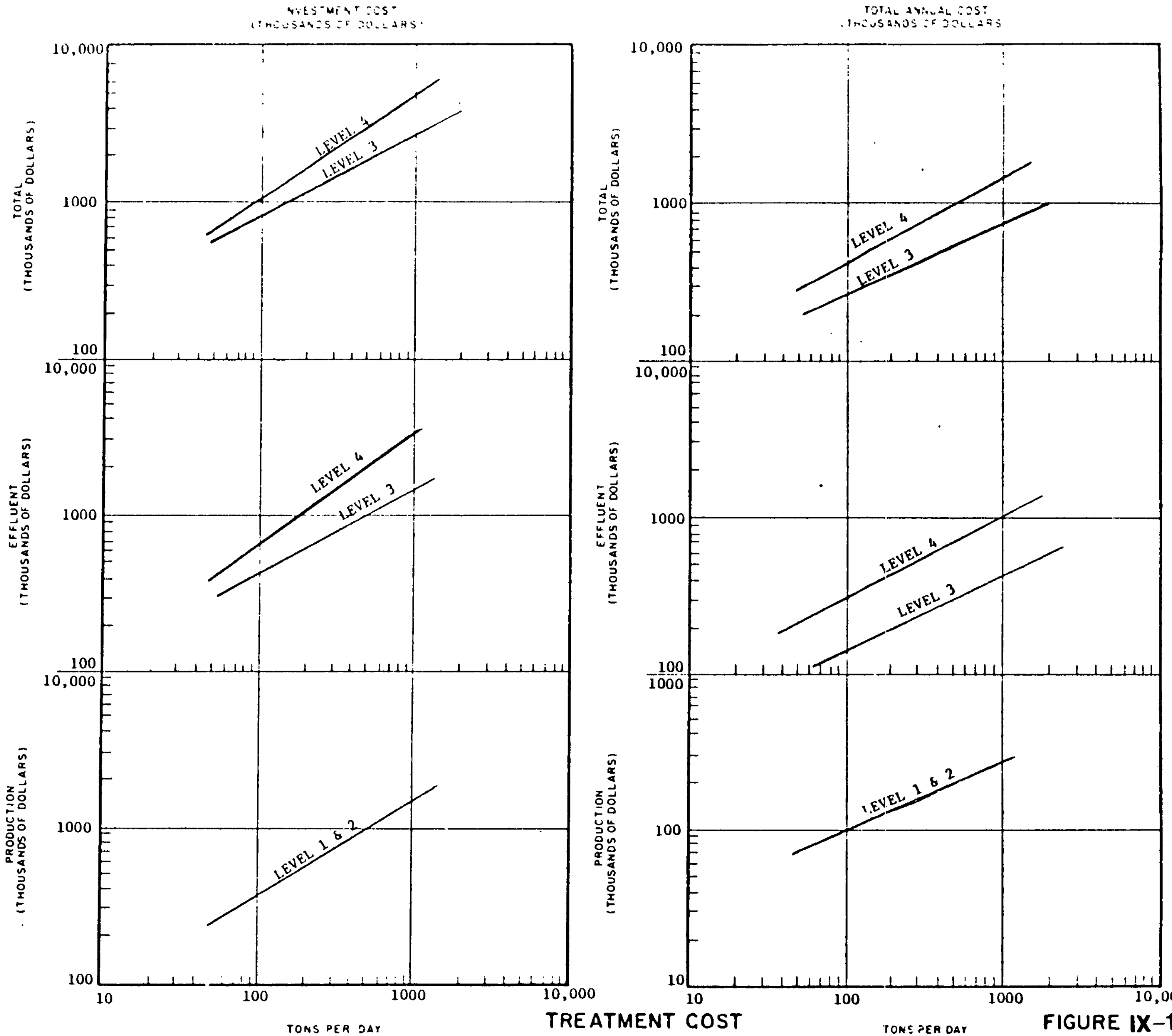
FIGURE IX-14

101 DEINK - FINE AND TISSUE



TREATMENT COST

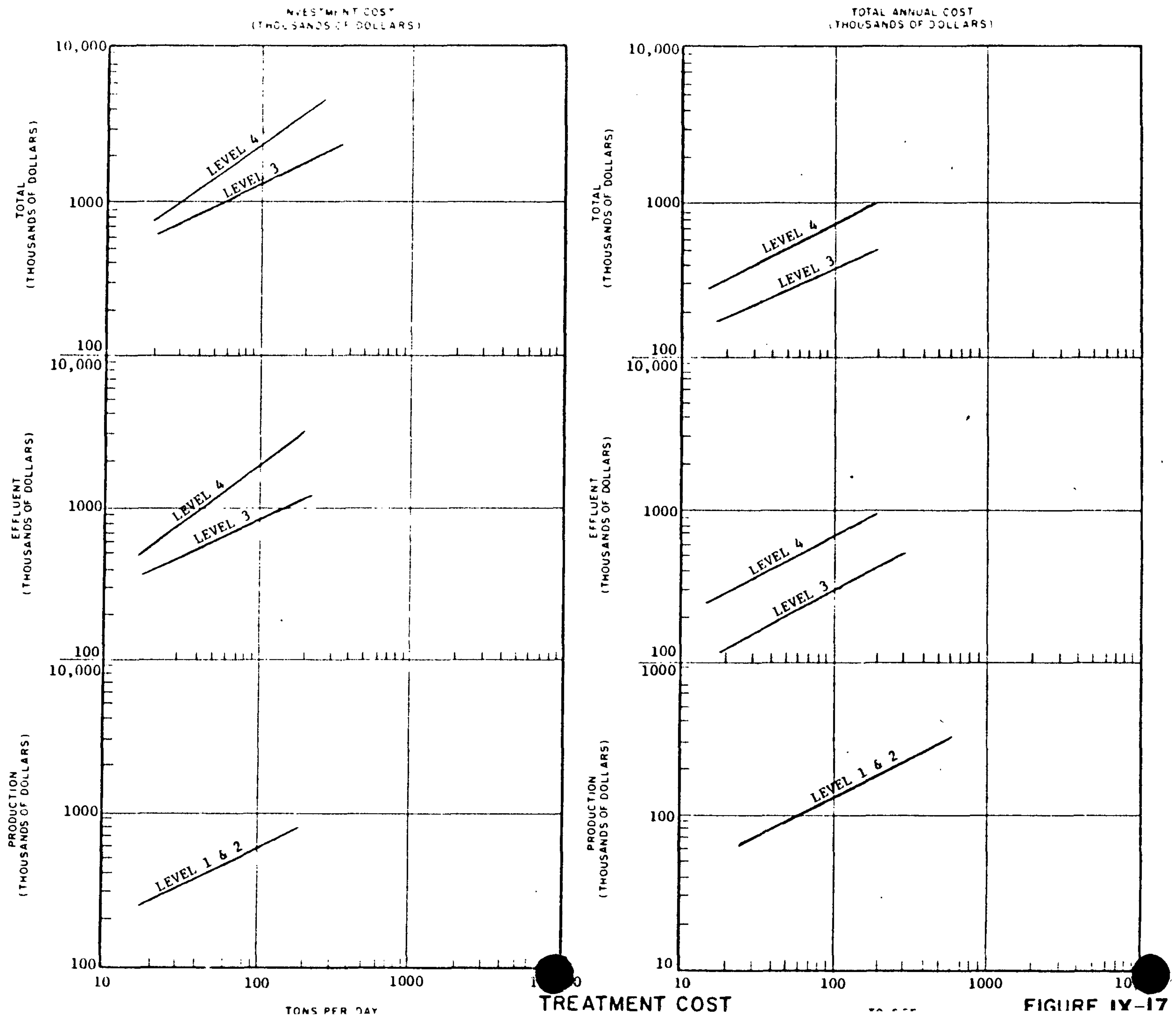
FIGURE IX-15



TREATMENT COST

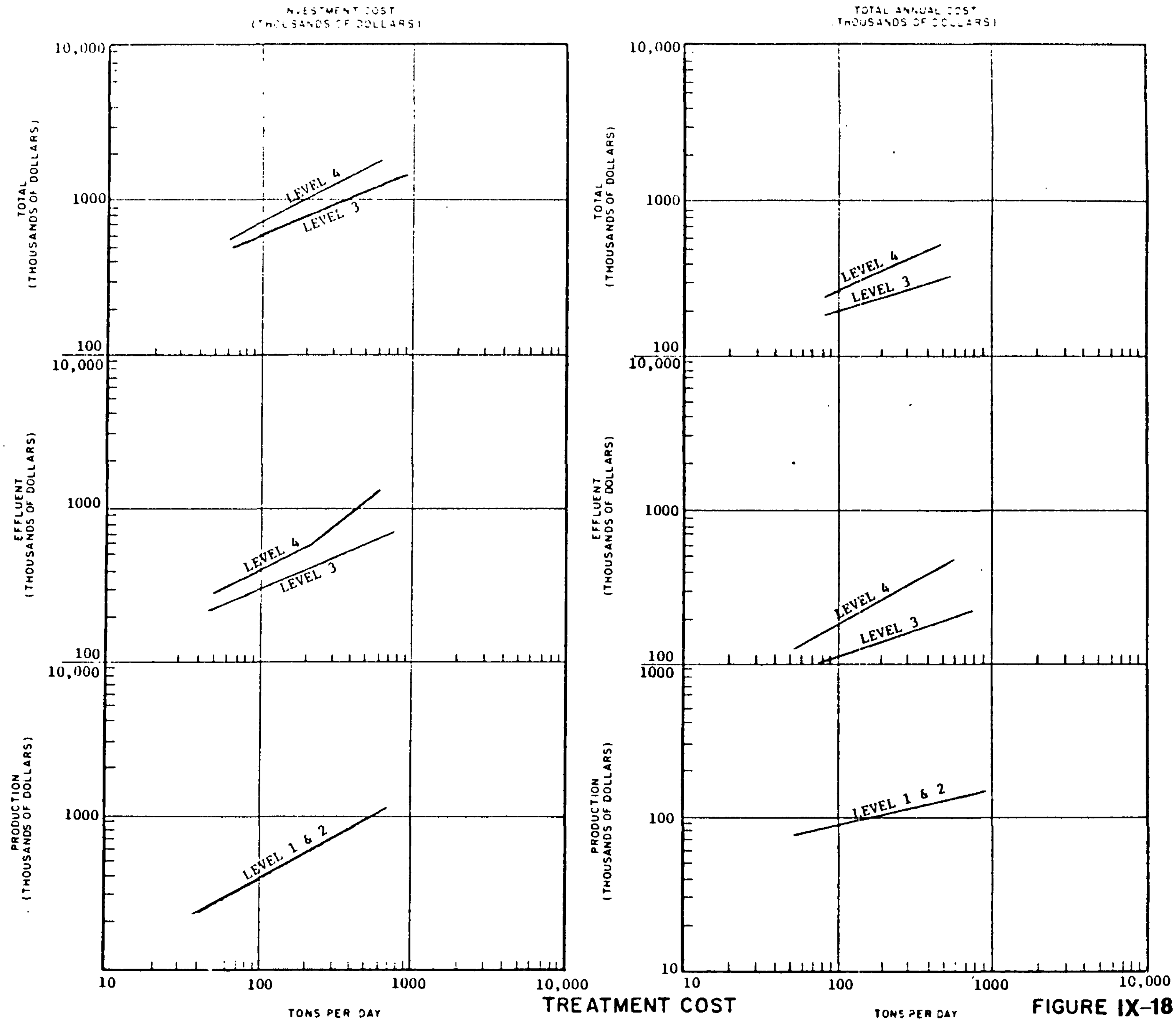
112 WASTEPAPER - BOARD

FIGURE IX-16



TREATMENT COST

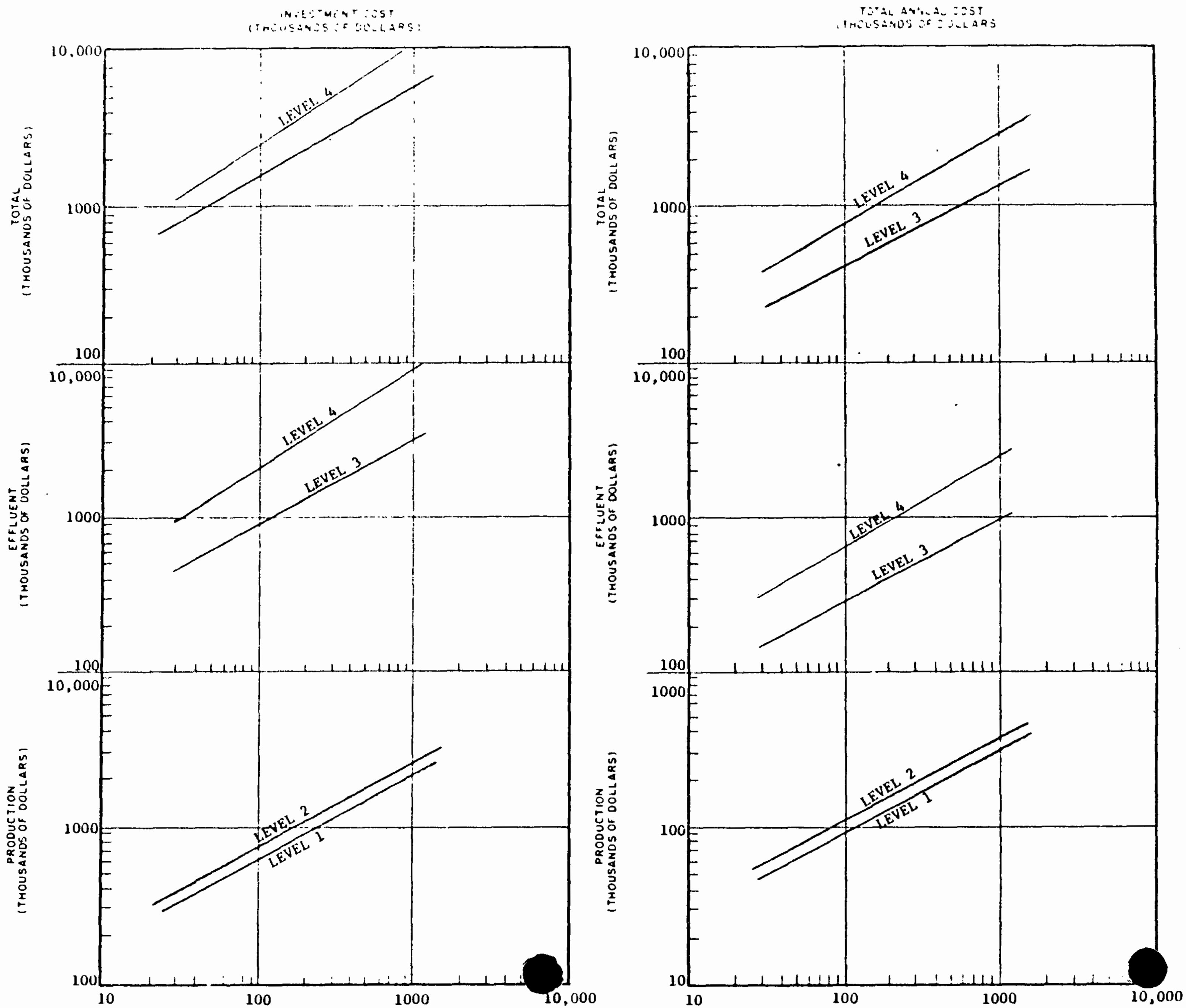
FIGURE IX-17

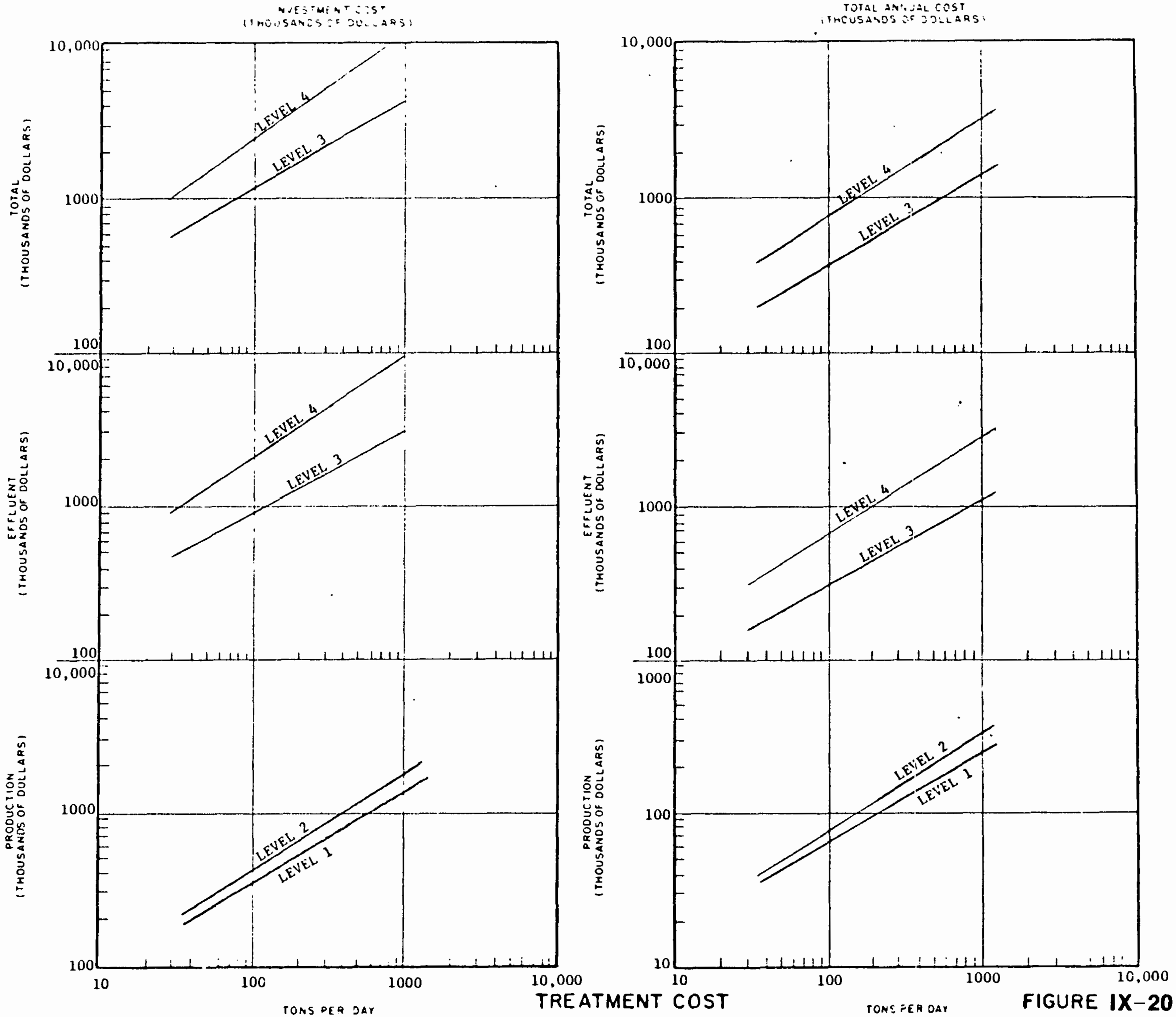


TREATMENT COST

FIGURE IX-18

114 WASTEPAPER - CONSTRUCTION PRODUCTS

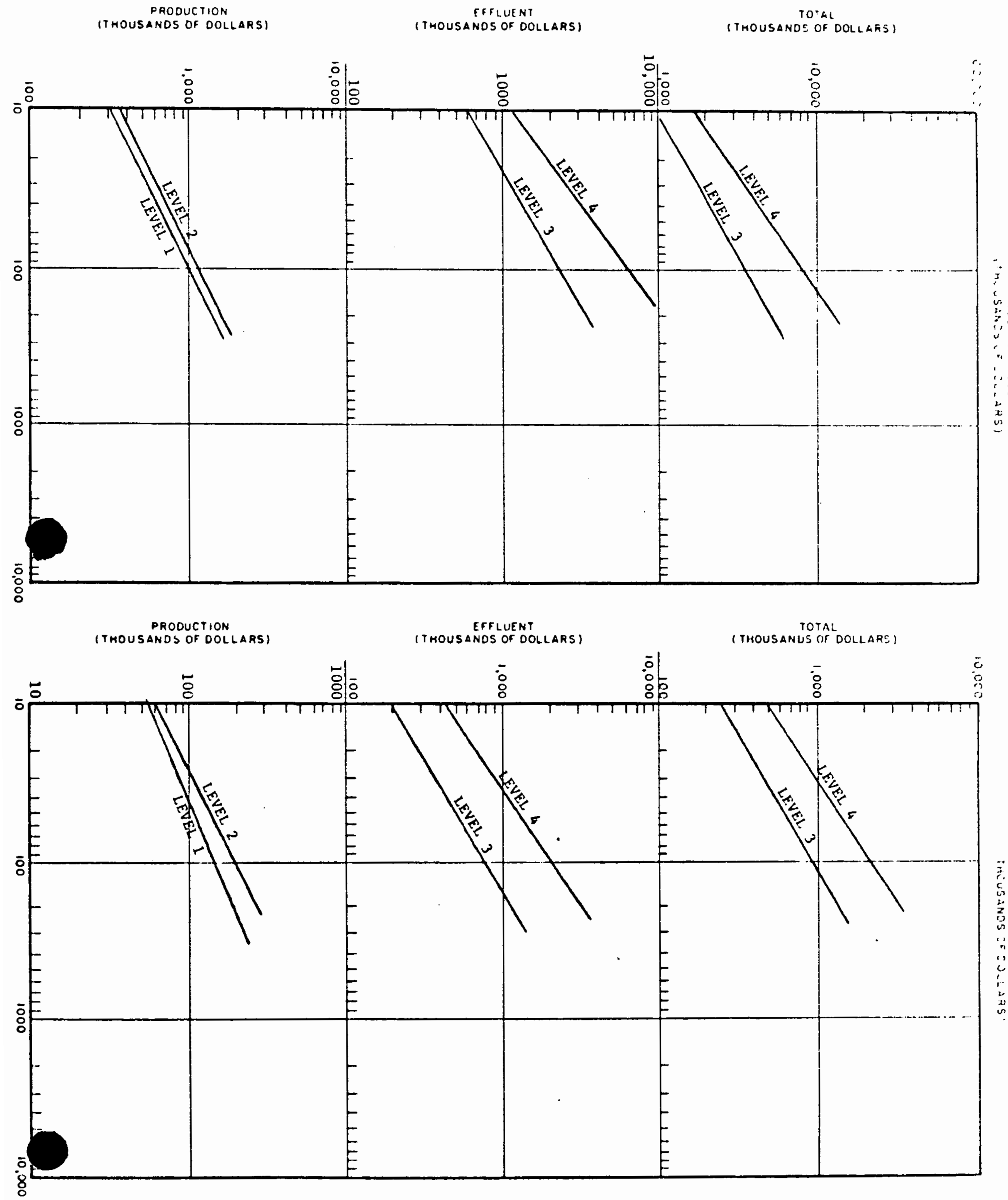

INVESTMENT COST
(THOUSANDS OF DOLLARS)
TOTAL ANNUAL COST
(THOUSANDS OF DOLLARS)
TOTAL
(THOUSANDS OF DOLLARS)
EFFLUENT
(THOUSANDS OF DOLLARS)
PRODUCTION
(THOUSANDS OF DOLLARS)
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
10,000
1000
100
10
10
100
1000
10,000

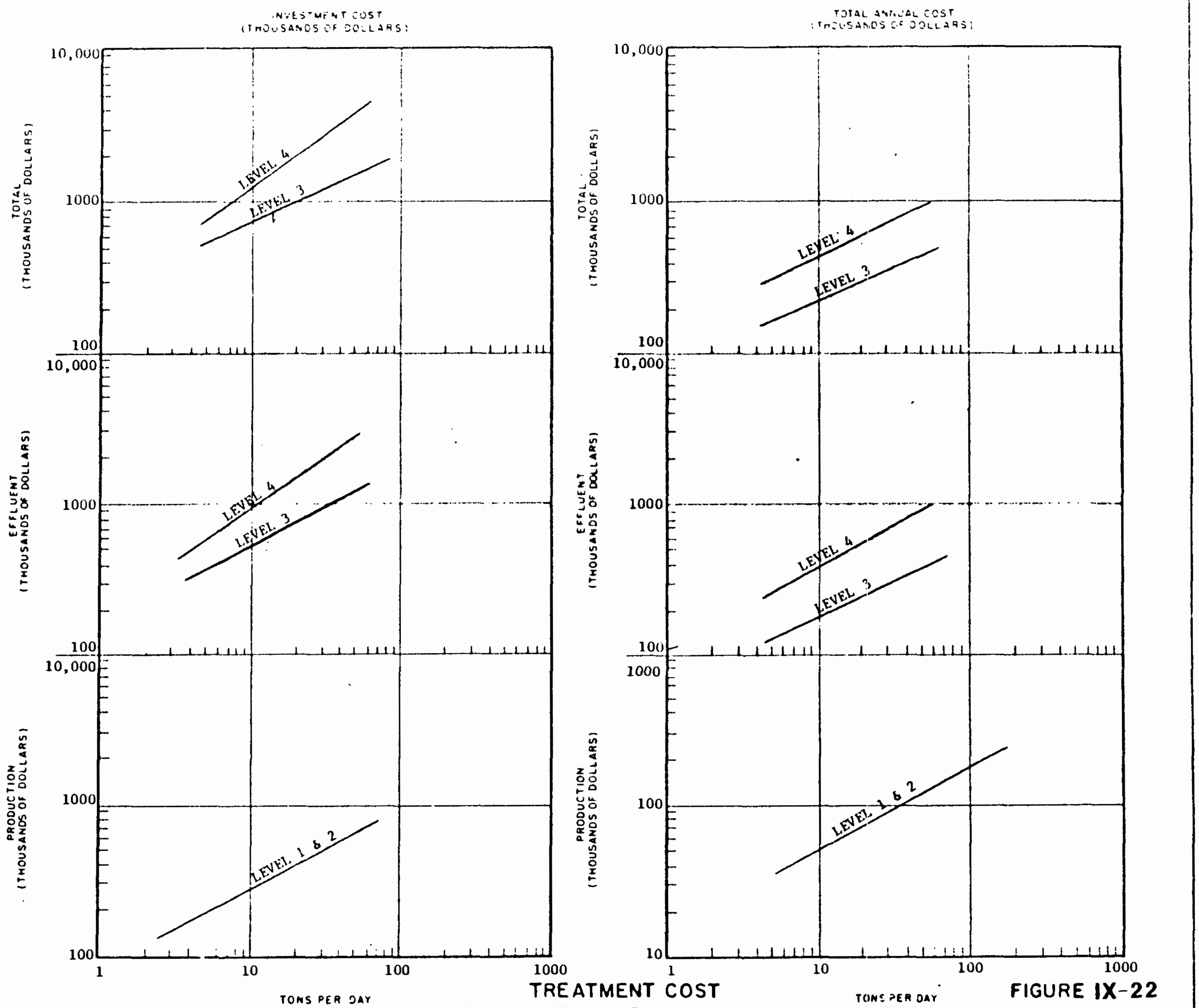


TREATMENT COST

202 NON-INTEGRATED - TISSUE

FIGURE IX-20

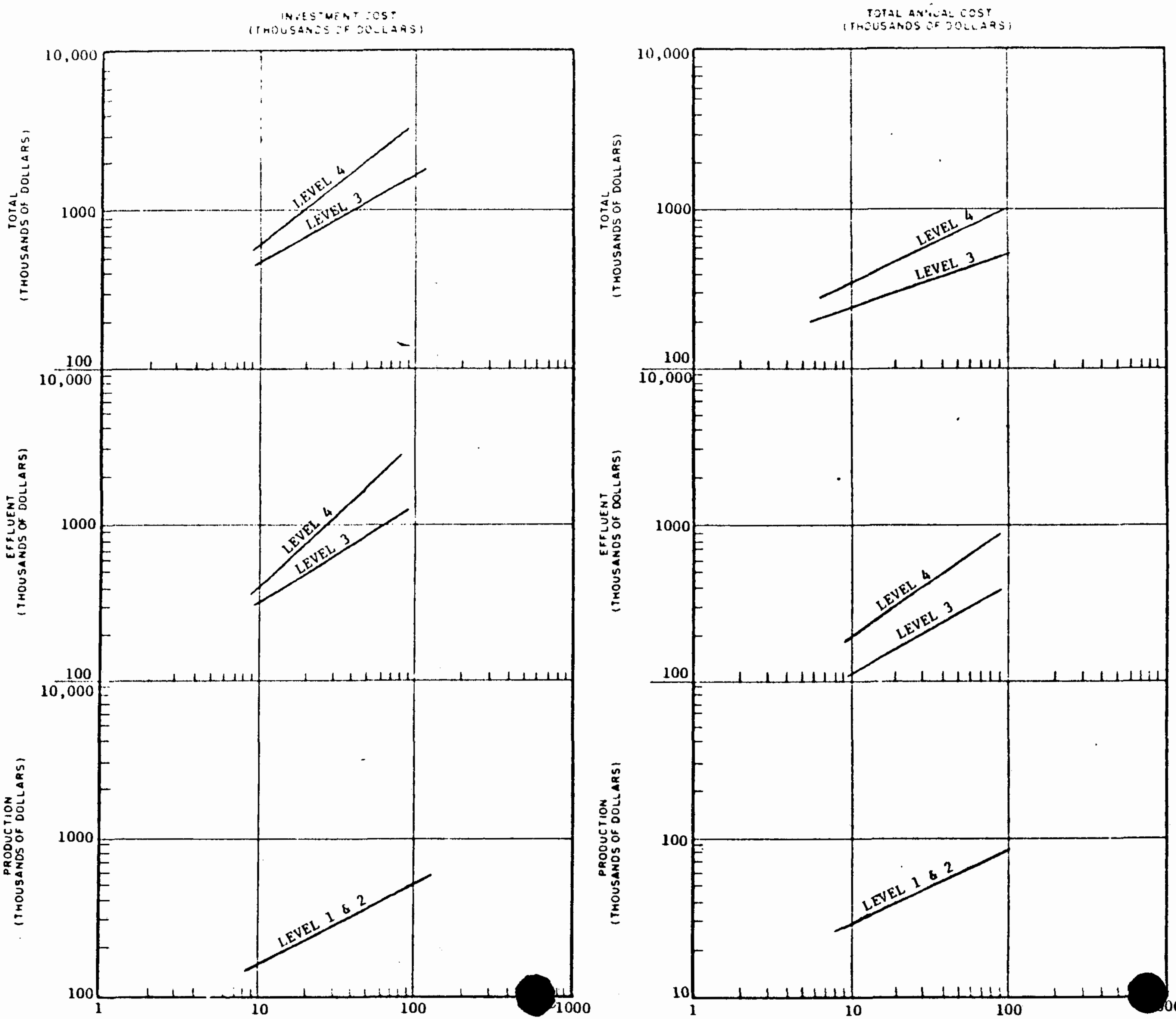

PRODUCTION
(THOUSANDS OF DOLLARS)
EFFLUENT
(THOUSANDS OF DOLLARS)
TOTAL
(THOUSANDS OF DOLLARS)
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
PRODUCTION
(THOUSANDS OF DOLLARS)
EFFLUENT
(THOUSANDS OF DOLLARS)
TOTAL
(THOUSANDS OF DOLLARS)
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4



TREATMENT COST

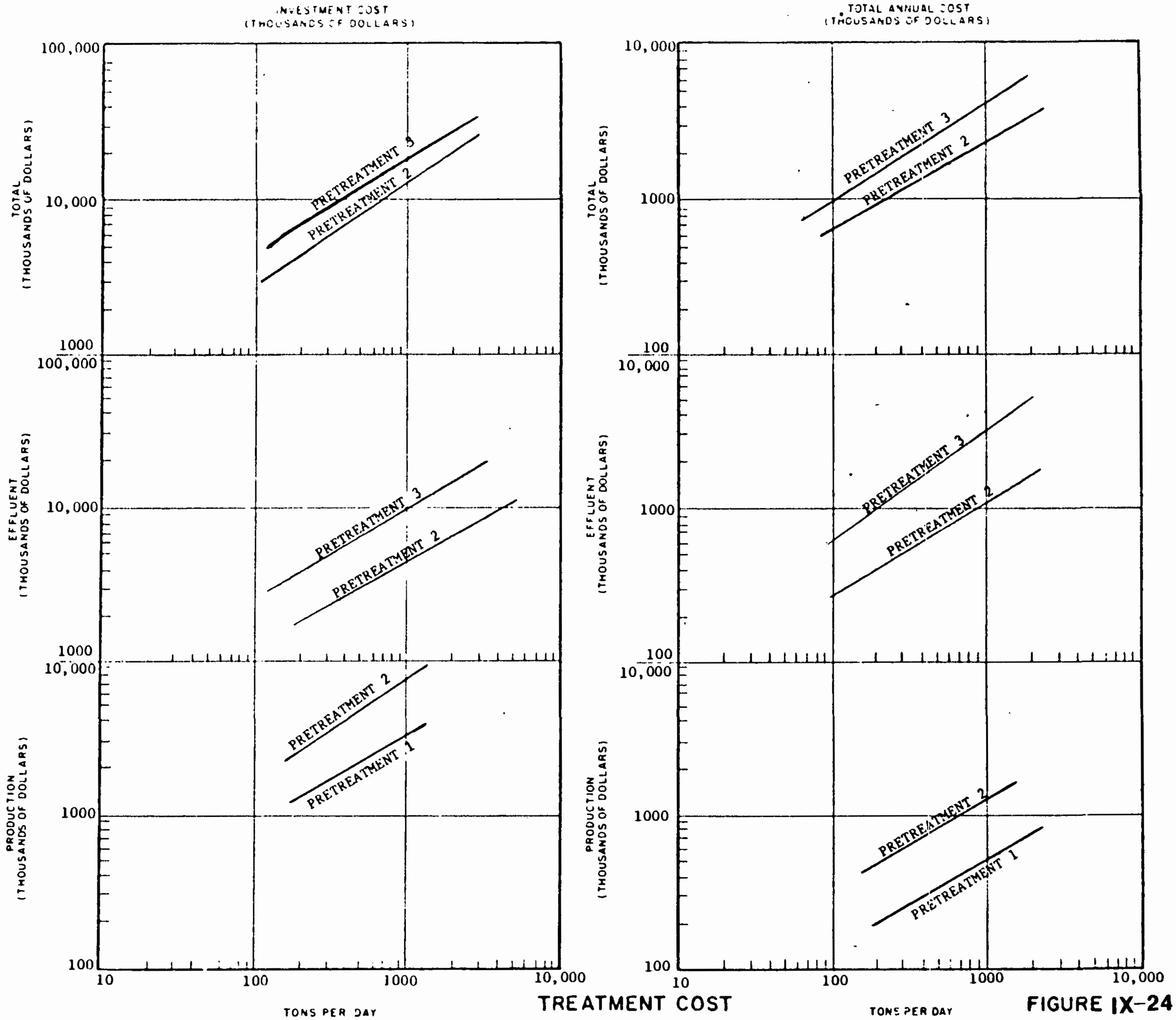
205 NON-INTEGRATED - FILTER AND NON-WOVEN

FIGURE IX-22



TREATMENT COST

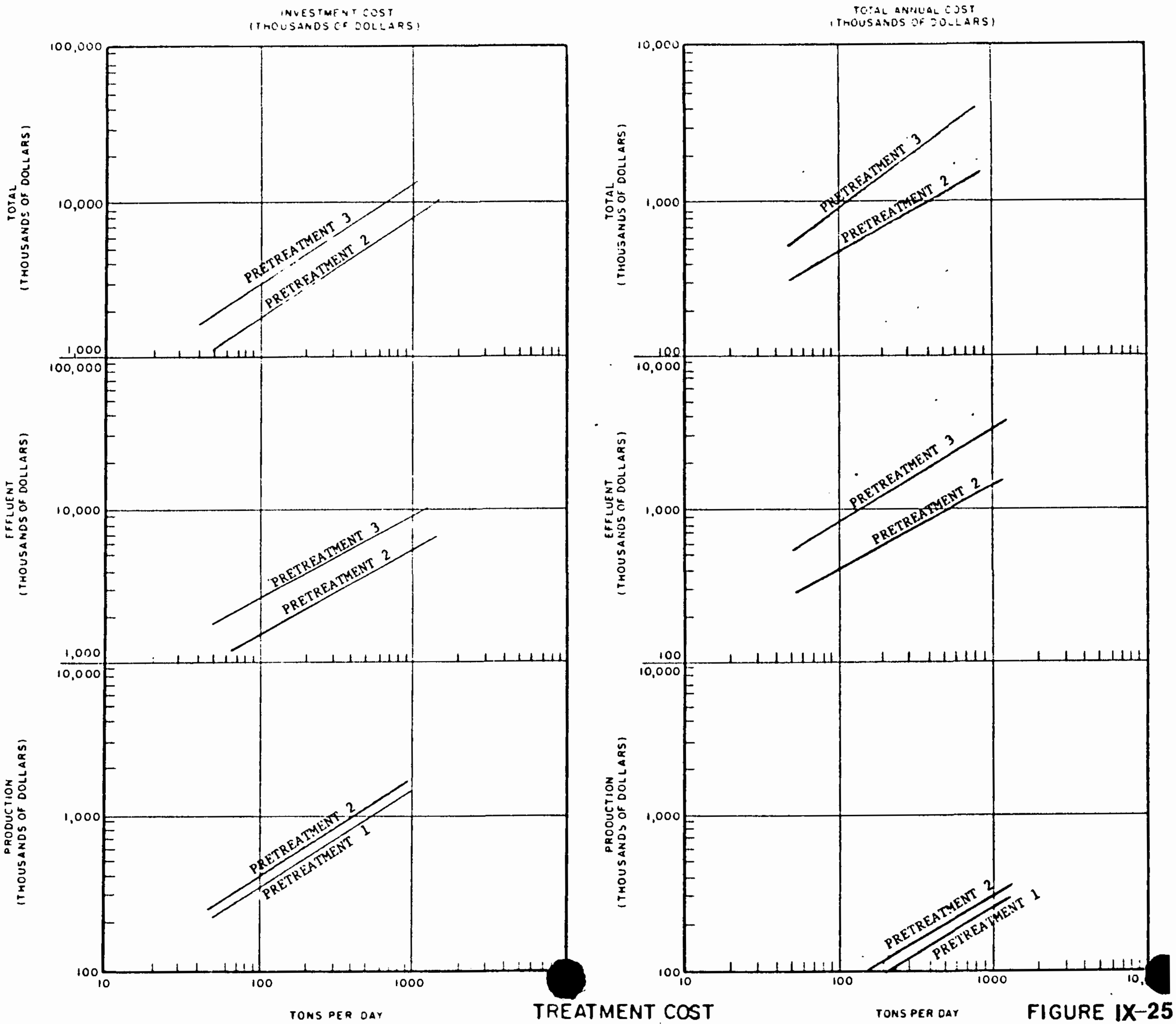
FIGURE IX-23



TREATMENT COST

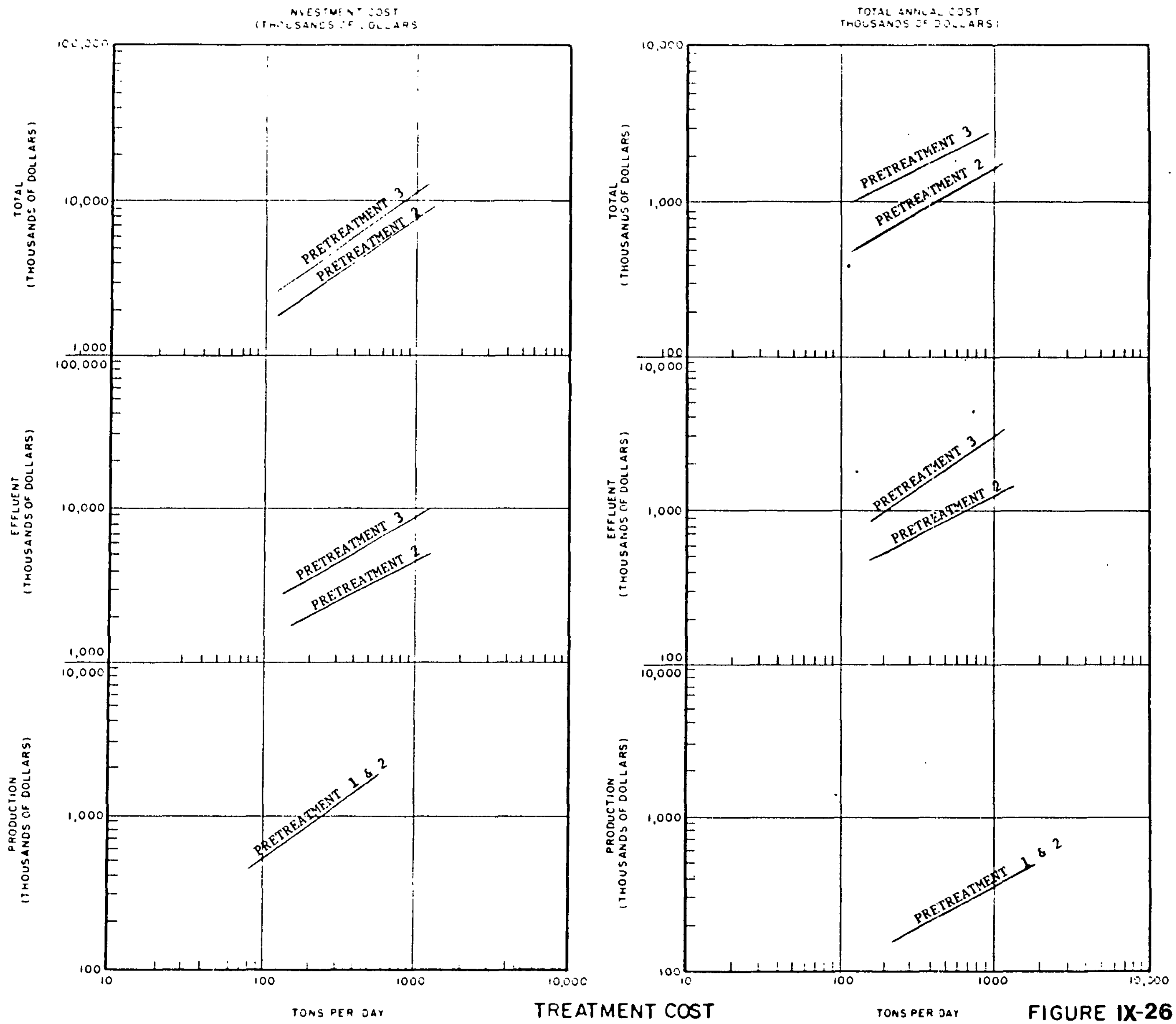
FIGURE IX-24

014 ALKALINE - FINE



TREATMENT COST

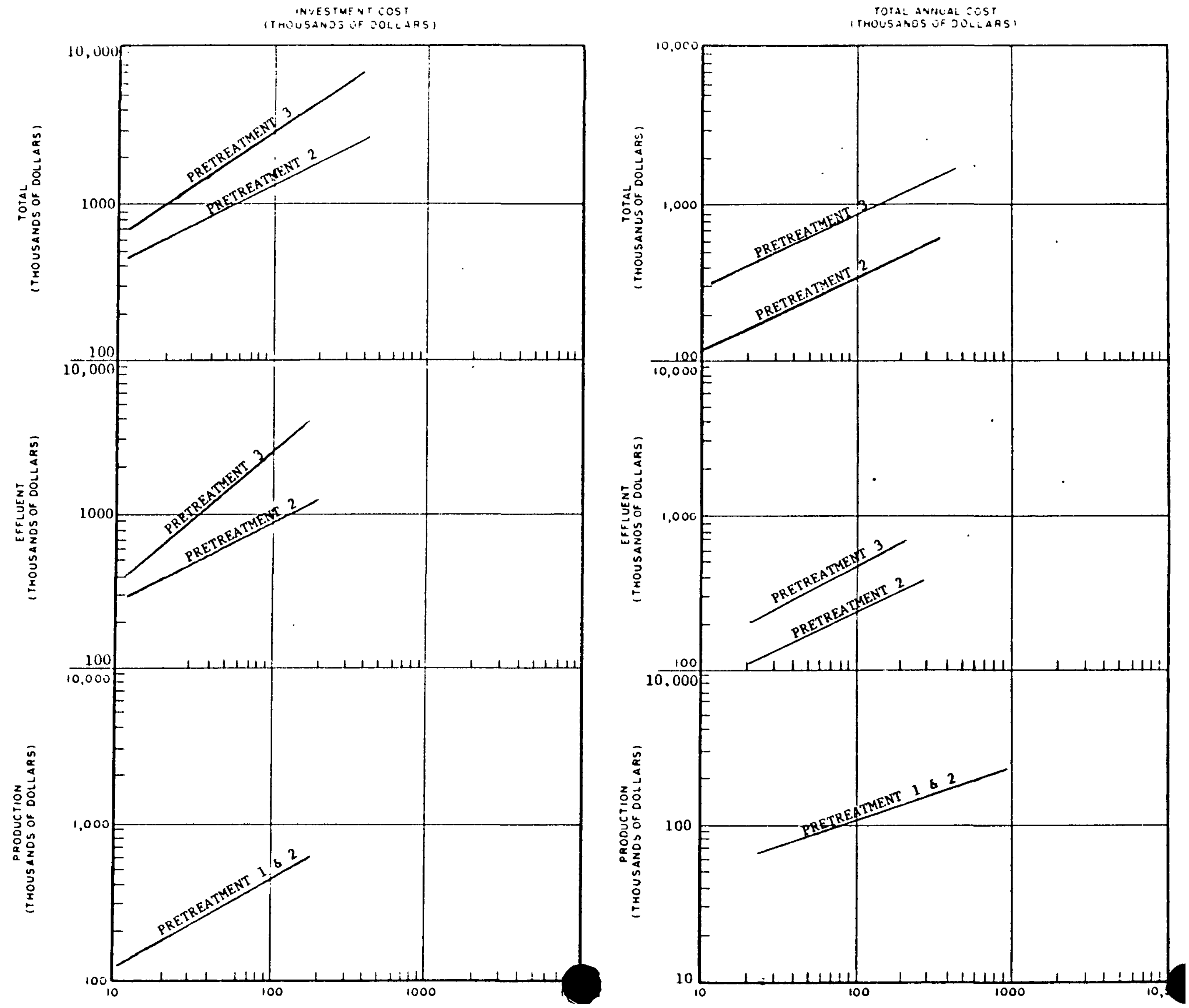
FIGURE IX-25



TREATMENT COST

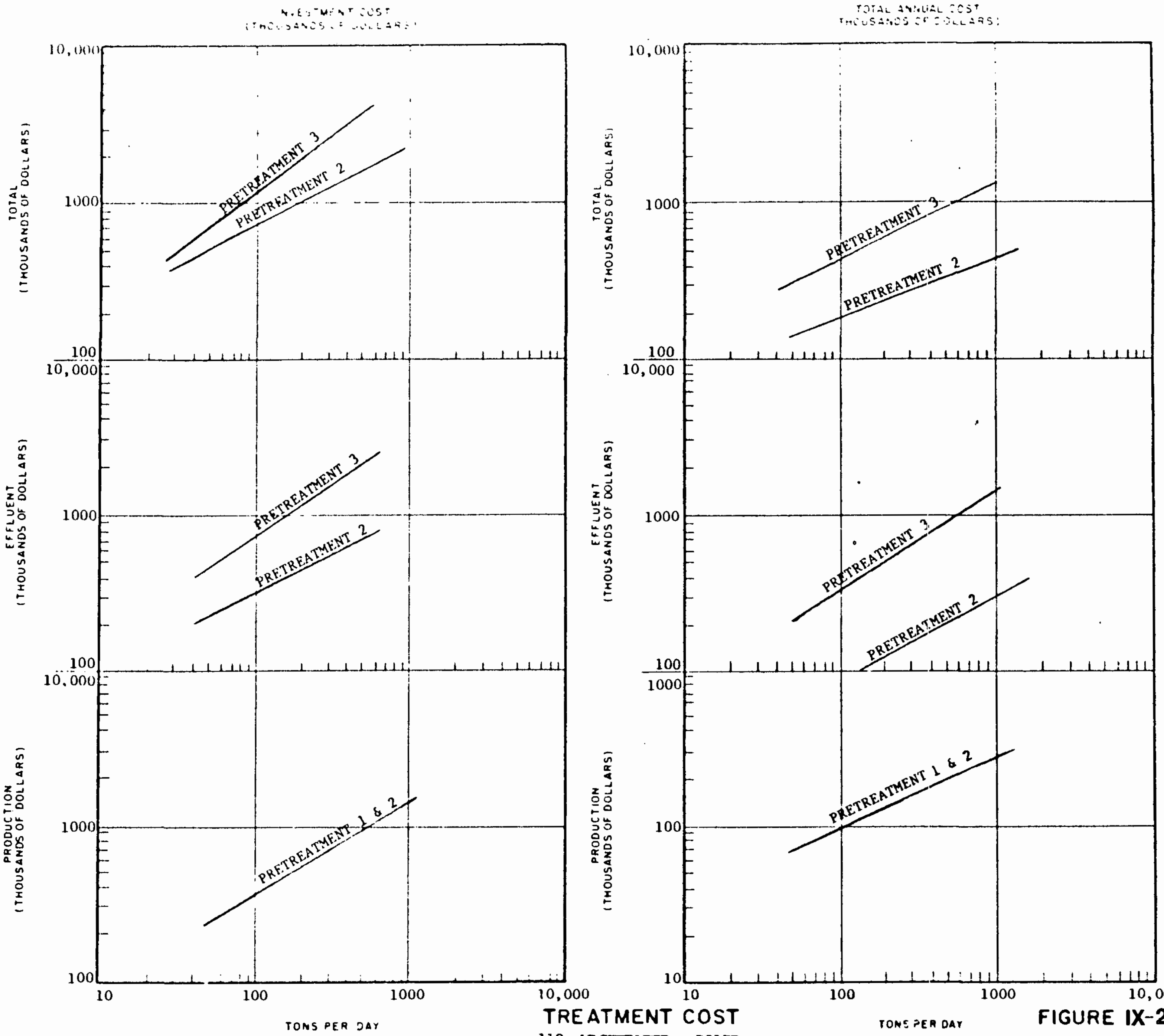
102 DEINK - NEWSPRINT

FIGURE IX-26



TREATMENT COST

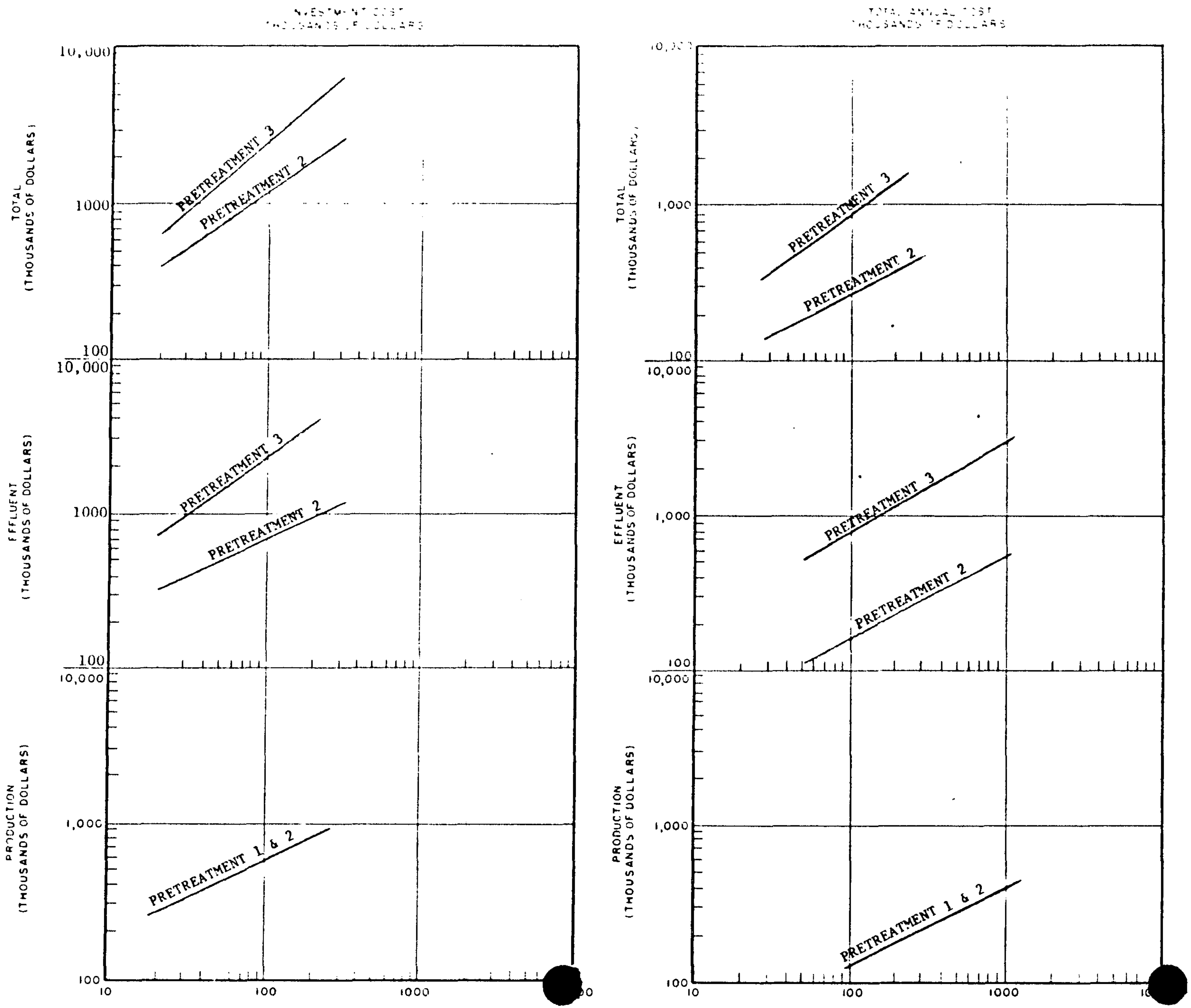
FIGURE IX-27



TREATMENT COST

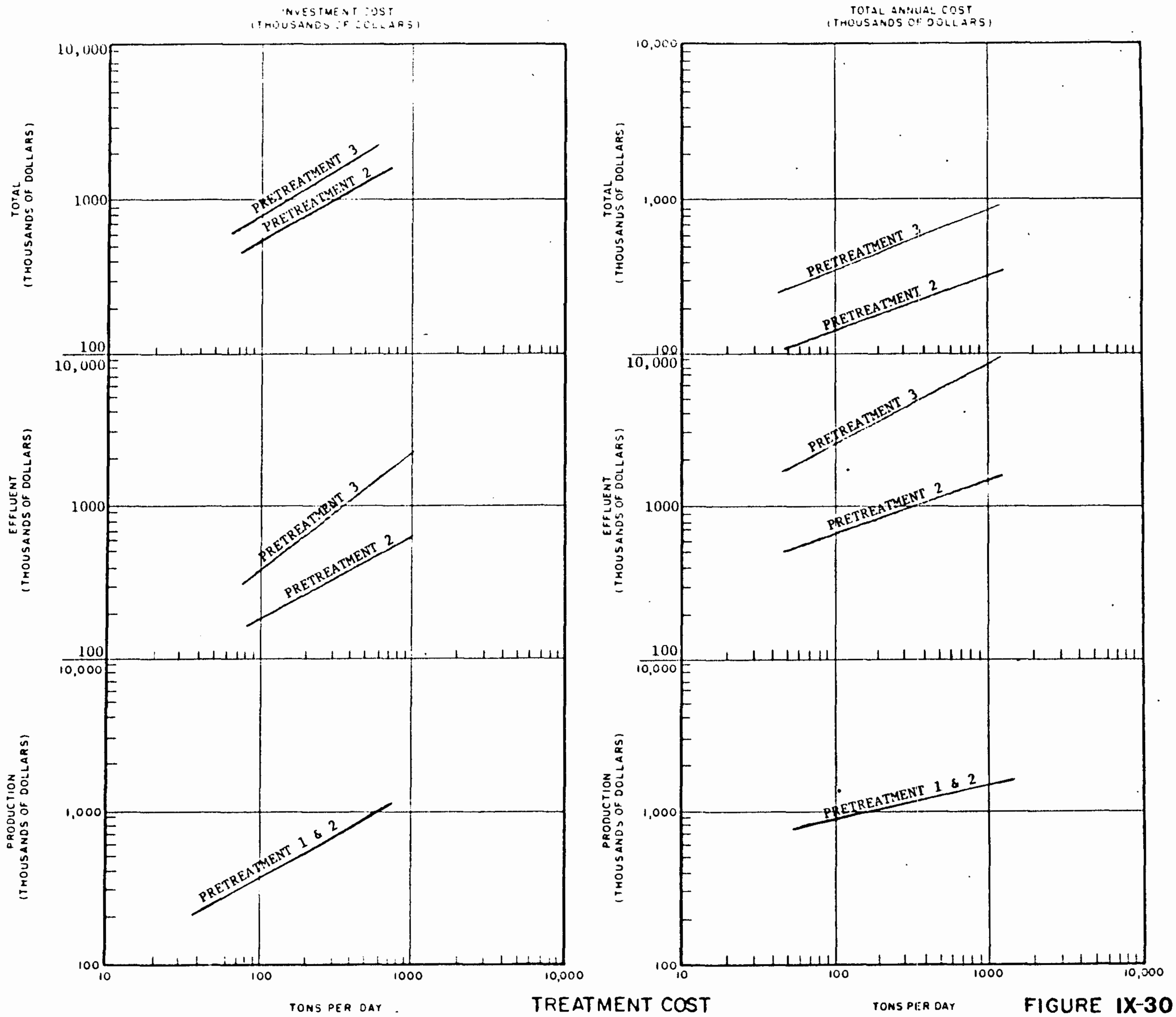
112 WASTEPAPER - BOARD

FIGURE IX-28



TREATMENT COST

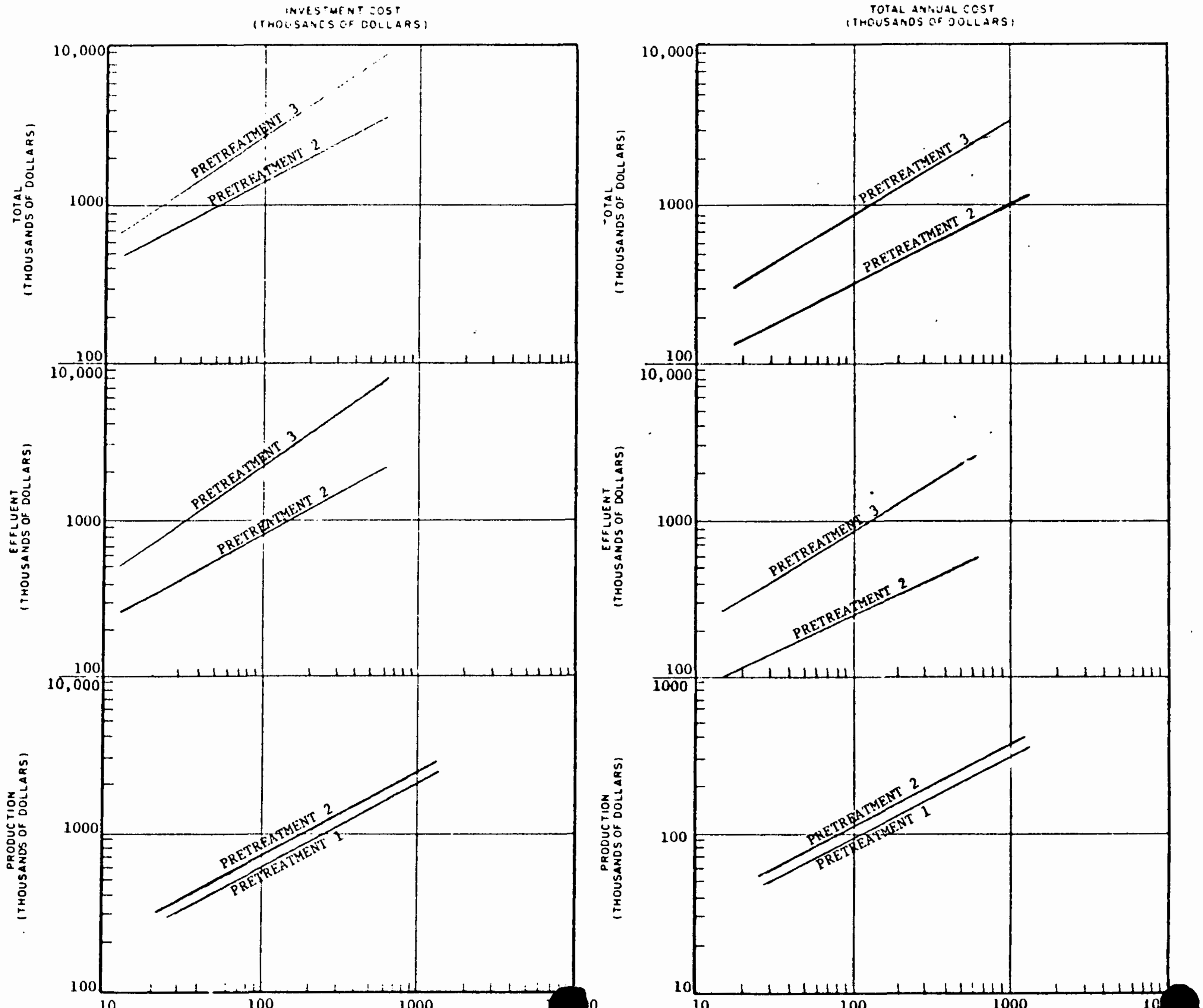
FIGURE IX-29



TREATMENT COST

FIGURE IX-30

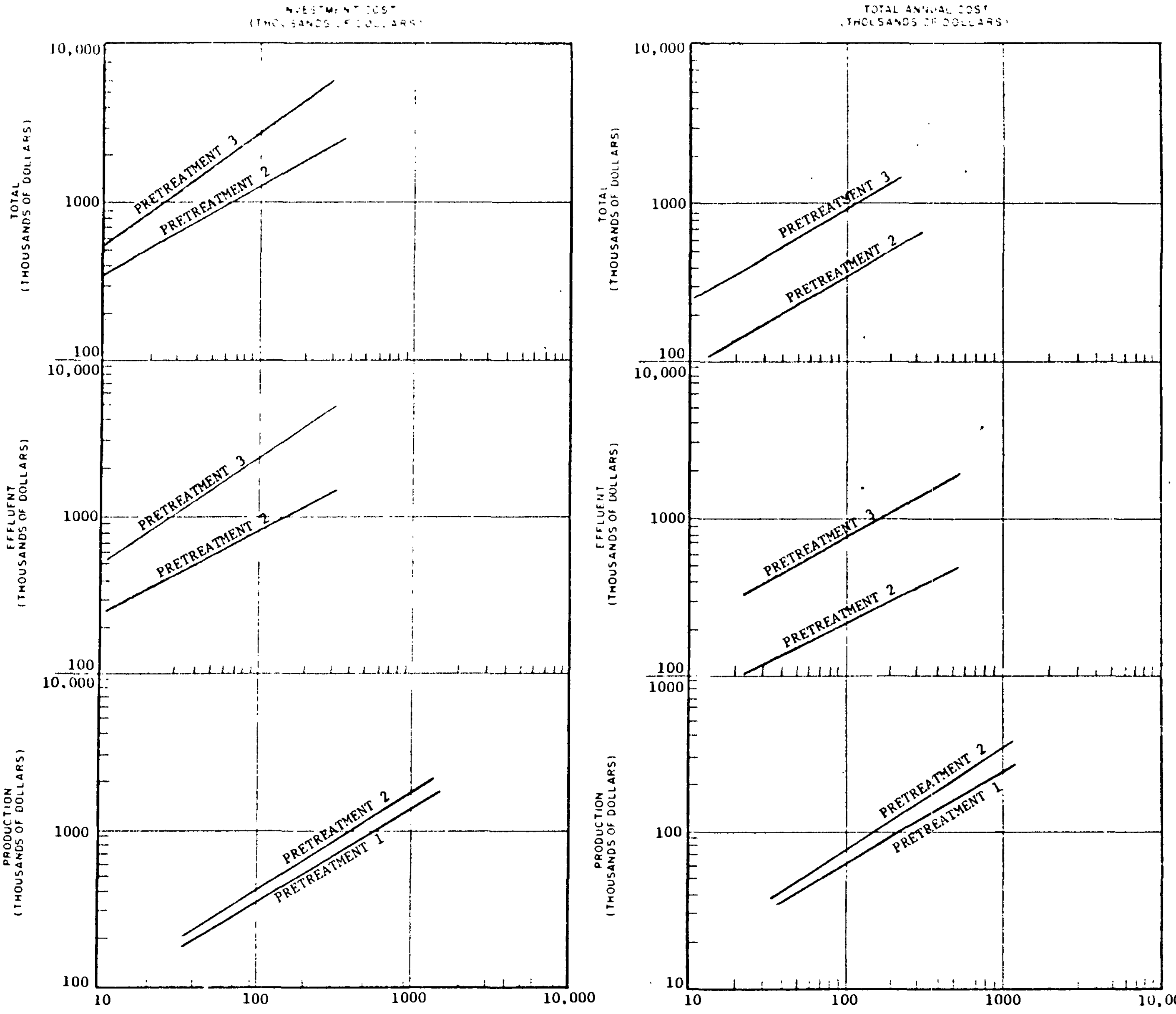
114 WASTEPAPER - CONSTRUCTION PRODUCTS



TREATMENT COST

201 NON-INTEGRATED - FINE

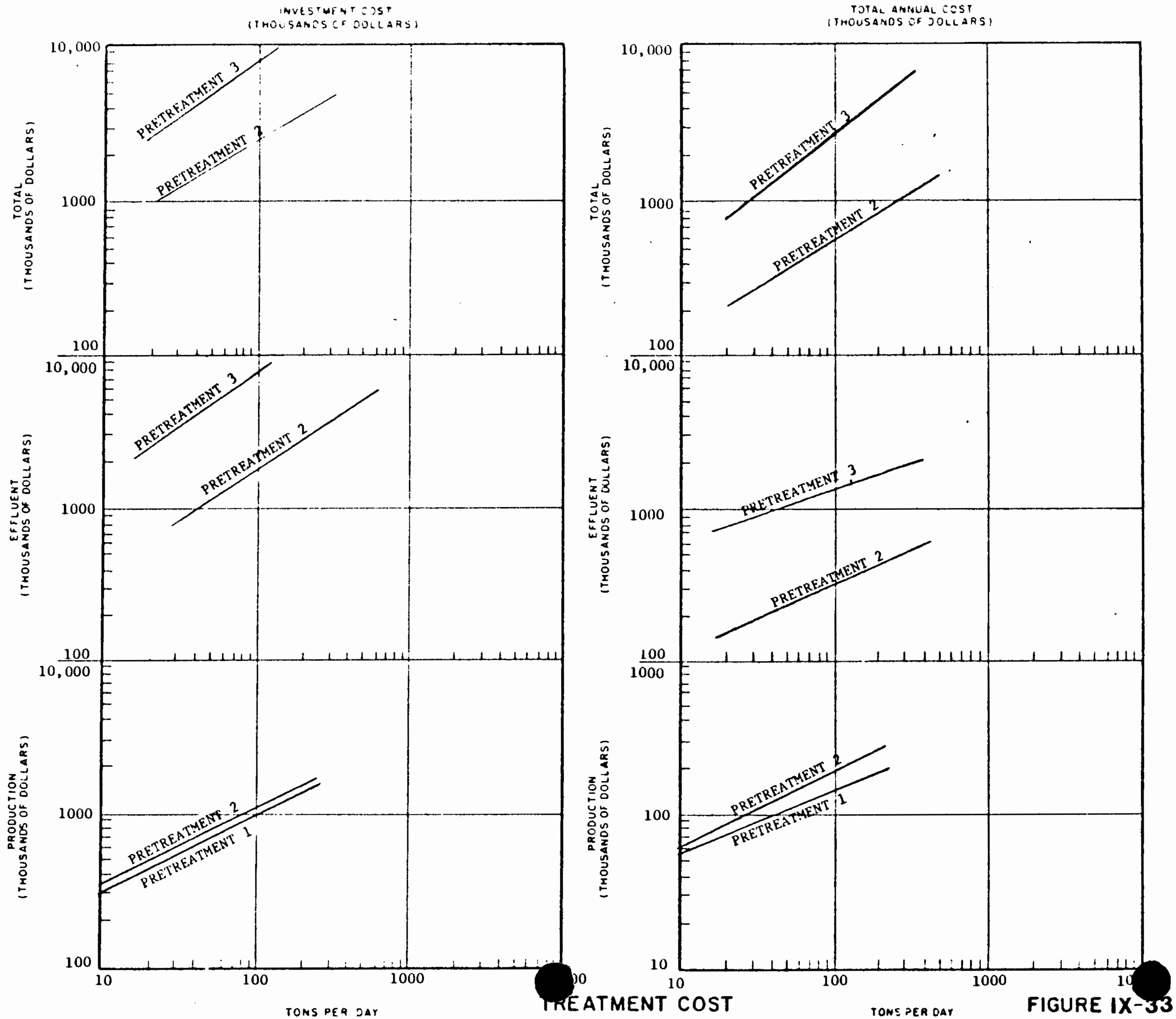
FIGURE IX-31



TREATMENT COST

FIGURE IX-32

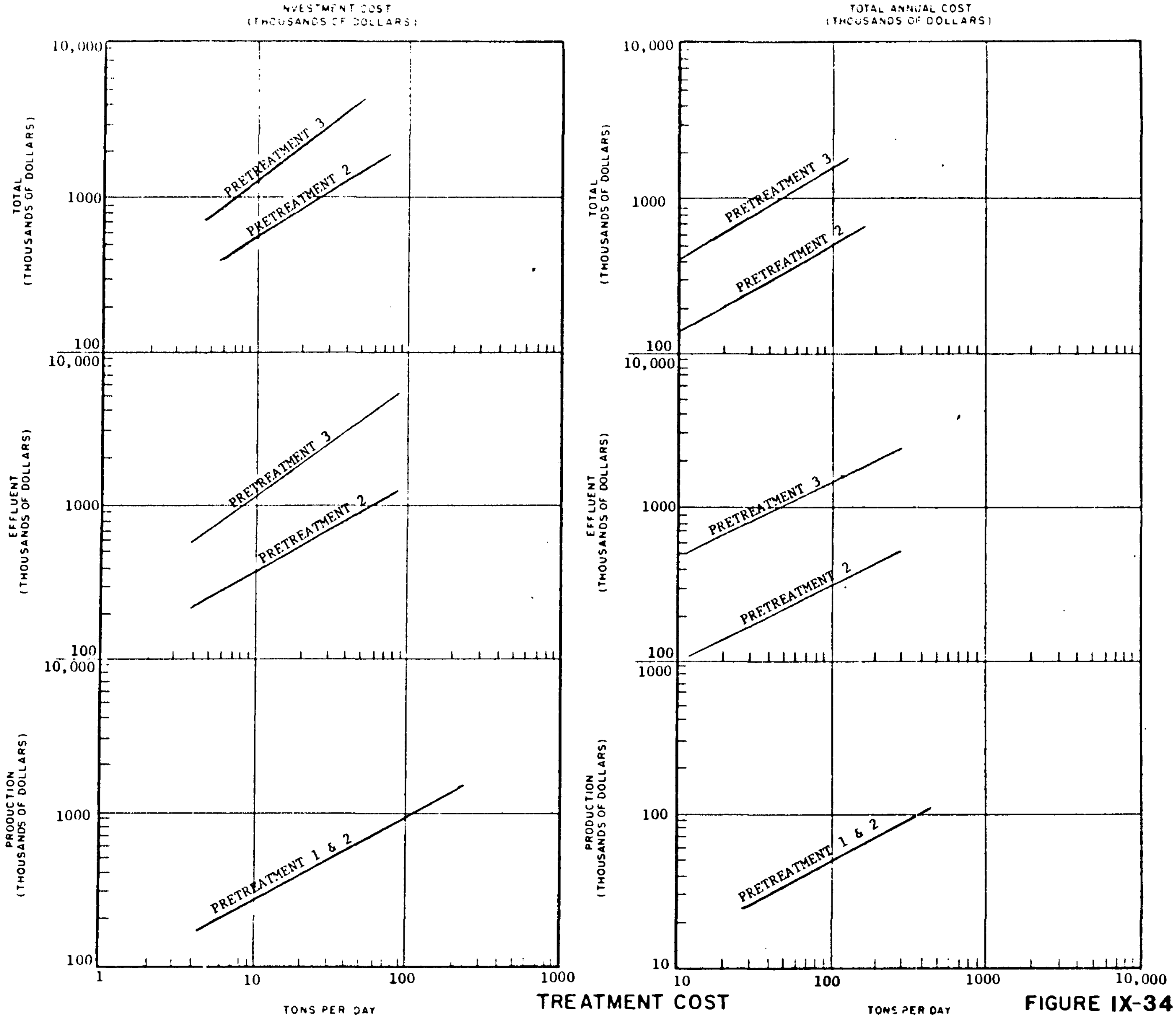
202 NON-INTEGRATED - TISSUE



TREATMENT COST

FIGURE IX-33

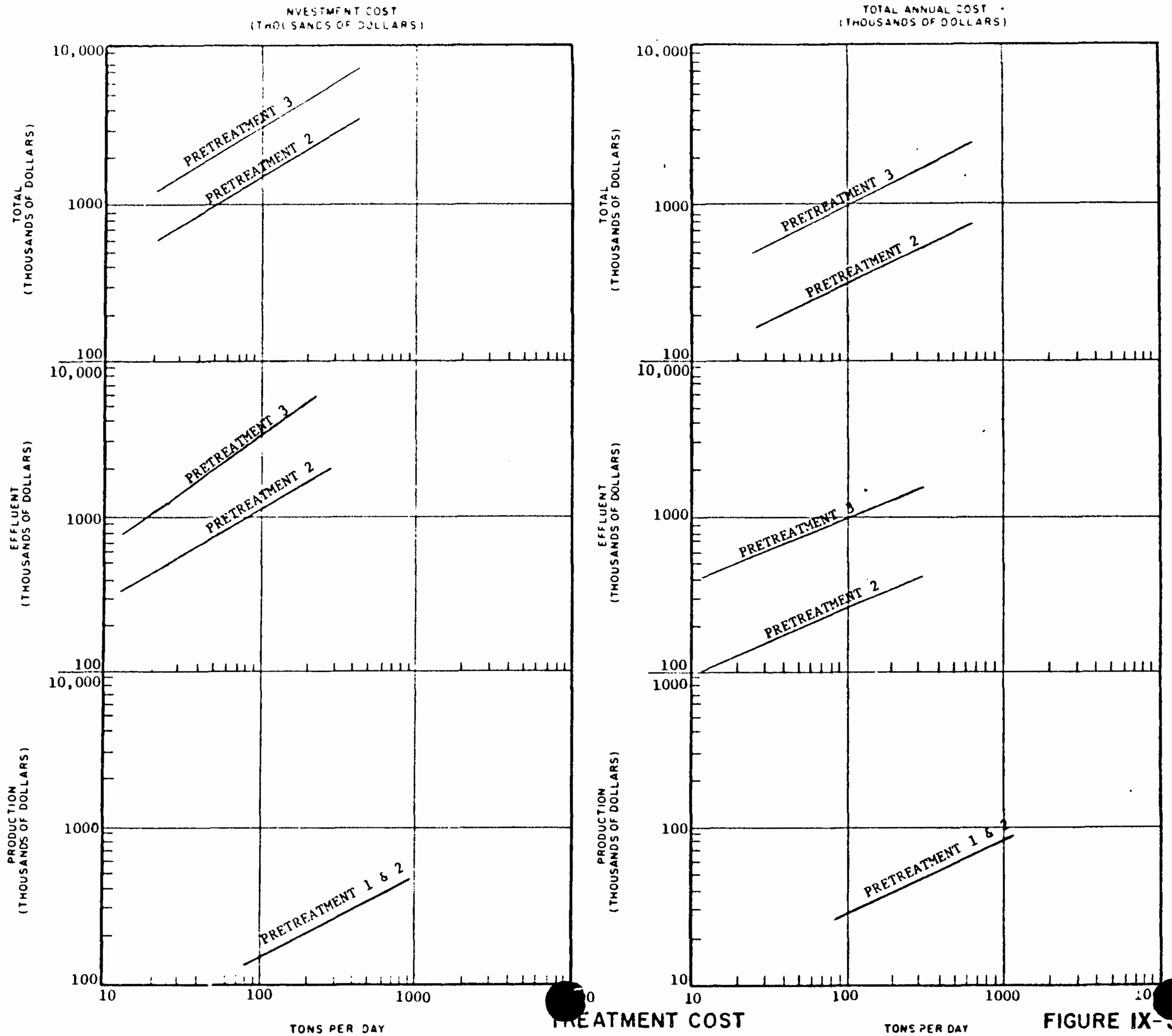
204



TREATMENT COST

FIGURE IX-34

205 NON-INTEGRATED - FILTER AND NON-WOVEN



TREATMENT COST

FIGURE IX-35

211 NON-INTEGRATED PAPERBOARD

CHEMICAL CLARIFICATION

CAPITAL COST ($ 1000)

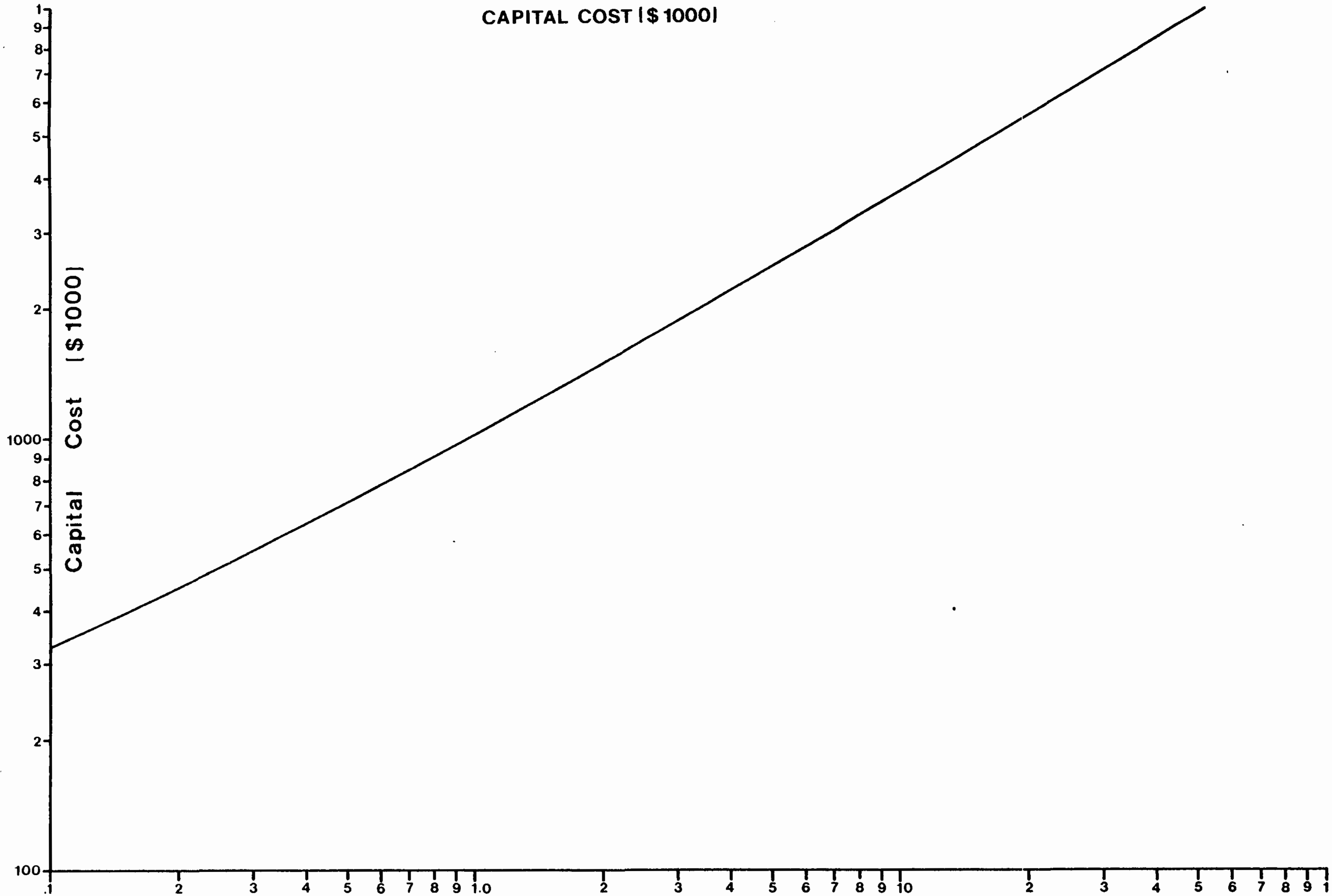
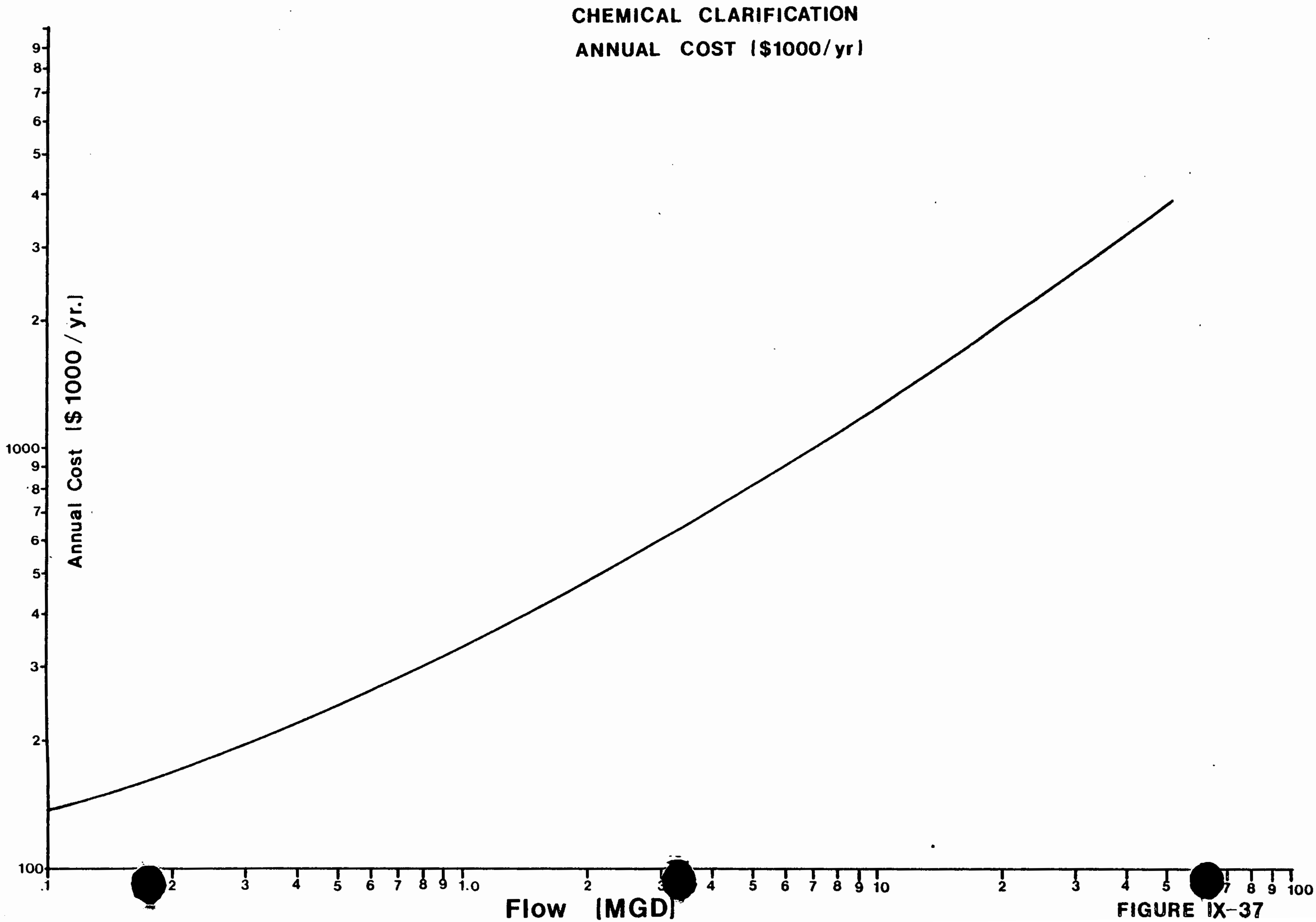


FIGURE IX-36



CHEMICAL CLARIFICATION
ANNUAL COST ($1000/yr)
Annual Cost ($1000/yr.)
Flow (MGD)

FIGURE IX-37

CARBON ADSORPTION PLUS CHEMICAL CLARIFICATION

CAPITAL COST ($1000)

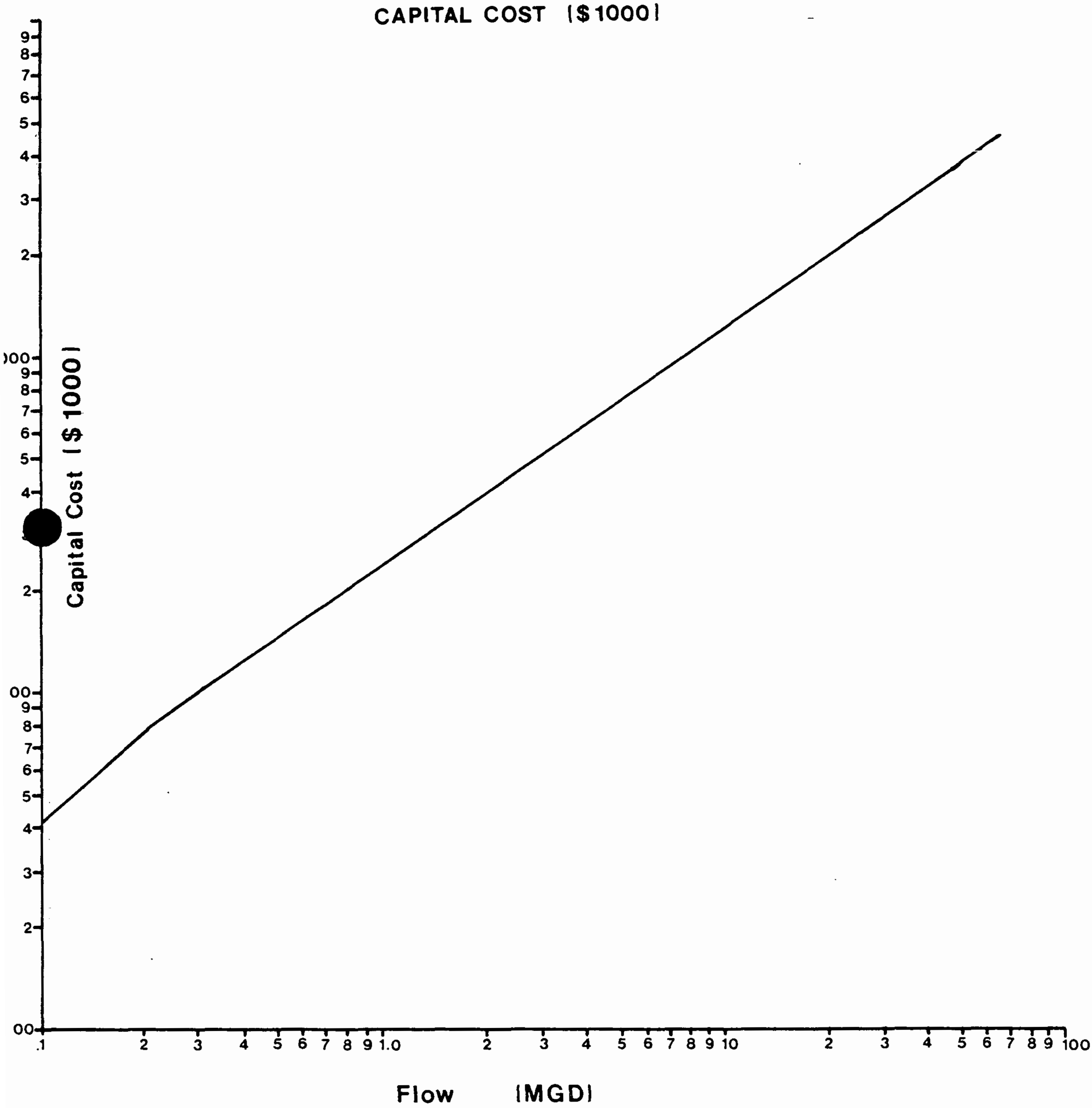
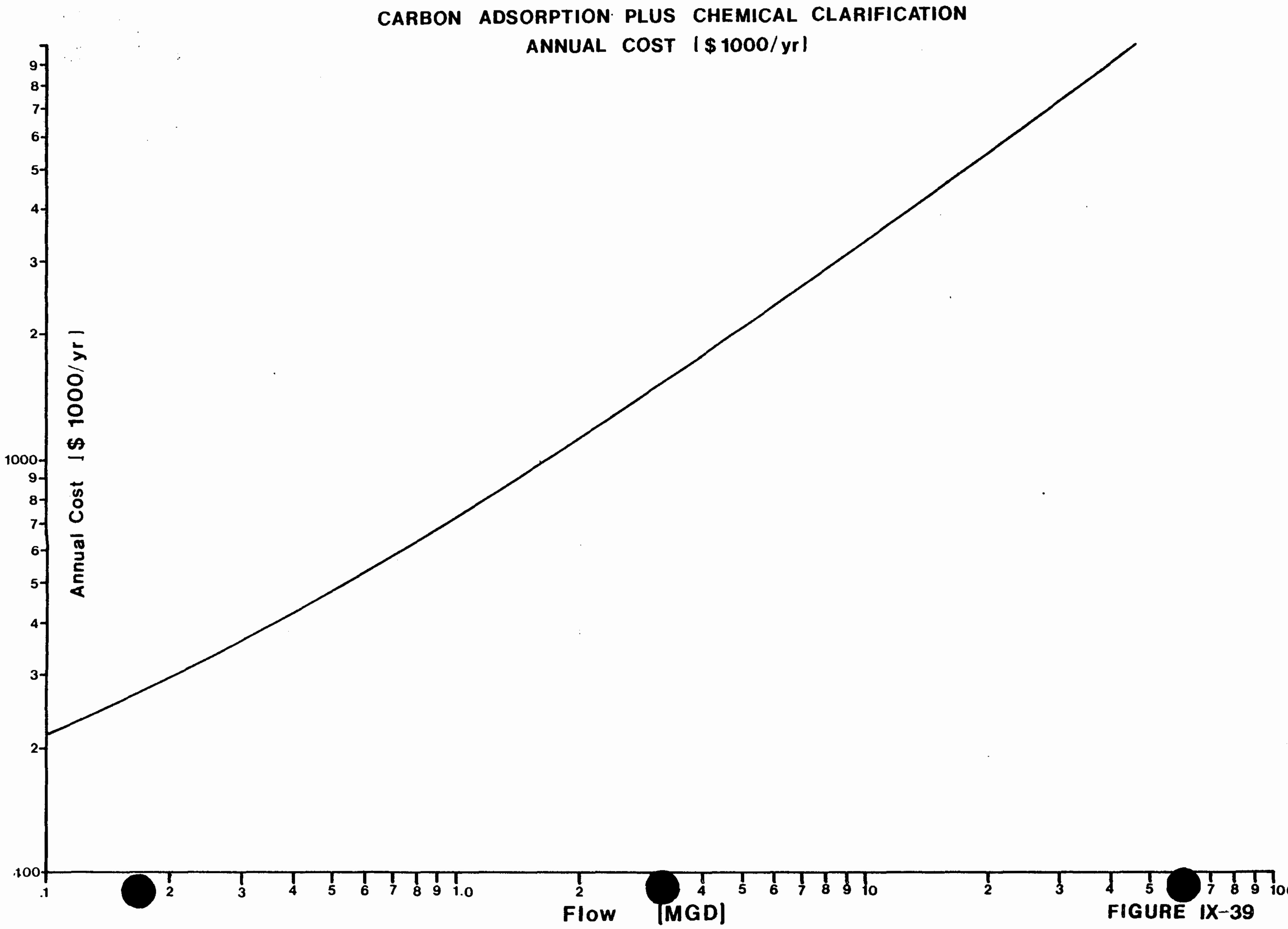


FIGURE IX-38



CARBON ADSORPTION PLUS CHEMICAL CLARIFICATION
ANNUAL COST ($1000/yr)
Annual Cost ($ 1000/yr)
1000
100
Flow [MGD]

FIGURE IX-39

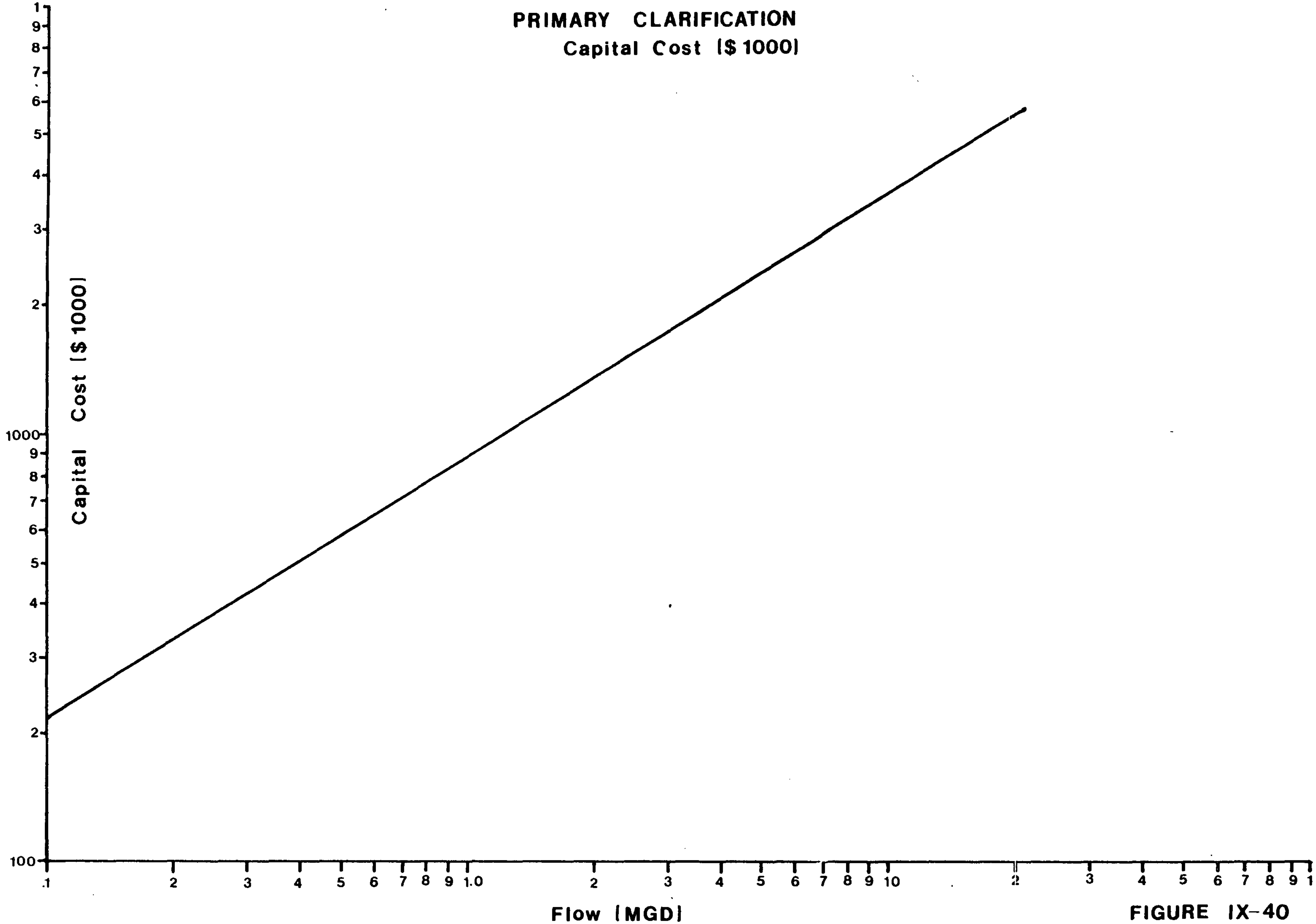

PRIMARY CLARIFICATION
Capital Cost ($1000)
Capital Cost ($1000)
Flow (MGD)
100
1000
.1
1.0
10

FIGURE IX-40

PRIMARY CLARIFICATION
ANNUAL COST ($1000)

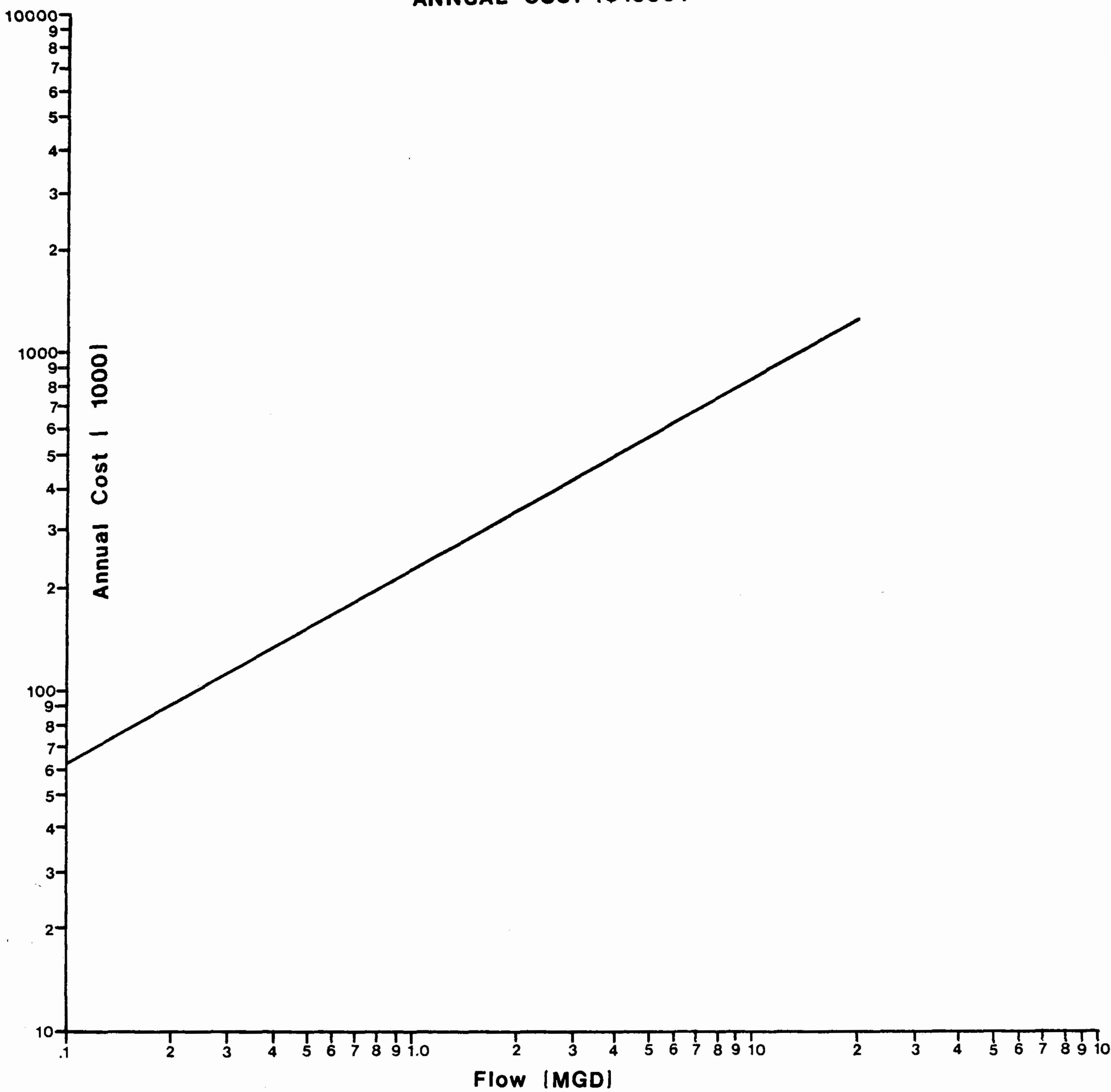


FIGURE IX-41

SAMPLE CALCULATION
COST ESTIMATE FOR MILL IN THE
INTEGRATED-MISCELLANEOUS GROUPING

Assume a 1,000-tpd mill producing 40% Alkaline-Market pulp (Subcategory 012) and 60% Alkaline-Fine paper (subcategory 014). Therefore, 400 tpd of Alkaline-Market pulp is produced along with 600 tpd of Alkaline-Fine paper.

From Figure IX-3, Level 2 production process control costs are as follows for a 400-tpd Subcategory 012 mill:

Capital Cost = $2,000,000
Annual Cost = 410,000

From Figure IX-5, Level 2 production process control costs are as follows for a 600-tpd Subcategory 014 mill:

Capital Cost = $5,500,000
Annual Cost = 900,000

Therefore, total capital cost = $7,500,000, and total annual cost = $1,310,000

External treatment costs for miscellaneous mills are obtained by computing the flow corresponding to each portion of production. From Table IX-14:

Flow (Subcategory 012) = 400 tpd x 29.5 kgal/t = 11,800 kgal/day
= 11.8 mgd
Flow (Subcategory 014) = 600 tpd x 17.3 kgal/t = 10,400 kgal/day
= 10.4 mgd

Therefore, total flow for this miscellaneous mill = 22.2 mgd.

Level 3 external treatment consists of chemical clarification and ancillary processes. Capital cost is estimated from Figure IX-36; annual cost is estimated from Figure IX-37, as follows:

Capital Cost = $6,100,000
Annual Cost = 2,250,000

The total capital and total annual cost for Level 2 production controls plus chemically assisted clarification may be determined by adding their respective costs as follows:

Total Capital Cost (Level 2 plus 3) = $7,500,000 + $6,100,000 = $13,600,000
Total Annual Cost (Level 2 plus 3) = 1,310,000 + 2,250,000 = 3,560,000

TABLE IX-14

SUMMARY OF LEVEL 1 AND 2 PURE MILL WASTEWATER FLOWS

	Production Process	Level 1 Flow kl/kkg	Level 1 Flow (kgal/t)	Level 2 Flow kl/kkg	Level 2 Flow (kgal/t)
011	Alkaline-Dissolving	207.2	(49.7)	198.5	(47.6)
012	Alkaline-Market	137.6	(33.0)	123.0	(29.5)
013	Alkaline-BCT	125.9	(30.2)	102.2	(24.5)
014	Alkaline-Fine	88.4	(21.2)	72.1	(17.3)
015	Alkaline-Unbleached				
	. Linerboard	36.3	(8.7)	35.5	(8.5)
	. BAG	54.6	(13.1)	53.4	(12.8)
016	Semi-Chemical (100%)	43.4	(10.4)	32.1	(7.7)
017	Unbleached-Alkaline and Semi-Chemical	35.4	(8.5)	35.4	(8.5)
019	Alkaline-News	67.9	(16.3)	57.5	(13.8)
021	Sulfite-Dissolving	204.7	(49.1)	183.9	(44.1)
022	Sulfite-Papergrade	120.5	(28.9)	117.2	(28.1)
	*Chemi-Mechanical Pulp			67.5	(16.2)
032	Thermo-Mechanical Pulp	42.5	(10.2)	42.5	(10.2)
033	Groundwood-CMN (100%)	83.0	(19.9)	83.0	(19.9)
034	Groundwood-Fine (100%)	88.0	(21.1)	71.9	(17.0)
101	Deink-Fine and Tissue				
	. Tissue	58.4	(14.0)	55.5	(13.3)
	. Fine	77.2	(18.5)	73.4	(17.6)
102	Deink-Newsprint	57.5	(13.8)	55.5	(13.3)
111	Wastepaper-Tissue . 100% Industrial	48.4	(11.6)	48.4	(11.6)
112	Wastepaper-Board				
	. Board	8.3	(2.0)	8.3	(2.0)
	. Linerboard	15.0	(3.6)	15.0	(3.6)
	. Corrugated	2.1	(0.5)	2.1	(0.5)
	. Chip and Filler	5.4	(1.3)	5.4	(1.3)
	. Folding Box	8.8	(2.1)	8.8	(2.1)
	. Set-up Box	10.8	(2.6)	10.8	(2.6)
	. Gypsum Board	6.3	(1.5)	6.3	(1.5)
113	Wastepaper-Molded Products	41.3	(9.9)	41.3	(9.9)
114	Wastepaper-Construction Products				
	. Wastepaper	6.7	(1.6)	6.7	(1.6)
	. 50% Wastepaper/50% TMP	5.8	(1.4)	5.8	(1.4)
201	Nonintegrated-Fine	34.3	(8.2)	32.6	(7.8)
202	Nonintegrated-Tissue	36.3	(8.7)	34.2	(8.2)
204	Nonintegrated-Lightweight				
	. Lightweight	213.5	(51.2)	209.3	(50.2)
	. Electrical	326.1	(78.2)	319.8	(76.7)
205	Nonintegrated Filter and Nonwoven	125.9	(30.2)	125.9	(30.2)
211	Nonintegrated Paperboard				
	. Board	62.6	(15.0)	62.6	(15.0)
	. Electrical	151.0	(36.2)	151.0	(36.2)

*Miscellaneous Grouping - not a subcategory.

FACTORS AFFECTING COSTS

Each mill in a subcategory can be expected to differ in certain respects from the representative model mill. These differences will alter the costs for achieving the various applicable levels of treatment. Among the factors affecting costs are location, climate, mill age, savings, retrofit requirements, site limitations, raw wastewater quality, and production capacity. In addition at certain mills may combination of production processes may be employed.

Location

Due to differences in construction, labor and energy costs, similar mills in different locations may incur different costs for similar controls. To estimate the magnitude of these effects, Table IX-15 shows average regional factors that may be applied to the model mill costs. Table IX-16 presents the regional distribution of mills by subcategory.

TABLE IX-15

REGIONAL COST ADJUSTMENT FACTORS

Region	Capital Cost(205)	O&M Cost(198)	Energy Cost(200)
Northeast	1.03	0.92	1.22
North Central	1.01	1.11	1.05
South	0.90	0.78	1.04
Plains/Mountain	0.96	0.99	0.90
West	1.09	1.18	0.78

Climate

Biological treatment systems constructed in cold climates often require longer detention times due to bio-kinetic considerations (in Section VII) that result in higher capital and operating costs. The costs presented are representative of moderate climate design criteria.

Climate can also affect the design of other unit processes. For example, warm climate mills may be operated with open pit pumps, above ground piping, and exposed process equipment, while at colder climate mills such designs cannot be utilized. Model mill cost estimates reflect design based on cold climates. At those mills in warm climates, lower costs may be realized than those presented in the cost estimates.

TABLE IX-16

DISTRIBUTION OF MILLS BY REGION AND SUBCATEGORY

Subcategory	Region: Northeast	North-Central	Southeast	Plains & Mtn.	West	Total
011 Alkaline-Dissolving			3			3
012 Alkaline-Market	1	2	2	1	3	9
013 Alkaline-BCT	-	1	4	2	1	8
014 Alkaline-Fine	8	4	2	3	1	18
015 Alkaline-Unbleached	-	2	17	7	3	29
016 Semi-Chemical	1	9	6	2	1	19
017 Alkaline-Unbleached and Semi-Chemical	-	-	4	3	3	10
019 Alkaline-Newsprint	-	-	2	1	-	3
021 Sulfite-Dissolving	2	-	1	-	5	8
022 Sulfite-Papergrade	-	10	-	-	6	16
*Chemi-Mechanical Pulp	-	1	-	-	1	2
032 Thermo-Mechanical Pulp	1	-	-	-	1	2
033 Groundwood-CMN	4	-	1	-	1	6
034 Groundwood-Fine	2	6	-	-	-	8
101 Deink-Fine and Tissue	7	8	-	1	1	17
102 Deink-Newsprint	1	1	-	-	1	3
111 Wastepaper-Tissue	13	4	3	-	2	22
112 Wastepaper-Board	58	49	19	8	13	147
113 Wastepaper-Molded Products	2	6	2	1	4	15
114 Wastepaper-Construction Products	8	16	12	15	7	58
201 Nonintegrated-Fine	22	15	-	-	2	39
202 Nonintegrated-Tissue	12	6	4	-	4	26
204 Nonintegrated-Lightweight	12	5	1	-	-	18
205 Nonintegrated-Filter and Nonwoven	7	3	1	2	1	14
211 Nonintegrated-Paperboard	8	3	-	1	-	12
Totals	169	151	84	47	61	512

*Miscellaneous grouping - not a subcategory.

Production Capacity

Economies of scale are realized when facilities are installed and vary depending on the item under consideration. In order to estimate the net effects of production capacity, each level of treatment has been evaluated over a representative range of mill sizes for each subcategory.

Age

Mill age can have an impact on the cost of implementing various production process controls. This factor was considered in the development of model mill costs by accounting for relative difficulty in installing and replacing process equipment and effluent sewers.

The chronological age of a mill, however, is not always a good measure of the relative ease with which production process controls may be implemented. This results from the fact that older mills often have undergone extensive rebuilding or expansion, often resulting in better implementation conditions.

Savings

Material and Energy Savings. The production process controls discussed herein can result in more efficient operation, with substantial savings of material and energy. Tables IX-11, 12, and 13 presented the net costs for operation, maintenance and energy. Table IX-17 compares operating and maintenance costs to savings realized after implementation of Level 1 and 2 production process controls.

Other Savings. The savings in materials and energy which may result from implementation of production process controls are supplemented by other possible savings not accounted for in Table IX-17. Such additional savings include the benefits which can result from improved recovery systems and the manufacture of byproducts such as black liquor soap, turpentine, solvents, glues and nutrients. The recycle of effluent streams may also recycle heat which may represent a possible savings at some mills, particularly in colder climates. Such savings may not be common to all mills in a subcategory, but may be considerations at selected mills depending on location, production processes and other factors.

Retrofit Requirements

The model mill costs presented assume that production process and effluent treatment controls have been installed and are properly operated so as to attain BPT discharge limits. For those cases where mills are not currently meeting existing BPT discharge limitations, an additional cost for retrofitting existing treatment may be incurred for the mill to attain BATEA discharge limits.

TABLE IX-17

GROSS O & M AND ENERGY COSTS AND SAVINGS FOR
PRODUCTION PROCESS CONTROLS ($1000/yr)

Subcategory		Production (t/d)	Level	Gross O&M Cost	Gross O&M Savings	Gross Energy Cost	Gross Energy Savings
011	Alkaline-Dissolving	1,000	1	209.1	524.3	353.1	51.0
			2	262.7	524.3	373.7	80.6
012	Alkaline-Market	600	1	78.2	224.5	135.3	9.2
			2	107.2	224.5	178.3	46.0
013	Alkaline-BCT	800	1	121.8	424.9	220.0	7.1
			2	144.0	424.9	264.6	72.4
014	Alkaline-Fine	800	1	106.5	353.5	182.1	42.0
			2	172.0	387.7	232.0	69.7
015	Alkaline-Unbleached	1,000	1	60.0	323.1	151.9	70.7
			2	105.0	330.8	180.5	70.7
016	Semi-Chemical	425	1	45.6	43.8	65.5	20.6
			2	61.2	70.6	141.3	72.6
017	Alkaline-Unbleached & Semi-Chemical	1,500	1	128.5	454.8	273.5	91.4
			2	146.2	454.8	276.2	91.4
019	Alkaline-Newsprint	1,400	1	153.9	513.2	204.2	157.7
			2	202.8	532.9	259.5	202.9

TABLE IX-17 (Continued)

Subcategory	Production (t/d)	Level	Gross O&M Cost	Gross O&M Savings	Gross Energy Cost	Gross Energy Savings
021 Sulfite-Dissolving	600	1	903.5	656.5	808.7	26.0
		2	962.8	656.5	850.2	138.0
022 Sulfite-Papergrade	450	1	165.4	571.5	166.3	176.9
		2	170.4	571.5	171.1	176.9
032 Thermo-Mechanical Pulp	350	1	22.9	80.4	24.4	54.0
		2	22.9	80.4	24.4	54.0
033 Groundwood-CMN	600	1	72.6	182.6	44.3	206.0
		2	73.5	182.6	46.5	206.0
034 Groundwood-Fine	500	1	97.1	189.4	21.2	37.1
		2	109.9	210.5	40.3	63.4
101 Deink-Fine & Tissue	180	1	42.8	80.7	23.3	29.8
		2	45.9	80.7	26.2	29.8
102 Deink-Newsprint	400	1	62.6	88.3	42.0	96.0
		2	63.3	88.3	44.8	96.0
111 Wastepaper-Tissue	45	1	38.8	4.9	8.4	11.0
		2	38.8	4.9	8.4	11.0
112 Wastepaper-Board	160	1	53.9	11.1	18.0	29.8
		2	53.9	11.1	18.0	29.8
113 Wastepaper-Molded Products	50	1	18.8	0	11.2	8.4
		2	18.8	0	11.2	8.4
114 Wastepaper-Construction Products	100	1	43.2	18.6	13.8	5.7
		2	43.2	18.6	13.8	5.7

TABLE IX-17 (Continued)

Subcategory	Production (t/d)	Level	Gross O&M Cost	Gross O&M Savings	Gross Energy Cost	Gross Energy Savings
201 Nonintegrated-Fine	215	1	24.7	64.6	62.8	71.2
		2	27.1	64.6	69.6	71.2
202 Nonintegrated-Tissue	180	1	17.6	79.0	38.8	30.7
		2	20.4	79.0	45.5	30.7
204 Nonintegrated-Lightweight	60	1	28.7	10.7	21.5	22.8
		2	31.2	11.6	23.4	24.8
205 Nonintegrated-Filter & Nonwoven	20	1	14.6	2.9	5.5	9.0
		2	14.6	2.9	5.5	9.0
211 Nonintegrated-Paperboard	40	1	10.7	5.1	4.4	3.0
		2	10.7	5.1	4.4	3.0

The estimated cost for the industry to attain BPT limits has previously been addressed.(2, 37) Therefore, retrofitting costs to attain BPT discharge limits are not included in the cost analysis for this study.

Site Limitations

At certain mills site considerations such as insufficient land availability and/or poor soil conditions may result in additional costs to the mill to attain effluent discharge limitations guidelines. A summary of responses to questions concerning availability of expansion in the data request program has been evaluated. From this data, it was determined that about one third of the reporting mills feel they have no available land on-site for expansion. However, it should be noted that no indication concerning the amount of land or type of expansion was indicated in the question. Less than 10 percent of the mills responding believed expansion land could be purchased.

The identified effluent treatment technologies of chemically assisted clarification and carbon adsorption are not land-intensive. The largest land requirement anticipated for chemical clarification is 3.0 acres, and that for carbon adsorption is 0.5 acres. Therefore, many mills reporting no available land for expansion may have sufficient area for these technologies which are not land-intensive.

Indirect discharge Level 3 treatment incorporates biological treatment for some subcategories. Where land availability precludes the use of aerated stabilization, the less land-intensive activated sludge process may be required. Model mill cost estimates for each of these alternatives has been presented, in cases where biological treatment is proposed as an alternative treatment.

In some cases the land available for expansion may require special construction and/or site development procedures due to existing soil conditions. Mill responses to whether special construction procedures would be required revealed that in about 25 percent of the cases, special considerations are known to be required.

For mills with insufficient land for proposed technologies and/or poor soil conditions, additional capital investment may be required to attain the identified levels of control. Without site-specific information concerning land availability and soil conditions, however, it is difficult to further evaluate possible additional costs. Such site-specific information is not currently available.

Raw Wastewater Characteristics

The flow and pollutant loading for an individual mill may vary from those of the model mill. These differences could affect the costs of effluent treatment. For example, carbon adsorption costs are highly dependent on flow for a given system design. However, a higher flow with lower pollutant loadings could result in no net change in cost to attain a given effluent quality due to different design requirements.

While variation in raw waste characteristics may occur, it is not anticipated that their net effect on costs will exceed the associated cost confidence interval for model mills.

ENERGY REQUIREMENTS

Introduction

Implementation of production process controls and effluent treatment technologies discussed in Sections VI and VII would affect existing energy demand. The estimated energy effects for the various technology options are presented in this section. In some cases, production process controls result in a net energy saving. It is possible that, even where a net energy savings is achieved in terms of total BTU's, the net energy cost could increase, because of the relative amounts of fuels and electricity used, and their respective prices.

The total model mill energy usage prior to implementation of the various technology options was determined from data in the American Paper Institute (API) monthly energy reports, and average power and fuel usage information from the data request program. An energy balance was developed for each model mill including spent liquor and hogged fuel where applicable.

Table IX-18 summarizes the model mill energy usage after installation of Levels 1 and 2 production controls. The table also provides an estimate of the percent change in energy (BTU) resulting from technology implementation. In all subcategories except Sulfite-Dissolving, a slight reduction in total energy usage results from the implementation of Level 1 and 2 production controls.

Implementation of effluent treatment processes such as wastewater pumping, chemically assisted clarification and solids dewatering would cause additional power demands. Carbon adsorption requires fuel for the regeneration process, as well as power for wastewater pumping and other unit operations.

The energy requirements for effluent treatment options including the energy requirements for ancillary processes such as pumping and sludge dewatering, are shown in Table IX-19.

OTHER CONSIDERATIONS

Benefits other than improved water quality can result from production process technology modifications. As noted earlier, these benefits include savings resulting from: 1) improved raw material usage; 2) better operating efficiency; and 3) improved byproduct recovery. The economic savings associated with these benefits have been estimated and were presented previously in Table IX-17.

There are other non-water-quality concerns to be considered in implementing effluent treatment and control technology, including: air pollution, noise,

TABLE IX-18

CURRENT MILL ENERGY USE AND EFFECT OF LEVEL 1 PLUS 2 PRODUCTION CONTROLS

Subcategory	Current Energy Used (Million BTU/ton) Fuel	(Purch.)	Electric	(Purch.)	Total(a)	Energy Used By Level 1 Plus 2 Production Control Million BTU/ton) Fuel	Electric	Total	Percent Of Purchased Energy Change Because Of Production Controls
011 Alkaline-Dissolving	42.2	(15.0)	2.83	(0.48)	42.7	0.22*	0.10	0.12*	0.8*
012 Alkaline-Market	31.5	(12.4)	2.55	(0.77)	32.3	0.21*	0.09	0.12*	0.9*
013 Alkaline-BCT	33.8	(14.6)	3.26	(1.34)	35.1	0.24*	0.10	0.14*	0.9*
014 Alkaline-Fine	31.6	(14.9)	3.53	(1.45)	33.0	0.25*	0.09	0.16*	1.0*
015 Alkaline-Unbleached	26.4	(11.7)	2.01	(0.70)	27.1	0.21*	0.05	0.16*	1.3*
016 Semi-Chemical	17.3	(11.6)	2.35	(2.35)	19.6	0.29*	0.05	0.24*	1.7*
017 Alkaline-Unbleached & Semi-Chemical	25.2	(13.0)	2.21	(0.66)	25.9	0.16*	0.05	0.11*	0.8*
019 Alkaline-Newsprint	27.1	(18.1)	4.66	(2.31)	29.4	0.40*	0.05	0.35*	1.7*
021 Sulfite-Dissolving	38.3	(12.8)	2.55	(1.33)	39.6	0.95*	0.11	1.06	7.5
022 Sulfite-Papergrade	28.5	(14.7)	3.20	(2.65)	31.1	0.70*	0.11	0.59*	3.4*
032 Thermo-Mechanical Pulp	12.4	(12.4)	5.44	(3.54)	15.9	0.35*	0.02	0.33*	2.1*
033 Groundwood-CMN	11.5	(10.3)	6.12	(5.10)	16.6	0.65*	0.02	0.63*	4.1*
034 Groundwood-Fine	13.2	(12.2)	5.44	(3.70)	16.9	0.45*	0.02	0.43*	2.7*
101 Deink-Fine & Tissue	17.8	(17.6)	1.70	(1.39)	19.2	0.63*	0.04	0.59*	3.1*
102 Deink-Newsprint	13.5	(13.5)	1.02	(0.51)	14.0	0.37*	0.03	0.34*	2.4*
111 Wastepaper-Tissue	18.0	(18.0)	2.72	(2.72)	20.7	0.44*	0.07	0.37*	1.8*
112 Wastepaper-Board	12.2	(12.2)	1.94	(1.80)	14.0	0.15*	0.04	0.11*	0.8*
113 Wastepaper-Molded Products	18.4	(18.4)	2.72	(2.72)	21.1	0.28*	0.07	0.21*	1.0*
114 Wastepaper-Construction Products	11.7	(11.7)	1.36	(1.36)	13.1	0.09*	0.04	0.05*	0.4*
201 Nonintegrated-Fine	16.7	(16.4)	1.94	(1.32)	18.0	0.86*	0.10	0.76*	4.3*
202 Nonintegrated-Tissue	15.2	(15.2)	3.37	(2.35)	17.5	0.43*	0.08	0.35*	2.0*
204 Nonintegrated-Lightweight	33.8	(32.8)	3.88	(0.20)	34.0	1.02*	0.10	0.92*	2.8*
205 Nonintegrated-Filter & Nonwoven	21.5	(21.5)	3.55	(3.55)	25.0	0.93*	0.10	0.83*	3.3*
211 Nonintegrated-Paperboard	18.6	(18.6)	3.89	(3.89)	22.5	0.18*	0.04	0.14*	0.6*

*Indicates net reduction in purchased energy usage.

(a) Total energy use reflects total fuel plus purchased electricity.

TABLE IX-19

ENERGY REQUIREMENTS FOR EFFLUENT TREATMENT ALTERNATIVES

Subcategory	Energy (Thousand BTU/Ton) By Technology Option: Chemical(a) Clarification	Carbon(a) Adsorption	Primary(b) Clarification	Act. Sludge(c) Plus Chemical Clarification	Aerated(c) Stabilization Plus Chemical Clarification
011 Alkaline-Dissolving	51.9	671	--	219	348
012 Alkaline-Market	47.8	490	--	191	277
013 Alkaline-BCT	37.2	380	--	236	143
014 Alkaline-Fine	31.4	277	31	133	167
015 Alkaline-Unbleached	17.4	134	--	75	140
016 Semi-Chemical	20.8	81	--	109	147
017 Alkaline-Unbleached & Semi-Chemical	15.0	131	--	85	120
019 Alkaline-Newsprint	21.8	213	--	109	137
021 Sulfite-Dissolving	60.1	676	--	492	734
022 Sulfite-Papergrade	40.6	320	--	198	143
032 Thermo-Mechanical Pulp	32.1	147	--	277	352
033 Groundwood-CMN	28.7	203	--	106	133
034 Groundwood-Fine	28.3	156	--	160	195
101 Deink-Fine & Tissue	65.9	253	89	72	78
102 Deink-Newsprint	--	--	58	106	133
111 Wastepaper-Tissue	97.7	317	116	--	--
112 Wastepaper-Board	21.8	45	17	--	--
113 Wastepaper-Molded	78.9	284	51	--	--
114 Wastepaper-Construction	11.7	39	10	--	--
201 Nonintegrated-Fine	35.8	128	48	--	--
202 Nonintegrated-Tissue	115.0	406	55	--	--
204 Nonintegrated-Lightweight	158.0	850	147	--	--
205 Nonintegrated-Filter & Nonwoven	245	1130	188	--	--
211 Nonintegrated-Paperboard	158	679	191	--	--

(a)Where considered as an option for direct dischargers.
(b)Where considered as an option for indirect dischargers.
(c)Where considered as an option for new point sources.

and solid waste disposal. These aspects of implementation are discussed in the following paragraphs.

Air Pollution

Most of the proposed Level 1 and 2 internal control measures would have little direct impact upon air emissions. Many items reduce energy use per ton by promoting extensive water reuse and stock savings. However, when additional steam is required, as for evaporation of bleach plant effluent (Sulfite-Dissolving subcategory) then potentially more sulfur dioxide generation could occur. Such an increase would be directly proportional to the increased boiler firing rate and the sulfur content of the fuel used.

Production process controls which help retain more spent liquor in the liquor recovery cycle include: improved brownstock washing, decker filtrate reuse, use of relief and blow condensates, neutralization of spent sulfite liquor before evaporation, and more complete use of evaporator condensates. These controls tend to retain more sulfur containing compounds in the liquor system. As sulfur levels increase, along with increased total liquor solids to recovery, potential emissions will increase. With modern design recovery systems of adequate capacity, emission levels of mercaptans, hydrogen sulfide, and other compounds to the atmosphere would not increase beyond allowable limits. If, however, the mill is operating an overloaded recovery furnace, or is at peak allowable load, a small incremental addition to the emission level could occur. Generally, the normal variations in firing rates, sulfidity, and liquor solids overshadow the effects resulting from production process control.

Noise Potential

There is no readily identifiable potential for substantially increased noise associated with any of the proposed production control technology options. Existing effluent treatment processes are not currently a significant source of noise. The implementation of the various effluent technology options considered is not anticipated to result in a significant increase in noise.

Solid Wastes. Solid wastes generated by the pulp, paper and paperboard industry originate from wastewater treatment, wood processing, power generation and personnel activity.

The total solid waste generated by the pulp and paper industry in 1974 was 560-630 pounds per ton of production.(208) The largest single source of waste is wood processing, which accounts for about half the total. This waste consists primarily of bark with some wood and dirt included. Much of this waste is burned in a hogged fuel boiler for power generation. There are apparently no statistics concerning the amount of wood processing waste currently being used for power generation.

In a 1974 study, pulp, paper, and paperboard industry personnel generated about 0.227 kg (0.5 lb) of refuse per employee per shift, resulting in a total annual industry generation rate of 16,546 metric tons (16,546 tons).(37)

Wastewater treatment facilities produce both primary and biological sludges which are usually dewatered prior to disposal. The amount of wastewater treatment facility sludge generated depends on a number of conditions including: 1) raw waste characteristics; 2) the existence and efficiency of the primary clarifier; 3) the type of biological treatment system employed; and 4) the efficiency of biological solids removal from the wastewater. The amount of wastewater treatment facility sludge at a given mill is anticipated to far exceed the amount of refuse generated by mill personnel.

Installation of chemically assisted clarification would have an impact on the amount of wastewater sludge generated. To assess this impact, the amount of primary and secondary sludge generated at the model mill in each subcategory has been estimated. The amount of additional sludge anticipated from chemical clarification has also been estimated. These quantity estimates were based on sludge production criteria outlined in Section VII.

This analysis yielded increases of from 13 to 63 percent over current sludge production on a dry solids basis due to chemically assisted clarification. A summary of anticipated sludge productions is shown in Table IX-20.

This additional sludge production would have an impact on sludge disposal systems and practices. For example, landfill sites would be more rapidly filled.

Implementation of carbon adsorption as a polishing treatment is not anticipated to affect the sludge production rates of primary, biological and/or chemically assisted clarification technologies.

The use of primary and/or biological treatment for indirect dischargers is not anticipated to greatly alter current sludge production. Rather, less sludge will be generated at the POTW and a roughly equivalent amount generated at the mill.

Available Solid Waste Disposal Technology. Acceptable techniques for solid waste disposal include: incineration, composting, pyrolysis-gasification and landfill.

Incineration is a preferred method for disposal of organic wastes with low moisture contents. For the pulp, paper and paperboard industry these include log sorting and mill yard wastes, but usually exclude sludge. No mills which responded to the data request program indicated that they were incinerating wastewater sludges.

Composting is an emerging technology that theoretically could be applied to pulp, paper and paperboard mill wastewater treatment sludges. By this method, sludge is converted to inert organic material which may be used as a soil conditioner. Pyrolysis-gasification may play a future role in solid waste

TABLE IX-20

WASTEWATER SLUDGE PRODUCTION SUMMARY

ubcategory	Prod. (t/d)	Estimated Solids Production (1000 lb/day, dry basis): Primary Plus Biological(a)	Primary Only(b)	Chemical Clarification	Percent Increase For Chemical Clarification: Over Primary and Biological Solids	Over Primary Solids
11 Alkaline-Dissolving	1000	103	70	26	25	37
12 Alkaline-Market	600	38	24	10	26	42
13 Alkaline-BCT	800	63	44	12	19	27
14 Alkaline-Fine	800	72	56	12	17	21
15 Alkaline-Unbleached	1000	27	19	5	19	26
16 Semi-Chemical	425	15	10	2	13	13
17 Alkaline-Unbleached & Semi-Chemical	1500	59	41	9	15	15
19 Alkaline-Newsprint	1400	112	87	17	15	20
21 Sulfite-Dissolving	600	121	76	18	14	24
22 Sulfite-Papergrade	450	32	21	6	19	29
32 Thermo-Mechanical Pulp	350	20	15	3	15	20
33 Groundwood-CMN	600	36	28	6	17	21
34 Groundwood-Fine	500	36	27	5	14	19
01 Deink-Fine & Tissue	180	44	37	5	11	14
11 Wastepaper-Tissue	45	2	1.6	0.3	15	19
12 Wastepaper-Board	160	0.5	0.4	0.1	20	25
13 Wastepaper-Molded Products	50	0.4	0.3	0.1	25	33
14 Wastepaper-Construction Products	350	0.3	0.2	0.1	33	50
01 Nonintegrated-Fine	215	7.5	6.4	1.3	17	20
02 Nonintegrated-Tissue	180	5.5	4.6	1.0	18	22
04 Nonintegrated-Lightweight	60	2.3	1.9	1.2	52	63
05 Nonintegrated-Filter & Nonwoven	20	0.4	0.4	0.2	50	50
11 Nonintegrated-Paperboard	40	1.8	1.6	0.4	22	25

a) Applies to model mills employing biological treatment followed by a secondary clarifier.
b) Applies to model mills without a secondary clarifier.

disposal. Commercial scale units from which economics and operating experience may be obtained have yet to be demonstrated.

Land application of wastewater treatment plant sludges is a viable disposal option. Sludge is applied to a field which will be used for agricultural production. The organics, nutrients and bulk of the sludge serve to enhance crop production capacity. A prerequisite for the technique is to have adequate and suitable land in reasonable proximity to the plant.

Landfills are the most prevalent means of solid waste disposal in the industry. The primary environmental problem associated with landfill disposal of wastewater sludges is the potential for contaminating ground and surface waters. Ground and surface water contamination will occur when leachate generated by the sludge comes in contact with uncontaminated waters. Leachate will be formed if rainfall or runoff is permitted to contact the sludge or if sludge is placed directly into ground or surface water. Leachate is also formed as water drains from the sludge after it is placed on the land.

Environmental safety procedures and knowledge of proper landfilling practices have increased widely in recent years. The EPA has established proper operating and design criteria for several landfll techniques for sludges of from 20 to 30 percent solids.(201) These techniques include:

Area Fill Layer
Area Fill Mound
Diked Containment
Narrow Trench
Wide Trench
Co-Disposal With Soil
Co-Disposal With Refuse

The cited reference describes required site and operating conditions for each method. Information concerning existing landfill practices and site conditions is limited. It is not anticipated that significant environmental problems would result from the landfilling of the chemical sludge, as long as proper disposal techniques are employed.

Flocculant Recovery

The potential exists for recovery of chemical flocculants used for effluent clarification. However, at this time an economical recovery technology does not exist. Should technology become available to economically recover and reuse alum, chemically assisted clarification would become less expensive, and sludge disposal requirements would be reduced.

IMPLEMENTATION REQUIREMENTS

Availability of Equipment

The Federal Water Pollution Control Act and amendments have spurred the development of many new control techniques and associated equipment. As the 1980's approach, industries in the pollution control field are continuing to grow and anticipate a good market for their products. This anticipation allows manufacturers to maintain a production capability above what the market currently demands.

By using this additional capability, an increased demand for either production process control equipment (Levels 1 and 2) or wastewater treatment equipment (Level 3 and 4) could be handled without any major delays. This ability appears to have no geographical limitations, because of the size of the industry and its ability to use local independent contractors to fabricate certain pieces of equipment. Therefore, due to present manufacturing capabilities it is anticipated that required equipment could be readily produced.

Availability of Labor Force

Manpower necessary for implementation of technology alternatives could come from two sources: 1) mill personnel; and 2) outside contractors. On jobs which cannot be completed during a normal shut-down or which are considered too complex for mill personnel, an outside contractor would be hired to perform the necessary tasks.

A Bureau of Labor Statistics study concluded that the availability of construction laborers to perform the required work is sufficient.(209) This availability is based on two major factors. This first factor is the short training time which is required for construction labor (6 to 12 months). The second factor is the willingness of construction labor to relocate. Therefore, availability of labor is not anticipated to be a problem in implementing the technology alternatives.

Construction Cost Index

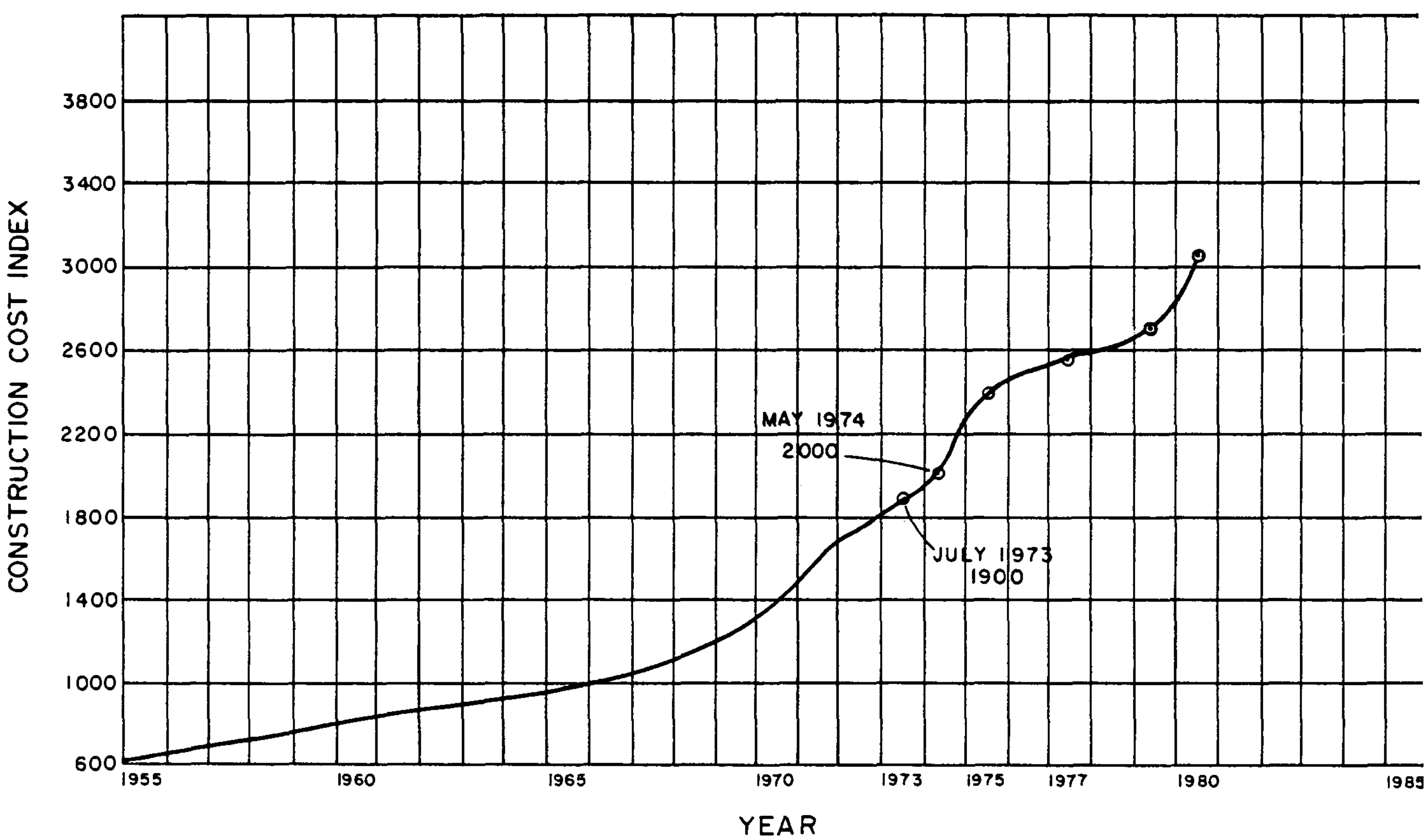
The Engineering News Record (ENR) Construction Cost Index is presented in Figure IX-42 for the period 1955 through 1977.

Time Required

It is difficult to estimate the time required to implement Level 1 and Level 2 technologies. Mill personnel will try to coordinate the project with a scheduled shut-down.

For Level 3 and 4, however, it was assumed that the work would be outside the mill and would require normal construction techniques and crews. The bar graphs presented in Figures IX-43 and 44 show the estimated time required to implement the Level 3 and 4 technologies, respectively.

FIGURE IX-42
ENGINEERING NEWS RECORD
CONSTRUCTION COST INDEX



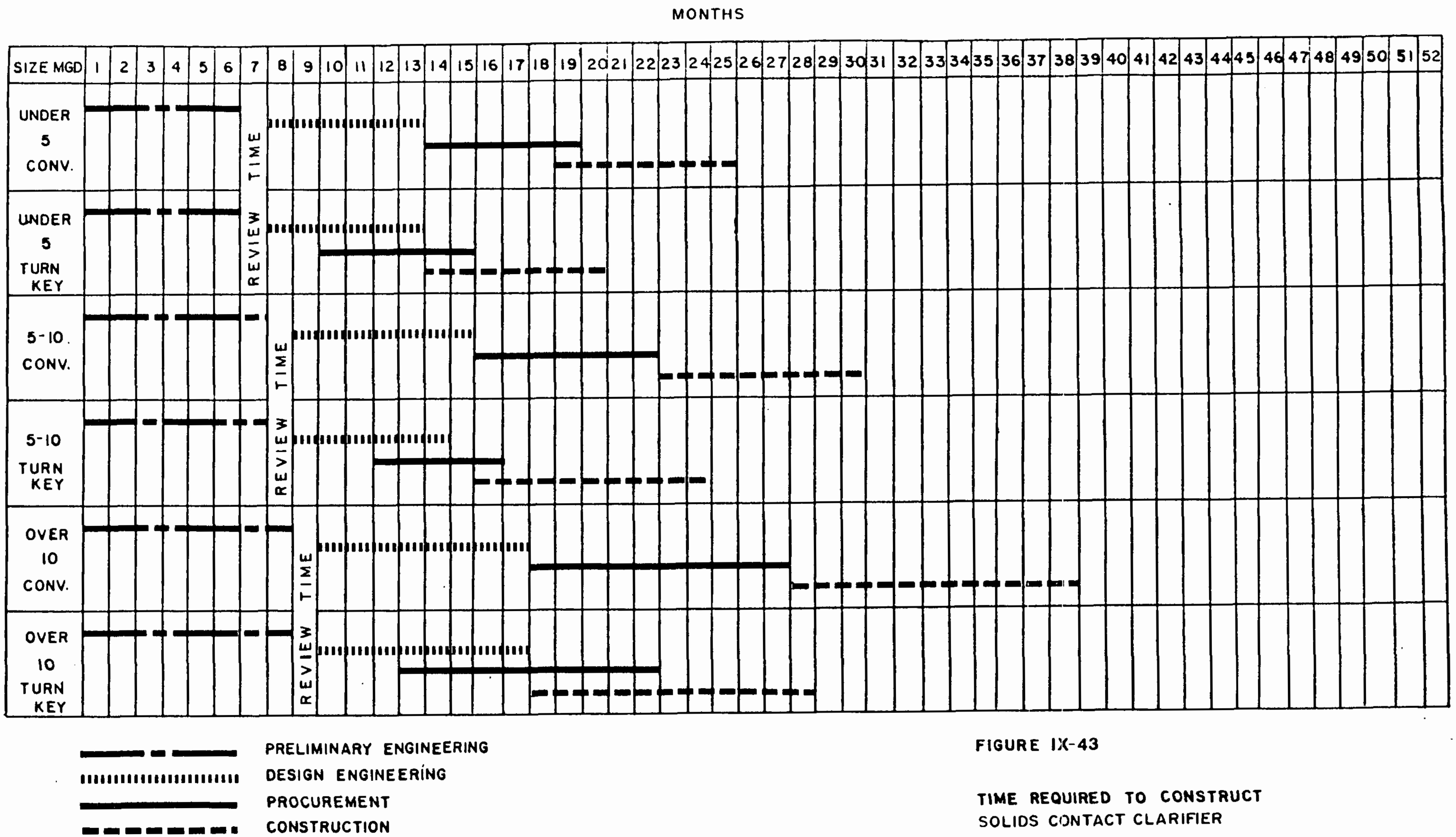


FIGURE IX-43

TIME REQUIRED TO CONSTRUCT
SOLIDS CONTACT CLARIFIER

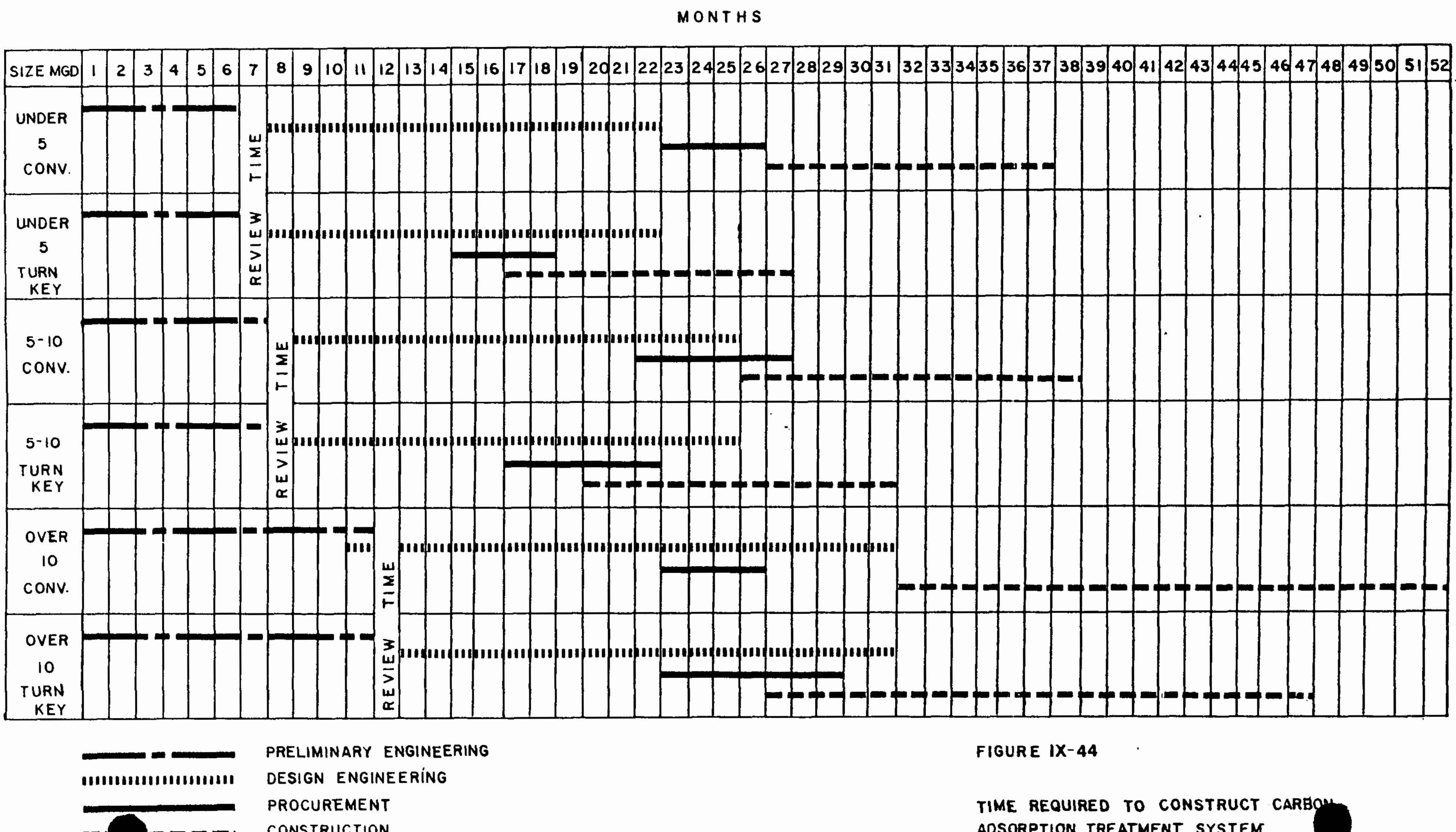


FIGURE IX-44

TIME REQUIRED TO CONSTRUCT CARBON ADSORPTION TREATMENT SYSTEM

APPENDIX A

SUMMARY OF VERIFICATION ANALYSIS RESULTS

TABLE A-1

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 012 - ALKALINE-MARKET

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		AERATION INF	5	1	0	0	<1
		FINAL EFF	4	2	0	0	<1
21	2,4,6-TRICHLOROPHENOL						
		AERATION INF	1	2	3	0	11
		FINAL EFF	0	6	0	0	5
23	CHLOROFORM						
		AERATION INF	1	0	0	5	1222
		FINAL EFF	0	3	3	0	12
31	2,4-DICHLOROPHENOL						
		AERATION INF	2	4	0	0	4
		FINAL EFF	2	4	0	0	4
38	ETHYLBENZENE						
		AERATION INF	5	0	1	0	14
44	METHYLENE CHLORIDE						
		RAW WATER	1	1	0	0	<1
		AERATION INF	3	3	0	0	<1
		FINAL EFF	4	2	0	0	<1
65	PHENOL						
		AERATION INF	1	0	5	0	15
		FINAL EFF	1	5	0	0	1
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	1	1	0	43
		AERATION INF	1	2	3	0	11
		FINAL EFF	0	2	4	0	32
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	1	5	0	0	3
		FINAL EFF	1	3	2	0	8

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
70	DIETHYL PHTHALATE						
		AERATION INF	4	2	0	0	<1
86	TOLUENE						
		AERATION INF	3	3	0	0	1
119	CHROMIUM-CR						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	4	2	0	12
		FINAL EFF	0	1	5	0	26
120	COPPER-CU						
		RAW WATER	0	1	1	0	22
		AERATION INF	0	0	6	0	31
		FINAL EFF	0	3	3	0	14
122	LEAD-PB						
		RAW WATER	0	2	0	0	<1
		AERATION INF	0	4	2	0	9
		FINAL EFF	0	4	2	0	10
123	MERCURY						
		RAW WATER	0	2	0	0	<1
		AERATION INF	0	6	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	0	0	3
		AERATION INF	0	0	6	0	31
		FINAL EFF	0	1	5	0	14
128	ZINC-ZN						
		RAW WATER	0	1	1	0	15
		AERATION INF	0	0	1	5	154
		FINAL EFF	0	0	5	1	70
130	ABIETIC ACID						
		AERATION INF	1	0	2	3	177

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
130	ABIETIC ACID	(CONT.)					
		FINAL EFF	4	0	0	2	583
131	DEHYDROABIETIC ACID						
		RAW WATER	1	0	1	0	12
		AERATION INF	1	0	2	3	224
		FINAL EFF	2	1	0	3	430
132	ISOPIMARIC ACID						
		AERATION INF	3	0	2	1	58
		FINAL EFF	3	0	0	3	203
133	PIMARIC ACID						
		AERATION INF	3	0	0	3	78
		FINAL EFF	3	0	0	3	215
134	OLEIC ACID						
		AERATION INF	1	0	0	5	298
		FINAL EFF	0	0	2	4	153
135	LINOLEIC ACID						
		AERATION INF	1	0	0	5	698
		FINAL EFF	3	0	3	0	47
136	LINOLENIC ACID						
		AERATION INF	5	0	0	1	35
139	1-CHLORODEHYDROABIETIC ACID						
		AERATION INF	2	1	2	1	50
		FINAL EFF	3	0	2	1	42
140	DICHLORODEHYDROABIETIC ACID						
		AERATION INF	3	0	3	0	29
		FINAL EFF	3	0	3	0	19
141	TRICHLOROGUAIACOL						
		AERATION INF	3	0	3	0	9

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
142	TETRACHLOROGUAIACOL						
		AERATION INF	0	3	3	0	11

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	RANGE 50-85	RANGE >85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	0	2	114
		AERATION INF	0	0	3	3	80
		FINAL EFF	0	0	3	3	84
145	PHENOL D5						
		RAW WATER	0	0	2	0	72
		AERATION INF	0	0	6	0	70
		FINAL EFF	0	1	3	2	75
146	NAPTHALENE D8						
		RAW WATER	0	0	1	1	81
		AERATION INF	0	0	5	1	79
		FINAL EFF	0	2	1	3	73
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	2	121
		AERATION INF	0	0	4	2	84
		FINAL EFF	0	1	2	3	82

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	RANGE 5-500	RANGE >500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	52
		AERATION INF	0	0	0	6	1680
		FINAL EFF	0	0	0	6	1597
151	COD (MG/LITER)						
		AERATION INF	0	0	0	6	[illegible]

TABLE A-2

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 013 - ALKALINE-BCT

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		RAW WATER	2	1	0	0	<1
		FINAL EFF	8	1	0	0	<1
21	2,4,6-TRICHLOROPHENOL						
		AERATION INF	1	6	2	0	8
		FINAL EFF	8	1	0	0	<1
23	CHLOROFORM						
		AERATION INF	0	0	0	9	1550
		FINAL EFF	1	6	2	0	6
31	2,4-DICHLOROPHENOL						
		AERATION INF	5	4	0	0	1
		FINAL EFF	7	2	0	0	<1
38	ETHYLBENZENE						
		FINAL EFF	8	1	0	0	<1
44	METHYLENE CHLORIDE						
		RAW WATER	2	1	0	0	1
		AERATION INF	2	7	0	0	2
		FINAL EFF	4	5	0	0	2
64	PENTACHLOROPHENOL						
		AERATION INF	6	1	2	0	6
		FINAL EFF	6	0	3	0	6
65	PHENOL						
		RAW WATER	2	1	0	0	<1
		AERATION INF	0	0	9	0	55
		FINAL EFF	5	2	2	0	5
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	2	1	0	0	2

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
66	BIS(2-ETHYL HEXYL) PHTHALATE (CONT.)						
		AERATION INF	1	8	0	0	3
		FINAL EFF	3	6	0	0	2
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	4	5	0	0	2
		FINAL EFF	8	1	0	0	<1
78	ANTHRACENE						
		AERATION INF	8	1	0	0	<1
85	TETRACHLOROETHYLENE						
		AERATION INF	6	3	0	0	<1
86	TOLUENE						
		AERATION INF	3	6	0	0	1
87	TRICHLOROETHYLENE						
		AERATION INF	6	3	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	3	0	0	1
		AERATION INF	0	1	5	3	85
		FINAL EFF	0	3	5	1	55
120	COPPER-CU						
		RAW WATER	0	1	2	0	21
		AERATION INF	0	0	9	0	46
		FINAL EFF	0	2	7	0	17
122	LEAD-PB						
		RAW WATER	0	3	0	0	4
		AERATION INF	0	3	6	0	17
		FINAL EFF	0	3	6	0	18

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
123	MERCURY						
		RAW WATER	0	3	0	0	<1
		AERATION INF	0	9	0	0	<1
		FINAL EFF	0	9	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	3	0	0	3
		AERATION INF	0	3	5	1	36
		FINAL EFF	0	5	4	0	12
128	ZINC-ZN						
		RAW WATER	0	0	3	0	58
		AERATION INF	0	0	2	7	138
		FINAL EFF	0	0	6	3	110
130	ABIETIC ACID						
		AERATION INF	2	0	0	7	1043
		FINAL EFF	2	0	4	3	123
131	DEHYDROABIETIC ACID						
		AERATION INF	1	0	0	8	739
		FINAL EFF	0	0	4	5	123
132	ISOPIMARIC ACID						
		AERATION INF	2	0	4	3	96
		FINAL EFF	2	1	6	0	21
133	PIMARIC ACID						
		AERATION INF	2	0	4	3	115
		FINAL EFF	3	0	6	0	22
134	OLEIC ACID						
		AERATION INF	2	0	0	7	1084
135	LINOLEIC ACID						
		AERATION INF	3	0	0	6	508

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
139	1-CHLORODEHYDROABIETIC ACID						
		AERATION INF	4	0	4	1	52
		FINAL EFF	6	1	2	0	6
140	DICHLORODEHYDROABIETIC ACID						
		AERATION INF	7	1	1	0	2
		FINAL EFF	8	1	0	0	<1
141	TRICHLOROGUAIACOL						
		AERATION INF	8	1	0	0	<1
142	TETRACHLOROGUAIACOL						
		AERATION INF	3	4	2	0	5
		FINAL EFF	8	1	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	2	88
		AERATION INF	1	3	3	2	57
		FINAL EFF	0	3	2	1	51
145	PHENOL D5						
		RAW WATER	0	1	2	0	48
		AERATION INF	1	2	6	0	59
		FINAL EFF	0	3	1	2	60
146	NAPTHALENE D8						
		RAW WATER	0	1	0	0	42
		AERATION INF	0	2	1	0	46
		FINAL EFF	0	1	2	0	59

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	50-85	>85	AVERAGE % RECOVERY
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	1	0	82
		AERATION INF	0	1	2	0	60
		FINAL EFF	0	0	3	0	58

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	67
		AERATION INF	0	0	0	9	1233
		FINAL EFF	0	0	0	8	1619
151	COD (MG/LITER)						
		AERATION INF	0	0	3	6	766
		FINAL EFF	0	0	9	0	397

TABLE A-3

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 014 - ALKALINE-FINE

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
11	1,1,1-TRICHLOROETHANE						
		AERATION INF	8	0	1	0	8
21	2,4,6-TRICHLOROPHENOL						
		AERATION INF	0	5	4	0	11
		FINAL EFF	2	7	0	0	3
23	CHLOROFORM						
		AERATION INF	3	0	1	5	781
		FINAL EFF	0	3	3	3	52
31	2,4-DICHLOROPHENOL						
		RAW WATER	2	1	0	0	2
		AERATION INF	7	2	0	0	<1
		FINAL EFF	8	1	0	0	<1
44	METHYLENE CHLORIDE						
		RAW WATER	2	1	0	0	2
		AERATION INF	6	3	0	0	<1
		FINAL EFF	7	2	0	0	<1
48	DICHLOROBROMETHANE						
		AERATION INF	7	0	2	0	4
64	PENTACHLOROPHENOL						
		AERATION INF	6	2	1	0	3
		FINAL EFF	7	2	0	0	<1
65	PHENOL						
		AERATION INF	3	2	4	0	7
		FINAL EFF	7	2	0	0	<1
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	1	1	1	0	4

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGED CONC. UG/L
66	BIS(2-ETHYL HEXYL) PHTHALATE (CONT.)						
		AERATION INF	2	2	4	1	28
		FINAL EFF	3	0	6	0	16
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	7	2	0	0	<1
		FINAL EFF	8	1	0	0	<1
70	DIETHYL PHTHALATE						
		AERATION INF	8	1	0	0	<1
85	TETRACHLOROETHYLENE						
		AERATION INF	8	1	0	0	<1
86	TOLUENE						
		AERATION INF	1	7	0	1	23
119	CHROMIUM-CR						
		RAW WATER	0	3	0	0	2
		AERATION INF	0	4	5	0	26
		FINAL EFF	0	6	3	0	7
120	COPPER-CU						
		RAW WATER	0	2	1	0	6
		AERATION INF	0	1	8	0	22
		FINAL EFF	0	5	4	0	8
122	LEAD-PB						
		RAW WATER	0	3	0	0	3
		AERATION INF	0	8	1	0	6
		FINAL EFF	0	7	2	0	6
123	MERCURY						
		RAW WATER	0	3	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
123	MERCURY	(CONT.)					
		AERATION INF	0	9	0	0	<1
		FINAL EFF	0	9	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	3	0	0	2
		AERATION INF	0	3	6	0	16
		FINAL EFF	0	5	4	0	8
128	ZINC-ZN						
		RAW WATER	0	1	2	0	19
		AERATION INF	0	0	3	6	149
		FINAL EFF	0	0	8	1	71
130	ABIETIC ACID						
		AERATION INF	4	0	0	5	191
		FINAL EFF	8	0	1	0	1
131	DEHYDROABIETIC ACID						
		AERATION INF	3	0	0	6	181
		FINAL EFF	5	4	0	0	3
132	ISOPIMARIC ACID						
		AERATION INF	3	0	5	1	48
133	PIMARIC ACID						
		AERATION INF	3	0	6	0	40
134	OLEIC ACID						
		AERATION INF	6	0	0	3	175
		FINAL EFF	7	0	1	1	18
135	LINOLEIC ACID						
		AERATION INF	6	0	0	3	94

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
136	LINOLENIC ACID						
		AERATION INF	8	0	1	0	10
137	EPOXYSTEARIC ACID						
		RAW WATER	2	0	0	1	37
139	1-CHLORODEHYDROABIETIC ACID						
		AERATION INF	2	1	5	1	41
140	DICHLORODEHYDROABIETIC ACID						
		AERATION INF	7	1	1	0	4
141	TRICHLOROGUAIACOL						
		RAW WATER	2	0	1	0	4
		AERATION INF	5	4	0	0	2
		FINAL EFF	8	1	0	0	<1
142	TETRACHLOROGUAIACOL						
		RAW WATER	2	0	1	0	8
		AERATION INF	2	5	2	0	6
		FINAL EFF	6	3	0	0	2
143	XYLENES						
		AERATION INF	7	2	0	0	1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	2	93
		AERATION INF	0	2	4	3	73
		FINAL EFF	0	0	4	5	90

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
145	PHENOL D5						
		RAW WATER	0	2	1	0	32
		AERATION INF	0	4	5	0	54
		FINAL EFF	0	2	6	1	61
146	NAPTHALENE D8						
		RAW WATER	0	1	1	0	50
		AERATION INF	0	3	3	0	44
		FINAL EFF	0	1	5	0	68
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	2	111
		AERATION INF	0	1	2	3	73
		FINAL EFF	0	0	2	4	100

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	5
		AERATION INF	0	0	0	9	850
		FINAL EFF	0	0	2	7	826
151	COD (MG/LITER)						
		AERATION INF	0	0	2	7	576
		FINAL EFF	0	0	9	0	244

TABLE A-4

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 015 - ALKALINE-UNBLEACHED

*Only those compounds detected at the raw water, aeration influent, aeration effluent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		AERATION INF	6	1	0	0	<1
		FINAL EFF	4	2	0	0	<1
23	CHLOROFORM						
		AERATION INF	6	3	0	0	<1
38	ETHYLBENZENE						
		AERATION INF	6	3	0	0	<1
44	METHYLENE CHLORIDE						
		RAW WATER	2	0	1	0	3
		AERATION INF	2	6	0	1	34
		FINAL EFF	1	5	0	0	4
54	ISOPHORONE						
		AERATION INF	6	1	2	0	4
65	PHENOL						
		RAW WATER	1	2	0	0	<1
		AERATION INF	0	0	7	2	85
		AERATION EFF	0	3	0	0	3
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	2	1	0	0	<1
		AERATION INF	4	3	1	1	18
		AERATION EFF	2	1	0	0	3
		FINAL EFF	5	1	0	0	<1
67	BUTYL BENZYL PHTHALATE						
		AERATION INF	7	0	2	0	8
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	5	3	1	0	2

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	10-100	>100	AVERAGE CONC. UG/L
68	DI-N-BUTYL PHTHALATE	(CONT.)					
		AERATION EFF	0	3	0	0	1
85	TETRACHLOROETHYLENE						
		AERATION INF	7	2	0	0	<1
86	TOLUENE						
		AERATION INF	2	6	1	0	4
119	CHROMIUM-CR						
		RAW WATER	0	2	1	0	7
		AERATION INF	1	1	7	0	14
		AERATION EFF	0	3	0	0	7
		FINAL EFF	0	3	3	0	12
120	COPPER-CU						
		RAW WATER	0	3	0	0	4
		*AERATION INF	0	2	7	0	19
		*AERATION EFF	0	3	0	0	5
		FINAL EFF	0	3	3	0	9
122	LEAD-PB						
		RAW WATER	0	2	1	0	21
		AERATION INF	0	4	5	0	14
		AERATION EFF	0	2	1	0	5
		FINAL EFF	0	3	3	0	16
123	MERCURY						
		RAW WATER	0	3	0	0	<1
		AERATION INF	0	9	0	0	<1
		AERATION EFF	0	3	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	1	0	7

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
124	NICKEL-NI	(CONT.)					
		AERATION INF	0	7	2	0	6
		AERATION EFF	0	3	0	0	5
		FINAL EFF	0	5	1	0	5
128	ZINC-ZN						
		RAW WATER	0	0	3	0	14
		AERATION INF	0	0	5	4	114
		AERATION EFF	0	0	3	0	67
		FINAL EFF	0	0	3	3	81
130	ABIETIC ACID						
		AERATION INF	0	0	0	9	2026
		FINAL EFF	0	0	3	3	121
131	DEHYDROABIETIC ACID						
		AERATION INF	0	0	0	9	741
		AERATION EFF	0	1	2	0	11
		FINAL EFF	0	0	6	0	52
132	ISOPIMARIC ACID						
		AERATION INF	0	0	2	7	325
		AERATION EFF	1	1	1	0	6
		FINAL EFF	3	0	3	0	15
133	PIMARIC ACID						
		AERATION INF	0	0	3	6	323
		AERATION EFF	2	1	0	0	<1
		FINAL EFF	2	0	4	0	17
134	OLEIC ACID						
		RAW WATER	2	1	0	0	<1
		AERATION INF	0	0	0	9	1070
		AERATION EFF	0	1	2	0	38

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
134	OLEIC ACID (CONT.)						
		FINAL EFF	0	0	2	4	107
135	LINOLEIC ACID						
		AERATION INF	0	0	0	9	453
136	LINOLENIC ACID						
		AERATION INF	6	0	1	2	169
140	DICHLORODEHYDROABIETIC ACID						
		AERATION INF	8	1	0	0	<1
143	XYLENES						
		AERATION INF	3	1	5	0	14

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	RANGE 50-85	RANGE >85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	1	2	0	54
		AERATION INF	1	3	1	4	55
		AERATION EFF	0	0	2	1	76
		FINAL EFF	0	3	1	2	59
145	PHENOL D5						
		RAW WATER	0	2	1	0	37
		AERATION INF	0	4	2	3	58
		AERATION EFF	0	0	3	0	64
		FINAL EFF	0	3	3	0	47
146	NAPTHALENE D8						
		RAW WATER	0	2	1	0	44

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	RANGE 50-85	RANGE >85	AVERAGE % RECOVERY
146	NAPTHALENE DB	(CONT.)					
		AERATION INF	0	6	2	1	45
		AERATION EFF	0	1	2	0	53
		FINAL EFF	0	4	2	0	35
148	DI-AMYL PHTHALATE						
		RAW WATER	0	1	1	1	75
		AERATION INF	0	2	3	4	80
		AERATION EFF	0	0	3	0	62
		FINAL EFF	0	3	2	1	49

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	RANGE 5-500	RANGE >500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	128
		AERATION INF	0	0	5	4	811
		AERATION EFF	0	0	3	0	213
		FINAL EFF	0	0	3	3	1208
151	COD (MG/LITER)						
		AERATION INF	0	0	0	9	948
		FINAL EFF	0	0	5	4	545

TABLE A-5

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 016 - SEMI-CHEMICAL

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		AERATION INF	3	3	0	0	3
		FINAL EFF	4	2	0	0	<1
23	CHLOROFORM						
		AERATION INF	3	3	0	0	1
38	ETHYLBENZENE						
		AERATION INF	4	2	0	0	<1
		FINAL EFF	4	2	0	0	<1
44	METHYLENE CHLORIDE						
		AERATION INF	2	3	1	0	6
		FINAL EFF	0	5	1	0	5
55	NAPTHALENE						
		AERATION INF	4	2	0	0	2
64	PENTACHLOROPHENOL						
		AERATION INF	5	1	0	0	<1
		FINAL EFF	5	1	0	0	<1
65	PHENOL						
		RAW WATER	1	1	0	0	2
		AERATION INF	0	0	0	6	230
		FINAL EFF	0	3	3	0	14
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	1	0	1	0	11
		AERATION INF	1	1	4	0	21
		FINAL EFF	0	3	3	0	15
67	BUTYL BENZYL PHTHALATE						
		AERATION INF	5	1	0	0	<1
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	0	5	1	0	4

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
86	TOLUENE						
		AERATION INF	3	3	0	0	2
		FINAL EFF	3	3	0	0	1
87	TRICHLOROETHYLENE						
		AERATION INF	3	2	1	0	5
119	CHROMIUM-CR						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	0	6	0	29
		FINAL EFF	0	0	6	0	19
120	COPPER-CU						
		RAW WATER	0	2	0	0	5
		AERATION INF	0	0	4	2	79
		FINAL EFF	0	1	5	0	25
121	CYANIDE						
		RAW WATER	0	3	0	0	9
		AERATION INF	0	3	0	0	9
		FINAL EFF	0	3	0	0	9
122	LEAD-PB						
		RAW WATER	0	2	0	0	4
		AERATION INF	0	0	3	3	95
		FINAL EFF	0	0	6	0	35
123	MERCURY						
		RAW WATER	1	1	0	0	<1
		AERATION INF	0	6	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	0	0	3
		AERATION INF	0	2	4	0	12
		FINAL EFF	0	3	3	0	10

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
128	ZINC-ZN						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	0	3	3	143
		FINAL EFF	1	0	4	1	61
130	ABIETIC ACID						
		AERATION INF	3	0	0	3	128
		FINAL EFF	3	0	3	0	19
131	DEHYDROABIETIC ACID						
		AERATION INF	0	0	1	5	168
		FINAL EFF	2	1	3	0	14
132	ISOPIMARIC ACID						
		AERATION INF	0	0	6	0	34
		FINAL EFF	3	0	3	0	7
133	PIMARIC ACID						
		AERATION INF	3	0	2	1	27
		FINAL EFF	5	0	1	0	2
134	OLEIC ACID						
		AERATION INF	0	0	2	4	115
		FINAL EFF	5	0	1	0	6
135	LINOLEIC ACID						
		AERATION INF	3	0	1	2	61
		FINAL EFF	4	0	2	0	4
136	LINOLENIC ACID						
		AERATION INF	3	0	2	1	49
139	1-CHLORODEHYDROABIETIC ACID						
		FINAL EFF	4	1	1	0	4
140	DICHLORODEHYDROABIETIC ACID						
		FINAL EFF	4	0	2	0	7

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
143	XYLENES						
		AERATION INF	4	2	0	0	<1
		FINAL EFF	3	3	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	2	0	83
		AERATION INF	0	2	4	0	55
		FINAL EFF	0	5	1	0	37
145	PHENOL D5						
		RAW WATER	0	1	1	0	53
		AERATION INF	0	2	4	0	50
		FINAL EFF	0	3	3	0	49
146	NAPTHALENE D8						
		RAW WATER	0	0	2	0	72
		AERATION INF	0	0	4	2	70
		FINAL EFF	0	1	5	0	53
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	2	100
		AERATION INF	0	3	3	0	53
		FINAL EFF	0	4	2	0	39

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	58
		AERATION INF	0	0	0	6	3915
		FINAL EFF	0	0	0	6	3825
151	COD (MG/LITER)						
		AERATION INF	0	0	0	6	2410
		FINAL EFF	0	0	0	6	1493

TABLE A-6

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 017 - ALKALINE UNBLEACHED & SEMI-CHEMICAL

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORIT NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERA CONC. UG/L
4	BENZENE						
		AERATION INF	3	3	0	0	1
11	1,1,1-TRICHLOROETHANE						
		AERATION INF	3	3	0	0	3
23	CHLOROFORM						
		RAW WATER	1	1	0	0	<1
		AERATION INF	4	2	0	0	1
44	METHYLENE CHLORIDE						
		RAW WATER	1	1	0	0	3
		AERATION INF	3	1	0	2	58
		FINAL EFF	5	0	1	0	13
64	PENTACHLOROPHENOL						
		AERATION INF	5	1	0	0	1
65	PHENOL						
		AERATION INF	0	0	6	0	56
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		AERATION INF	1	2	3	0	10
		FINAL EFF	1	1	4	0	10
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	2	3	1	0	5
70	DIETHYL PHTHALATE						
		AERATION INF	4	0	2	0	7
86	TOLUENE						
		AERATION INF	3	3	0	0	2
87	TRICHLOROETHYLENE						
		AERATION INF	4	2	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
107	P.C.B. 1254						
		RAW WATER	0	2	0	0	2
		AERATION INF	3	3	0	0	<1
		FINAL EFF	2	4	0	0	2
109	P.C.B. 1232						
		RAW WATER	1	1	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	1	5	0	29
		FINAL EFF	0	2	4	0	19
120	COPPER-CU						
		RAW WATER	0	1	1	0	8
		AERATION INF	0	0	6	0	38
		FINAL EFF	0	2	4	0	15
121	CYANIDE						
		RAW WATER	0	1	5	0	10
		AERATION INF	0	3	3	0	16
		FINAL EFF	0	3	3	0	10
122	LEAD-PB						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	1	5	0	24
		FINAL EFF	0	3	3	0	13
123	MERCURY						
		RAW WATER	0	2	0	0	<1
		AERATION INF	0	6	0	0	<1
		FINAL EFF	1	5	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	4	2	0	10

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	RANGE ND	<10	10-100	>100	AVERAGE CONC. UG/L
124	NICKEL-NI	(CONT.)					
		FINAL EFF	0	5	1	0	5
128	ZINC-ZN						
		RAW WATER	0	2	0	0	6
		AERATION INF	0	0	6	0	40
		FINAL EFF	0	0	6	0	25
130	ABIETIC ACID						
		RAW WATER	1	0	1	0	24
		AERATION INF	0	0	0	6	1392
		FINAL EFF	0	0	0	6	710
131	DEHYDROABIETIC ACID						
		RAW WATER	1	0	1	0	9
		AERATION INF	0	0	0	6	607
		FINAL EFF	0	0	0	6	235
132	ISOPIMARIC ACID						
		AERATION INF	0	0	0	6	547
		FINAL EFF	0	0	0	6	187
133	PIMARIC ACID						
		AERATION INF	0	0	3	3	152
		FINAL EFF	0	0	3	3	95
134	OLEIC ACID						
		AERATION INF	0	0	0	6	618
		FINAL EFF	0	0	0	6	407
135	LINOLEIC ACID						
		AERATION INF	0	0	1	5	441
		FINAL EFF	3	0	2	1	59
137	EPOXYSTEARIC ACID						
		AERATION INF	3	0	1	2	133

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
137	EPOXYSTEARIC ACID (CONT.)						
		FINAL EFF	4	0	0	2	57
143	XYLENES						
		AERATION INF	3	0	3	0	11

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	2	0	62
		AERATION INF	0	6	0	0	27
		FINAL EFF	0	5	1	0	47
145	PHENOL D5						
		RAW WATER	0	2	0	0	45
		AERATION INF	0	4	2	0	53
		FINAL EFF	0	0	6	0	59
146	NAPTHALENE D8						
		RAW WATER	0	1	1	0	44
		AERATION INF	0	2	4	0	57
		FINAL EFF	0	4	1	1	55
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	1	1	88
		AERATION INF	0	2	4	0	57
		FINAL EFF	0	0	5	1	72

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	23
		AERATION INF	0	0	5	1	425
		FINAL EFF	0	0	6	0	258
151	COD (MG/LITER)						

TABLE A-7

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 022 - SULFITE-PAPERGRADE

*Only those compounds detected at the raw water, aeration influent, secondary clarifier effluent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		AERATION INF	5	0	1	3	53
		FINAL EFF	7	2	3	0	12
11	1,1,1-TRICHLOROETHANE						
		AERATION INF	6	0	0	3	414
		SEC. CLARIF	1	2	0	0	3
		FINAL EFF	9	3	0	0	2
13	1,1-DICHLOROETHANE						
		AERATION INF	6	2	1	0	4
21	2,4,6-TRICHLOROPHENOL						
		AERATION INF	6	0	3	0	4
		FINAL EFF	7	3	0	2	39
23	CHLOROFORM						
		AERATION INF	1	0	0	8	3211
		SEC. CLARIF	0	0	3	0	56
		FINAL EFF	0	0	0	12	433
24	2-CHLOROPHENOL						
		FINAL EFF	9	0	3	0	9
31	2,4-DICHLOROPHENOL						
		AERATION INF	6	3	0	0	<1
		FINAL EFF	9	0	2	1	27
44	METHYLENE CHLORIDE						
		AERATION INF	2	1	3	3	464
		SEC. CLARIF	2	0	1	0	5
		FINAL EFF	0	7	4	1	271
48	DICHLOROBROMETHANE						
		AERATION INF	6	1	2	0	9

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
48	DICHLOROBROMETHANE (CONT.)						
		FINAL EFF	11	1	0	0	<1
55	NAPTHALENE						
		AERATION INF	6	0	2	1	34
		FINAL EFF	9	1	2	0	9
64	PENTACHLOROPHENOL						
		RAW WATER	3	1	0	0	<1
		AERATION INF	6	1	2	0	4
		FINAL EFF	11	1	0	0	<1
65	PHENOL						
		RAW WATER	3	1	0	0	2
		AERATION INF	1	2	4	2	53
		SEC. CLARIF	1	2	0	0	2
		FINAL EFF	4	5	1	2	41
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	2	1	0	1	66
		AERATION INF	2	4	2	1	38
		SEC. CLARIF	1	2	0	0	3
		FINAL EFF	1	6	5	0	21
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	8	1	0	0	<1
70	DIETHYL PHTHALATE						
		AERATION INF	8	1	0	0	<1
		FINAL EFF	11	0	1	0	1
86	TOLUENE						
		AERATION INF	3	2	4	0	15
		FINAL EFF	5	3	4	0	14

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
87	TRICHLOROETHYLENE						
		AERATION INF	6	1	2	0	5
		FINAL EFF	10	2	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	3	1	0	6
		AERATION INF	2	2	5	0	13
		SEC. CLARIF	0	1	2	0	10
		FINAL EFF	3	5	4	0	7
120	COPPER-CU						
		RAW WATER	0	2	2	0	15
		AERATION INF	2	1	2	4	81
		SEC. CLARIF	0	0	3	0	20
		FINAL EFF	3	1	8	0	29
122	LEAD-PB						
		RAW WATER	0	3	1	0	5
		AERATION INF	2	3	4	0	13
		SEC. CLARIF	0	1	2	0	10
		FINAL EFF	3	4	5	0	10
123	MERCURY						
		RAW WATER	0	4	0	0	<1
		AERATION INF	0	9	0	0	<1
		SEC. CLARIF	0	3	0	0	<1
		FINAL EFF	0	12	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	4	0	0	3
		AERATION INF	2	0	7	0	16
		SEC. CLARIF	0	0	3	0	17
		FINAL EFF	3	5	4	0	6
128	ZINC-ZN						
		RAW WATER	0	2	2	0	26

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
128	ZINC-ZN	(CONT.)					
		AERATION INF	0	1	3	5	91
		SEC. CLARIF	0	0	3	0	58
		FINAL EFF	0	0	9	3	118
130	ABIETIC ACID						
		AERATION INF	3	0	2	4	135
		FINAL EFF	6	0	4	2	51
131	DEHYDROABIETIC ACID						
		AERATION INF	0	0	3	6	555
		FINAL EFF	3	0	5	4	246
132	ISOPIMARIC ACID						
		AERATION INF	3	0	4	2	62
		FINAL EFF	5	4	3	0	13
133	PIMARIC ACID						
		AERATION INF	7	0	2	0	8
		FINAL EFF	11	0	1	0	4
134	OLEIC ACID						
		AERATION INF	0	0	4	5	168
		SEC. CLARIF	0	0	3	0	25
		FINAL EFF	5	0	5	2	47
135	LINOLEIC ACID						
		AERATION INF	3	0	5	1	57
		FINAL EFF	8	0	3	1	26
136	LINOLENIC ACID						
		AERATION INF	7	0	2	0	12
137	EPOXYSTEARIC ACID						
		AERATION INF	7	0	0	2	49

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
137	EPOXYSTEARIC ACID (CONT.)						
		FINAL EFF	11	0	1	0	2
139	1-CHLORODEHYDROABIETIC ACID						
		AERATION INF	3	1	2	3	82
		FINAL EFF	9	0	3	0	20
140	DICHLORODEHYDROABIETIC ACID						
		AERATION INF	8	1	0	0	<1
		FINAL EFF	11	1	0	0	<1
141	TRICHLOROGUAIACOL						
		FINAL EFF	10	2	0	0	<1
142	TETRACHLOROGUAIACOL						
		AERATION INF	8	1	0	0	<1
143	XYLENES						
		AERATION INF	6	3	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	2	1	1	67
		AERATION INF	0	2	4	3	72
		SEC. CLARIF	0	3	0	0	24
		FINAL EFF	0	5	6	1	52
145	PHENOL D5						
		RAW WATER	0	3	0	1	47
		AERATION INF	0	3	6	0	57

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
145	PHENOL D5	(CONT.)					
		SEC. CLARIF	0	3	0	0	40
		FINAL EFF	0	8	4	0	43
146	NAPTHALENE D8						
		RAW WATER	0	2	1	1	50
		AERATION INF	0	1	8	0	72
		SEC. CLARIF	0	1	2	0	53
		FINAL EFF	0	7	4	1	47
148	DI-AMYL PHTHALATE						
		RAW WATER	0	2	1	1	71
		AERATION INF	0	2	5	2	66
		SEC. CLARIF	0	3	0	0	26
		FINAL EFF	0	8	4	0	39

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	4	0	93
		AERATION INF	0	0	3	6	2013
		SEC. CLARIF	0	0	0	3	4887
		FINAL EFF	0	0	3	9	1502
150	AMMONIA(MG/LITER AS N)						
		RAW WATER	0	0	1	0	210
		AERATION INF	0	1	2	0	105
		SEC. CLARIF	0	0	2	0	32
		FINAL EFF	0	0	3	0	21
151	COD (MG/LITER)						
		AERATION INF	0	0	0	9	4794

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
151	COD (MG/LITER)	(CONT.)					
		SEC. CLARIF	0	0	0	3	2887
		FINAL EFF	0	0	0	12	1342

TABLE A-8

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 031 - CHEMI-MECHANICAL PULP

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
38	ETHYLBENZENE						
		AERATION INF	2	1	0	0	<1
44	METHYLENE CHLORIDE						
		RAW WATER	0	1	0	0	4
		AERATION INF	1	1	1	0	5
		FINAL EFF	1	1	1	0	6
65	PHENOL						
		AERATION INF	0	0	3	0	31
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		AERATION INF	1	1	1	0	7
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	1	2	0	0	3
86	TOLUENE						
		AERATION INF	1	2	0	0	3
		FINAL EFF	2	1	0	0	1
107	P.C.B. 1254						
		AERATION INF	2	1	0	0	<1
		FINAL EFF	2	1	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	1	0	0	2
		AERATION INF	0	3	0	0	3
		FINAL EFF	0	3	0	0	4
120	COPPER-CU						
		RAW WATER	0	1	0	0	2
		AERATION INF	0	0	3	0	40
		FINAL EFF	0	1	2	0	16
121	CYANIDE						
		RAW WATER	0	1	2	0	10

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
121	CYANIDE	(CONT					
		AERATION INF	0	2	1	0	13
		FINAL EFF	0	3	0	0	9
122	LEAD-PB						
		RAW WATER	0	1	0	0	2
		AERATION INF	0	3	0	0	2
		FINAL EFF	0	3	0	0	3
123	MERCURY						
		RAW WATER	0	1	0	0	<1
		AERATION INF	0	3	0	0	<1
		FINAL EFF	0	3	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	1	0	0	2
		AERATION INF	0	3	0	0	3
		FINAL EFF	0	2	1	0	6
128	ZINC-ZN						
		RAW WATER	0	0	1	0	14
		AERATION INF	0	0	0	3	403
		FINAL EFF	0	0	0	3	110
130	ABIETIC ACID						
		AERATION INF	0	0	0	3	2700
		FINAL EFF	0	0	0	3	143
131	DEHYDROABIETIC ACID						
		AERATION INF	0	0	0	3	1400
		FINAL EFF	0	0	1	2	105
132	ISOPIMARIC ACID						
		AERATION INF	0	0	0	3	1020
		FINAL EFF	0	0	3	0	67
133	PIMARIC ACID						
		AERATION INF	0	0	0	3	747

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
133	PIMARIC ACID	(CONT.)					
		FINAL EFF	0	0	3	0	42
134	OLEIC ACID						
		AERATION INF	0	0	0	3	1280
		FINAL EFF	0	0	3	0	66
135	LINOLEIC ACID						
		AERATION INF	0	0	0	3	307
139	1-CHLORODEHYDROABIETIC ACID						
		AERATION INF	0	0	3	0	54
143	XYLENES						
		AERATION INF	1	0	1	1	57
		FINAL EFF	2	1	0	0	1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	0	1	99
		AERATION INF	0	1	2	0	57
		FINAL EFF	0	0	0	3	102
145	PHENOL D5						
		RAW WATER	0	1	0	0	44
		AERATION INF	0	2	1	0	52
		FINAL EFF	0	1	2	0	50
146	NAPTHALENE D8						
		RAW WATER	0	0	1	0	54
		AERATION INF	0	0	2	1	70
		FINAL EFF	0	1	2	0	56
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	1	112
		AERATION INF	0	0	1	2	85

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	RANGE				AVERAGE VALUE
			ND	<5	5-500	>500	
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	1	0	90
		AERATION INF	0	0	3	0	235
		FINAL EFF	0	0	3	0	42
151	COD (MG/LITER)						
		AERATION INF	0	0	0	3	567
		FINAL EFF	0	0	3	0	96

TABLE A-9

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 033 - GROUNDWOOD-CMN

*Only those compounds detected at the raw water, oxidation influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		OXID. INF	0	1	2	0	9
		FINAL EFF	2	1	0	0	<1
23	CHLOROFORM						
		OXID. INF	2	1	0	0	<1
44	METHYLENE CHLORIDE						
		FINAL EFF	2	1	0	0	<1
65	PHENOL						
		RAW WATER	0	1	0	0	8
		OXID. INF	0	0	3	0	16
		FINAL EFF	0	1	2	0	11
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	1	0	0	6
		OXID. INF	0	2	1	0	8
		FINAL EFF	0	2	1	0	9
86	TOLUENE						
		OXID. INF	0	0	1	2	293
		FINAL EFF	0	0	2	1	87
119	CHROMIUM-CR						
		RAW WATER	0	1	0	0	2
		OXID. INF	0	2	1	0	6
		FINAL EFF	0	3	0	0	4
120	COPPER-CU						
		RAW WATER	0	0	1	0	16
		OXID. INF	0	0	3	0	15
		FINAL EFF	0	2	1	0	5
121	CYANIDE						
		RAW WATER	0	1	2	0	10

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
121	CYANIDE (CONT.)						
		OXID. INF	0	3	0	0	9
		FINAL EFF	0	3	0	0	9
122	LEAD-PB						
		RAW WATER	0	1	0	0	2
		OXID. INF	0	2	1	0	13
		FINAL EFF	0	3	0	0	2
123	MERCURY						
		RAW WATER	0	1	0	0	<1
		OXID. INF	0	3	0	0	<1
		FINAL EFF	0	3	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	1	0	0	2
		OXID. INF	0	3	0	0	8
		FINAL EFF	0	2	1	0	7
128	ZINC-ZN						
		RAW WATER	0	0	1	0	10
		OXID. INF	0	0	0	3	483
		FINAL EFF	0	0	0	3	1600
130	ABIETIC ACID						
		OXID. INF	1	0	0	2	223
131	DEHYDROABIETIC ACID						
		RAW WATER	0	0	1	0	31
		OXID. INF	0	0	0	3	427
		FINAL EFF	0	0	3	0	45
132	ISOPIMARIC ACID						
		OXID. INF	1	0	2	0	14

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
134	OLEIC ACID						
		OXID. INF	0	0	2	1	74
135	LINOLEIC ACID						
		OXID. INF	2	0	1	0	16
143	XYLENES						
		OXID. INF	1	1	1	0	4

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	0	57
		OXID. INF	0	0	0	3	95
		FINAL EFF	0	1	2	0	55
145	PHENOL D5						
		RAW WATER	0	0	1	0	56
		OXID. INF	0	0	2	1	83
		FINAL EFF	0	0	3	0	67
146	NAPTHALENE D8						
		RAW WATER	0	1	0	0	24
		OXID. INF	0	0	1	2	94
		FINAL EFF	0	0	1	2	84
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	1	105
		OXID. INF	0	0	1	2	109
		FINAL EFF	0	0	0	3	116

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	1	0	5
		OXID. INF	0	0	3	0	25
		FINAL EFF	0	0	3	0	20
151	COD (MG/LITER)						
		OXID. INF	0	0	3	0	212
		FINAL EFF	0	0	3	0	194

TABLE A-10

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 034 - GROUNDWOOD-FINE

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		RAW WATER	1	1	0	0	3
23	CHLOROFORM						
		AERATION INF	0	0	3	3	99
		FINAL EFF	0	3	3	0	15
38	ETHYLBENZENE						
		AERATION INF	5	1	0	0	<1
44	METHYLENE CHLORIDE						
		RAW WATER	1	1	0	0	<1
		AERATION INF	5	0	1	0	2
64	PENTACHLOROPHENOL						
		AERATION INF	3	2	1	0	3
		FINAL EFF	4	2	0	0	<1
65	PHENOL						
		RAW WATER	1	1	0	0	2
		AERATION INF	0	0	6	0	28
		FINAL EFF	2	4	0	0	2
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	1	1	0	0	2
		AERATION INF	2	4	0	0	3
		FINAL EFF	1	5	0	0	4
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	3	3	0	0	<1
		FINAL EFF	3	3	0	0	<1
85	TETRACHLOROETHYLENE						
		AERATION INF	5	1	0	0	<1
86	TOLUENE						
		RAW WATER	1	1	0	0	2

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
86	TOLUENE	(CONT.)					
		AERATION INF	0	5	1	0	13
		FINAL EFF	3	3	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	5	1	0	5
		FINAL EFF	0	6	0	0	3
120	COPPER-CU						
		RAW WATER	0	2	0	0	5
		AERATION INF	0	0	6	0	28
		FINAL EFF	0	1	5	0	14
122	LEAD-PB						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	3	3	0	9
		FINAL EFF	0	5	1	0	8
123	MERCURY						
		RAW WATER	0	2	0	0	<1
		AERATION INF	0	6	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	0	0	5
		AERATION INF	0	6	0	0	5
		FINAL EFF	0	5	1	0	5
128	ZINC-ZN						
		RAW WATER	0	0	2	0	22
		AERATION INF	0	0	6	0	74
		FINAL EFF	0	1	5	0	45
130	ABIETIC ACID						
		AERATION INF	0	0	3	3	182

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
130	ABIETIC ACID (CONT.)						
		FINAL EFF	4	1	1	0	5
131	DEHYDROABIETIC ACID						
		AERATION INF	0	0	4	2	148
		FINAL EFF	0	0	6	0	26
132	ISOPIMARIC ACID						
		AERATION INF	1	2	2	1	29
		FINAL EFF	2	4	0	0	2
133	PIMARIC ACID						
		AERATION INF	4	0	0	2	50
		FINAL EFF	5	0	1	0	3
134	OLEIC ACID						
		AERATION INF	1	0	2	3	171
		FINAL EFF	4	0	2	0	13
135	LINOLEIC ACID						
		RAW WATER	1	0	1	0	17
		AERATION INF	3	0	0	3	168
		FINAL EFF	3	0	2	1	39
136	LINOLENIC ACID						
		AERATION INF	3	0	0	3	125

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	1	0	1	0	39
		AERATION INF	1	2	2	1	59
		FINAL EFF	0	0	4	2	78
145	PHENOL D5						
		RAW WATER	1	0	1	0	26
		AERATION INF	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
146	NAPTHALENE D8						
		RAW WATER	0	0	1	0	52
		AERATION INF	0	0	2	1	71
		FINAL EFF	0	0	3	0	63
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	1	109
		AERATION INF	0	0	2	1	83
		FINAL EFF	0	0	3	0	74

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	35
		AERATION INF	0	0	6	0	139
		FINAL EFF	0	0	6	0	21
151	COD (MG/LITER)						
		AERATION INF	0	0	1	5	625
		FINAL EFF	0	0	6	0	136

TABLE A-11

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

NONWOOD PULPING

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
11	1,1,1-TRICHLOROETHANE						
		AERATION INF	3	1	1	1	33
21	2,4,6-TRICHLOROPHENOL						
		AERATION INF	5	0	1	0	3
		FINAL EFF	5	1	0	0	<1
23	CHLOROFORM						
		RAW WATER	2	0	1	0	6
		AERATION INF	3	0	0	3	417
		FINAL EFF	3	1	2	0	5
44	METHYLENE CHLORIDE						
		AERATION INF	4	2	0	0	<1
		FINAL EFF	5	1	0	0	<1
64	PENTACHLOROPHENOL						
		AERATION INF	2	1	3	0	12
		FINAL EFF	5	1	0	0	<1
65	PHENOL						
		RAW WATER	1	2	0	0	<1
		AERATION INF	3	1	2	0	5
		FINAL EFF	2	4	0	0	3
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	2	1	0	15
		AERATION INF	2	2	2	0	8
		FINAL EFF	1	1	3	1	45
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	4	2	0	0	<1
		FINAL EFF	4	2	0	0	<1
70	DIETHYL PHTHALATE						
		AERATION INF	1	5	0	0	2

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
70	DIETHYL PHTHALATE	(CONT.)					
		FINAL EFF	4	2	0	0	1
86	TOLUENE						
		AERATION INF	5	1	0	0	<1
		FINAL EFF	3	0	1	2	55
119	CHROMIUM-CR						
		RAW WATER	0	3	0	0	3
		AERATION INF	0	6	0	0	5
		FINAL EFF	0	5	1	0	5
120	COPPER-CU						
		RAW WATER	0	1	2	0	9
		AERATION INF	0	1	5	0	39
		FINAL EFF	0	3	3	0	15
121	CYANIDE						
		RAW WATER	0	1	2	0	10
		AERATION INF	0	3	0	0	9
		FINAL EFF	0	2	1	0	9
122	LEAD-PB						
		RAW WATER	0	2	1	0	7
		AERATION INF	0	3	3	0	17
		FINAL EFF	0	2	4	0	11
123	MERCURY						
		RAW WATER	0	3	0	0	<1
		AERATION INF	0	6	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	3	0	0	3
		AERATION INF	0	6	0	0	5
		FINAL EFF	0	6	0	0	3

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
128	ZINC-ZN						
		RAW WATER	0	0	2	1	66
		AERATION INF	0	0	3	3	75
		FINAL EFF	0	0	6	0	33
130	ABIETIC ACID						
		AERATION INF	3	0	2	1	82
		FINAL EFF	4	0	2	0	18
131	DEHYDROABIETIC ACID						
		AERATION INF	2	1	0	3	249
		FINAL EFF	3	0	1	2	118
132	ISOPIMARIC ACID						
		AERATION INF	5	0	1	0	16
		FINAL EFF	4	0	2	0	8
133	PIMARIC ACID						
		AERATION INF	5	0	1	0	10
		FINAL EFF	5	0	1	0	4
134	OLEIC ACID						
		AERATION INF	2	0	1	3	220
		FINAL EFF	4	0	1	1	43
135	LINOLEIC ACID						
		AERATION INF	3	0	0	3	274
		FINAL EFF	5	1	0	0	<1
139	1-CHLORODEHYDROABIETIC ACID						
		AERATION INF	5	0	1	0	6
		FINAL EFF	5	1	0	0	<1
140	DICHLORODEHYDROABIETIC ACID						
		AERATION INF	5	1	0	0	<1
		FINAL EFF	5	0	1	0	3

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
143	XYLENES						
		AERATION INF	3	3	0	0	4

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	2	107
		AERATION INF	0	1	4	1	70
		FINAL EFF	0	1	2	3	84
145	PHENOL D5						
		RAW WATER	0	1	2	0	54
		AERATION INF	0	2	3	1	60
		FINAL EFF	0	1	5	0	60
146	NAPTHALENE D8						
		RAW WATER	0	1	1	1	79
		AERATION INF	0	1	3	2	83
		FINAL EFF	0	2	1	3	80
148	DI-AMYL PHTHALATE						
		RAW WATER	0	1	0	0	48
		AERATION INF	0	1	2	0	50
		FINAL EFF	0	1	2	0	61

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	16
		AERATION INF	0	0	3	3	1991
		FINAL EFF	0	0	3	3	1846
151	COD (MG/LITER)						
		AERATION INF					

TABLE A-12

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 101 - DEINK-FINE & TISSUE

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		AERATION INF	6	3	0	0	2
		FINAL EFF	4	5	0	0	2
7	CHLOROBENZENE						
		AERATION INF	6	0	3	0	14
10	1,2,-DICHLOROETHANE						
		AERATION INF	7	2	0	0	<1
11	1,1,1-TRICHLOROETHANE						
		AERATION INF	6	2	1	0	7
21	2,4,6-TRICHLOROPHENOL						
		AERATION INF	4	1	4	0	18
		FINAL EFF	5	0	4	0	16
23	CHLOROFORM						
		RAW WATER	2	1	0	0	1
		AERATION INF	0	0	3	6	1772
		FINAL EFF	0	2	6	1	68
24	2-CHLOROPHENOL						
		AERATION INF	8	1	0	0	<1
31	2,4-DICHLOROPHENOL						
		AERATION INF	5	4	0	0	2
		FINAL EFF	7	2	0	0	<1
38	ETHYLBENZENE						
		AERATION INF	6	0	3	0	11
44	METHYLENE CHLORIDE						
		AERATION INF	6	0	3	0	4
		FINAL EFF	6	3	0	0	<1
55	NAPTHALENE						
		AERATION I	5	0	3	1	42

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
64	PENTACHLOROPHENOL						
		AERATION INF	3	1	5	0	18
		FINAL EFF	3	1	5	0	15
65	PHENOL						
		AERATION INF	4	1	2	2	38
		FINAL EFF	8	0	1	0	8
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		AERATION INF	3	3	3	0	7
		FINAL EFF	2	7	0	0	2
68	DI-N-BUTYL PHTHALATE						
		RAW WATER	2	1	0	0	<1
		AERATION INF	5	2	2	0	5
		FINAL EFF	5	2	2	0	4
70	DIETHYL PHTHALATE						
		AERATION INF	8	0	1	0	1
		FINAL EFF	7	2	0	0	<1
85	TETRACHLOROETHYLENE						
		AERATION INF	6	0	2	1	32
86	TOLUENE						
		AERATION INF	0	3	5	1	25
		FINAL EFF	8	1	0	0	<1
87	TRICHLOROETHYLENE						
		AERATION INF	3	1	2	3	168
		FINAL EFF	6	2	1	0	2
106	P.C.B. 1242						
		AERATION INF	8	0	1	0	1
111	P.C.B. 1260						
		AERATION INF	8	1	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
119	CHROMIUM-CR						
		RAW WATER	0	2	1	0	5
		AERATION INF	0	2	7	0	22
		FINAL EFF	0	7	2	0	6
120	COPPER-CU						
		RAW WATER	0	2	1	0	4
		AERATION INF	0	1	8	0	34
		FINAL EFF	0	5	4	0	10
121	CYANIDE						
		RAW WATER	0	3	6	0	10
		AERATION INF	0	3	3	3	68
		FINAL EFF	0	2	4	3	89
122	LEAD-PB						
		RAW WATER	0	3	0	0	3
		AERATION INF	0	3	5	1	61
		FINAL EFF	0	5	4	0	13
123	MERCURY						
		RAW WATER	0	3	0	0	<1
		AERATION INF	0	9	0	0	<1
		FINAL EFF	0	9	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	1	0	6
		AERATION INF	0	7	2	0	8
		FINAL EFF	0	9	0	0	3
128	ZINC-ZN						
		RAW WATER	0	0	3	0	17
		AERATION INF	0	0	4	5	149
		FINAL EFF	0	1	8	0	41
130	ABIETIC ACID						
		AERATION INF	0	0	0	9	636

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
130	ABIETIC ACID	(CONT.)					
		FINAL EFF	3	0	5	1	56
131	DEHYDROABIETIC ACID						
		AERATION INF	1	0	0	8	2178
		FINAL EFF	1	0	2	6	210
132	ISOPIMARIC ACID						
		AERATION INF	1	0	2	6	295
		FINAL EFF	6	1	2	0	5
133	PIMARIC ACID						
		AERATION INF	1	0	6	2	69
134	OLEIC ACID						
		AERATION INF	0	0	2	7	549
		FINAL EFF	2	0	1	6	286
135	LINOLEIC ACID						
		AERATION INF	3	0	2	4	153
136	LINOLENIC ACID						
		AERATION INF	7	0	1	1	40
139	1-CHLORODEHYDROABIETIC ACID						
		AERATION INF	4	0	3	2	126
		FINAL EFF	7	0	2	0	5
140	DICHLORODEHYDROABIETIC ACID						
		AERATION INF	7	1	1	0	2
141	TRICHLOROGUAIACOL						
		AERATION INF	7	0	2	0	5
		FINAL EFF	6	0	3	0	5
142	TETRACHLOROGUAIACOL						
		AERATION INF	6	2	1	0	3

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
142	TETRACHLOROGUAIACOL (CONT.)						
		FINAL EFF	6	2	1	0	3
143	XYLENES						
		AERATION INF	6	2	1	0	4

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	2	87
		AERATION INF	0	0	2	7	115
		FINAL EFF	0	1	2	6	100
145	PHENOL D5						
		RAW WATER	0	2	1	0	37
		AERATION INF	0	4	4	1	53
		FINAL EFF	0	6	3	0	45
146	NAPTHALENE D8						
		RAW WATER	0	1	1	0	48
		AERATION INF	0	1	4	1	66
		FINAL EFF	0	2	4	0	58

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	11
		AERATION INF	0	0	9	0	108
		FINAL EFF	0	0	9		75
151	COD (MG/LITER)						
		AERATION	0	0	2	7	1366
		FINAL EFF	0	0	9	0	227

TABLE A-13

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 102 - DEINK NEWSPRINT

*Only those compounds detected at the raw water, and discharge to POTW have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
23	CHLOROFORM						
		RAW WATER	0	1	0	0	<1
		DISCH. POTW	0	3	0	0	<1
38	ETHYLBENZENE						
		DISCH. POTW	1	2	0	0	2
44	METHYLENE CHLORIDE						
		RAW WATER	0	1	0	0	3
		DISCH. POTW	2	1	0	0	<1
65	PHENOL						
		DISCH. POTW	2	1	0	0	1
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	0	1	0	14
		DISCH. POTW	0	1	2	0	13
67	BUTYL BENZYL PHTHALATE						
		DISCH. POTW	0	3	0	0	5
68	DI-N-BUTYL PHTHALATE						
		DISCH. POTW	2	1	0	0	<1
70	DIETHYL PHTHALATE						
		DISCH. POTW	2	1	0	0	1
86	TOLUENE						
		DISCH. POTW	0	1	2	0	14
119	CHROMIUM-CR						
		RAW WATER	0	1	0	0	3
		DISCH. POTW	0	1	2	0	29
120	COPPER-CU						
		RAW WATER	0	0	1	0	54

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
120	COPPER-CU	(CONT.)					
		DISCH. POTW	0	0	3	0	76
122	LEAD-PB						
		RAW WATER	0	0	1	0	10
		DISCH. POTW	0	0	1	2	163
123	MERCURY						
		RAW WATER	0	1	0	0	<1
		DISCH. POTW	0	3	0	0	1
124	NICKEL-NI						
		RAW WATER	0	1	0	0	3
		DISCH. POTW	0	2	1	0	15
128	ZINC-ZN						
		RAW WATER	0	0	1	0	10
		DISCH. POTW	0	0	0	3	335
130	ABIETIC ACID						
		DISCH. POTW	0	0	0	3	3467
131	DEHYDROABIETIC ACID						
		DISCH. POTW	0	0	0	3	3700
132	ISOPIMARIC ACID						
		DISCH. POTW	0	0	0	3	510
133	PIMARIC ACID						
		DISCH. POTW	0	0	0	3	257
134	OLEIC ACID						
		DISCH. POTW	0	0	0	3	1367
135	LINOLEIC ACID						
		DISCH. POTW	0	0	0	3	750

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
143	XYLENES						
		DISCH. POTW	0	1	1	1	46

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	0	1	96
		DISCH. POTW	0	0	2	1	77
145	PHENOL D5						
		RAW WATER	0	1	0	0	46
		DISCH. POTW	0	2	1	0	41
146	NAPTHALENE D8						
		RAW WATER	0	0	1	0	60
		DISCH. POTW	0	1	2	0	51
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	1	0	77
		DISCH. POTW	0	3	0	0	36

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	1	0	50
		DISCH. POTW	0	0	3	0	320
151	COD (MG/LITER)						
		DISCH. POTW	0	0	0	3	3733

TABLE A-14

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 111 - WASTEPAPER-TISSUE

*Only those compounds detected at the raw water, primary influent, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		FINAL EFF	8	1	0	0	<1
23	CHLOROFORM						
		AERATION INF	5	1	0	0	2
		FINAL EFF	8	1	0	0	<1
38	ETHYLBENZENE						
		PRIMARY INF	2	1	0	0	2
		AERATION INF	3	2	1	0	13
44	METHYLENE CHLORIDE						
		RAW WATER	2	1	0	0	2
		PRIMARY INF	0	2	1	0	5
		AERATION INF	3	0	2	1	87
		FINAL EFF	7	2	0	0	<1
55	NAPTHALENE						
		PRIMARY INF	0	0	3	0	26
		FINAL EFF	7	0	2	0	6
65	PHENOL						
		AERATION INF	0	3	2	1	41
		FINAL EFF	5	4	0	0	2
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		PRIMARY INF	0	3	0	0	4
		AERATION INF	1	3	2	0	10
		FINAL EFF	5	4	0	0	2
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	5	0	1	0	3
70	DIETHYL PHTHALATE						
		AERATION INF	4	0	2	0	13

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
85	TETRACHLOROETHYLENE						
		PRIMARY INF	1	1	0	1	74
		FINAL EFF	8	0	1	0	6
86	TOLUENE						
		PRIMARY INF	2	1	0	0	<1
		AERATION INF	1	5	0	0	2
		FINAL EFF	7	2	0	0	1
107	P.C.B. 1254						
		AERATION INF	5	1	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	2	1	0	10
		PRIMARY INF	0	1	2	0	17
		AERATION INF	0	3	3	0	20
		FINAL EFF	0	6	3	0	10
120	COPPER-CU						
		RAW WATER	0	3	0	0	4
		PRIMARY INF	0	1	2	0	13
		AERATION INF	0	0	6	0	55
		FINAL EFF	0	3	5	1	34
121	CYANIDE						
		RAW WATER	0	5	4	0	9
		PRIMARY INF	0	3	0	0	9
		AERATION INF	0	6	0	0	9
		FINAL EFF	0	9	0	0	9
122	LEAD-PB						
		RAW WATER	0	3	0	0	4
		PRIMARY INF	0	3	0	0	5
		AERATION INF	0	2	3	1	44

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	10-100	>100	AVERAGE CONC. UG/L
122	LEAD-PB	(CONT.)					
		FINAL EFF	0	6	2	1	26
123	MERCURY						
		RAW WATER	0	3	0	0	<1
		PRIMARY INF	0	3	0	0	<1
		AERATION INF	0	6	0	0	<1
		FINAL EFF	0	9	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	1	0	11
		PRIMARY INF	0	1	2	0	15
		AERATION INF	0	4	2	0	21
		FINAL EFF	0	6	3	0	9
128	ZINC-ZN						
		RAW WATER	0	3	0	0	4
		PRIMARY INF	0	0	3	0	54
		AERATION INF	0	0	3	3	492
		FINAL EFF	0	1	5	3	68
130	ABIETIC ACID						
		PRIMARY INF	0	0	0	3	203
		AERATION INF	2	0	3	1	54
		FINAL EFF	7	0	1	1	24
131	DEHYDROABIETIC ACID						
		PRIMARY INF	0	0	0	3	417
		AERATION INF	0	0	0	6	372
		FINAL EFF	2	0	4	3	97
132	ISOPIMARIC ACID						
		PRIMARY INF	0	0	3	0	28
		AERATION INF	3	0	3	0	16

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
133	PIMARIC ACID						
		PRIMARY INF	2	0	1	0	26
		AERATION INF	5	0	1	0	3
134	OLEIC ACID						
		PRIMARY INF	0	0	1	2	147
		AERATION INF	0	0	1	5	183
		FINAL EFF	3	0	1	5	137
143	XYLENES						
		PRIMARY INF	2	0	1	0	10
		AERATION INF	1	4	0	1	28
		FINAL EFF	8	0	1	0	1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	RANGE 50-85	RANGE >85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	2	84
		PRIMARY INF	0	0	1	2	93
		AERATION INF	0	1	3	2	71
		FINAL EFF	0	4	5	0	57
145	PHENOL D5						
		RAW WATER	0	2	1	0	42
		PRIMARY INF	0	2	1	0	45
		AERATION INF	0	2	3	1	58
		FINAL EFF	0	7	2	0	43
146	NAPTHALENE D8						
		RAW WATER	0	1	1	1	63
		PRIMARY INF	0	1	2	0	59

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
146	NAPTHALENE D8	(CONT.)					
		AERATION INF	0	1	4	1	69
		FINAL EFF	0	2	7	0	52
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	1	2	101
		PRIMARY INF	0	0	3	0	66
		AERATION INF	0	0	1	5	97
		FINAL EFF	0	2	6	1	67

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	5
		PRIMARY INF	0	0	3	0	23
		AERATION INF	0	0	6	0	88
		FINAL EFF	0	0	9	0	33
151	COD (MG/LITER)						
		PRIMARY INF	0	0	3	0	190
		AERATION INF	0	0	6	0	363
		FINAL EFF	0	0	8	0	169

TABLE A-15

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 112 - WASTEPAPER-BOARD

*Only those compounds detected at the raw water, primary influent, lagoon 1 influent, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		AERATION INF	8	1	0	0	<1
		FINAL EFF	17	1	0	0	<1
11	1,1,1-TRICHLOROETHANE						
		LAGOON 1	0	3	0	0	4
		PRIMARY INF	1	2	0	0	2
		AERATION INF	5	4	0	0	<1
		FINAL EFF	15	3	0	0	<1
21	2,4,6-TRICHLOROPHENOL						
		RAW WATER	5	0	1	0	4
		PRIMARY INF	0	0	0	3	360
		AERATION INF	4	5	0	0	2
		FINAL EFF	13	2	0	3	72
23	CHLOROFORM						
		RAW WATER	5	0	1	0	17
		LAGOON 1	1	2	0	0	2
		AERATION INF	0	0	9	0	19
		FINAL EFF	15	1	2	0	2
44	METHYLENE CHLORIDE						
		RAW WATER	5	1	0	0	<1
		LAGOON 1	2	1	0	0	<1
		AERATION INF	4	5	0	0	1
		FINAL EFF	12	5	0	1	9
47	BROMOFORM						
		PRIMARY INF	2	0	0	1	40
		FINAL EFF	17	0	1	0	3
48	DICHLOROBROMETHANE						
		RAW WATER	5	0	1	0	6
		PRIMARY INF	2	1	0	0	<1
		FINAL EFF	15	3	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
51	DIBROMOCHLOROMETHANE						
		RAW WATER	4	2	0	0	1
64	PENTACHLOROPHENOL						
		RAW WATER	5	0	1	0	9
		LAGOON 1	1	0	2	0	10
		PRIMARY INF	0	0	0	3	1050
		AERATION INF	6	1	2	0	3
		FINAL EFF	15	0	0	3	200
65	PHENOL						
		RAW WATER	4	2	0	0	<1
		LAGOON I	0	0	3	0	69
		PRIMARY INF	0	0	0	3	457
		TRICKLING INF	0	0	3	0	22
		AERATION INF	0	2	7	0	37
		FINAL EFF	13	1	1	3	72
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	3	2	1	0	3
		LAGOON 1	0	2	1	0	15
		PRIMARY INF	0	0	3	0	23
		TRICKLING INF	0	1	2	0	35
		AERATION INF	2	5	2	0	6
		FINAL EFF	5	7	5	1	73
67	BUTYL BENZYL PHTHALATE						
		LAGOON 1	0	0	2	1	101
		PRIMARY INF	0	0	2	1	80
		AERATION INF	8	1	0	0	<1
		FINAL EFF	15	0	3	0	11
68	DI-N-BUTYL PHTHALATE						
		LAGOON 1	0	0	3	0	18
		PRIMARY INF	1	0	2	0	32
		TRICKLING INF	0	2	1	0	8

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
68	DI-N-BUTYL PHTHALATE	(CONT.)					
		AERATION INF	4	3	2	0	
		FINAL EFF	15	0	3	0	
70	DIETHYL PHTHALATE						
		LAGOON 1	0	0	3	0	5[illegible]
		PRIMARY INF	0	0	2	1	7[illegible]
		AERATION INF	6	0	0	3	13[illegible]
		FINAL EFF	12	1	0	5	6[illegible]
85	TETRACHLOROETHYLENE						
		RAW WATER	4	1	1	0	[illegible]
		AERATION INF	8	1	0	0	<[illegible]
86	TOLUENE						
		LAGOON 1	2	1	0	0	<[illegible]
		PRIMARY INF	0	3	0	0	[illegible]
		AERATION INF	2	1	6	0	1[illegible]
		FINAL EFF	9	9	0	0	[illegible]
87	TRICHLOROETHYLENE						
		RAW WATER	5	0	1	0	[illegible]
		LAGOON 1	2	1	0	0	<1
		AERATION INF	5	4	0	0	1
107	P.C.B. 1254						
		RAW WATER	5	1	0	0	<1
		PRIMARY INF	1	2	0	0	<1
		AERATION INF	8	1	0	0	<1
		FINAL EFF	14	4	0	0	<1
110	P.C.B. 1248						
		LAGOON 1	3	2	1	0	18
		PRIMARY INF	1	2	0	0	<1
		AERATION INF	6	3	0	0	<1
		FINAL EFF	15	2	1	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
119	CHROMIUM-CR						
		RAW WATER	2	4	0	0	2
		LAGOON 1	0	0	2	1	341
		PRIMARY INF	1	0	0	2	170
		AERATION INF	2	2	5	0	17
		FINAL EFF	6	3	6	3	33
120	COPPER-CU						
		RAW WATER	2	4	0	0	3
		LAGOON 1	0	0	0	3	317
		PRIMARY INF	1	0	0	2	107
		AERATION INF	2	0	6	1	42
		FINAL EFF	6	1	8	3	37
121	CYANIDE						
		RAW WATER	0	6	12	0	10
		LAGOON 1	0	3	0	0	9
		PRIMARY INF	0	0	2	1	74
		TRICKLING INF	0	1	1	1	76
		AERATION INF	0	4	5	0	16
		FINAL EFF	0	11	7	0	14
122	LEAD-PB						
		RAW WATER	2	4	0	0	3
		LAGOON 1	0	0	0	3	443
		PRIMARY INF	1	0	0	2	153
		AERATION INF	2	0	5	2	49
		FINAL EFF	6	1	9	2	31
123	MERCURY						
		RAW WATER	0	6	0	0	<1
		LAGOON 1	0	3	0	0	<1
		PRIMARY INF	0	3	0	0	<1
		TRICKLING INF	0	3	0	0	<1
		AERATION INF	0	9	0	0	<1
		FINAL EFF	0	18	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
124	NICKEL-NI						
		RAW WATER	2	3	1	0	4
		LAGOON 1	0	0	2	1	77
		PRIMARY INF	1	0	2	0	37
		AERATION INF	2	3	4	0	27
		FINAL EFF	6	2	10	0	17
128	ZINC-ZN						
		RAW WATER	0	4	2	0	22
		LAGOON 1	0	0	0	3	2077
		PRIMARY INF	0	0	0	3	1433
		TRICKLING INF	0	0	0	3	1983
		AERATION INF	1	0	2	6	648
		FINAL EFF	0	0	5	13	344
130	ABIETIC ACID						
		LAGOON 1	0	0	0	3	813
		PRIMARY INF	0	0	0	3	407
		TRICKLING INF	0	0	0	3	1500
		AERATION INF	0	0	3	6	314
		FINAL EFF	12	0	6	0	16
131	DEHYDROABIETIC ACID						
		LAGOON 1	0	0	0	3	467
		PRIMARY INF	0	0	0	3	467
		TRICKLING INF	0	0	0	3	397
		AERATION INF	0	0	0	9	511
		FINAL EFF	3	0	10	5	62
132	ISOPIMARIC ACID						
		LAGOON 1	0	0	0	3	327
		PRIMARY INF	0	0	3	0	84
		TRICKLING INF	0	0	0	3	190
		AERATION INF	0	0	9	0	40
		FINAL EFF	17	1	0	0	<1
133	PIMARIC ACID						
		LAGOON 1	0	0	0	3	148

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
133	PIMARIC ACID	(CONT					
		PRIMARY INF	0	0	3	0	41
		TRICKLING INF	0	0	3	0	81
		AERATION INF	4	0	5	0	27
134	OLEIC ACID						
		RAW WATER	5	1	0	0	1
		LAGOON 1	0	0	0	3	617
		PRIMARY INF	0	0	0	3	290
		TRICKLING INF	0	0	0	3	533
		AERATION INF	0	0	2	7	182
		FINAL EFF	8	0	6	4	65
135	LINOLEIC ACID						
		AERATION INF	4	0	5	0	42
136	LINOLENIC ACID						
		AERATION INF	6	0	3	0	23
		FINAL EFF	17	0	1	0	<1
137	EPOXYSTEARIC ACID						
		LAGOON 1	0	0	0	3	413
143	XYLENES						
		LAGOON 1	1	2	0	0	<1
		PRIMARY INF	2	1	0	0	<1
		AERATION INF	6	3	0	0	2

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	1	2	3	88
		LAGOON 1	0	3	0	0	31
		PRIMARY INF	0	3	0	0	39
		TRICKLING INF	0	0	2	1	81
		AERATION INF	0	1	4	4	77
		FINAL EFF	0	0	11	7	88
145	PHENOL D5						

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
145	PHENOL D5	(CONT.)					
		LAGOON 1	0	3	0	0	35
		PRIMARY INF	0	0	2	1	80
		TRICKLING INF	0	1	1	1	64
		AERATION INF	0	4	5	0	57
		FINAL EFF	0	7	7	4	64
146	NAPTHALENE D8						
		RAW WATER	0	3	3	0	50
		LAGOON 1	0	2	1	0	42
		PRIMARY INF	0	2	1	0	55
		TRICKLING INF	0	3	0	0	34
		AERATION INF	0	3	6	0	55
		FINAL EFF	0	10	6	2	54
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	3	3	79
		LAGOON 1	0	1	2	0	53
		PRIMARY INF	0	1	1	1	61
		TRICKLING INF	0	2	1	0	50
		AERATION INF	0	1	5	3	73
		FINAL EFF	0	0	10	8	78

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	6	0	28
		LAGOON 1	0	0	3	0	185
		PRIMARY INF	0	0	0	3	960
		TRICKLING INF	0	0	3	0	39
		AERATION INF	0	0	8	1	191
		FINAL EFF	0	0	15	3	221
151	COD (MG/LITER)						
		LAGOON 1	0	0	0	3	3790
		PRIMARY INF	0	0	0	3	8833
		TRICKLING INF	0	0	1	2	563
		AERATION INF	1	0	[illegible]	[illegible]	[illegible]

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	RANGE ND	<5	5-500	>500	AVERAGE VALUE
		FINAL EFF	0	0	13	5	967

TABLE A-16

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 113 - WASTEPAPER-MOLDED PRODUCTS

*Only those compounds detected at the raw water, aeration influent, discharge to POTW and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		RAW WATER	1	1	0	0	2
44	METHYLENE CHLORIDE						
		RAW WATER	1	1	0	0	<1
		AERATION INF	1	2	0	0	<1
		FINAL EFF	2	1	0	0	<1
64	PENTACHLOROPHENOL						
		RAW WATER	1	1	0	0	2
		AERATION INF	2	1	0	0	2
65	PHENOL						
		RAW WATER	1	1	0	0	2
		AERATION INF	0	3	0	0	8
		DISCH. POTW	0	3	0	0	6
		FINAL EFF	2	1	0	0	<1
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	2	0	0	5
		AERATION INF	0	3	0	0	2
		DISCH. POTW	0	0	3	0	14
		FINAL EFF	2	1	0	0	<1
86	TOLUENE						
		RAW WATER	1	1	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	2	0	0	2
		AERATION INF	0	2	1	0	9
		DISCH. POTW	0	3	0	0	5
		FINAL EFF	0	3	0	0	3
120	COPPER-CU						
		RAW WATER	0	1	1	0	27
		AERATION INF	0	1	2	0	16

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
120	COPPER-CU	(CONT.)					
		DISCH. POTW	0	0	3	0	37
		FINAL EFF	0	3	0	0	4
121	CYANIDE						
		RAW WATER	0	2	4	0	10
		AERATION INF	0	3	0	0	9
		DISCH. POTW	0	3	0	0	9
		FINAL EFF	0	3	0	0	9
122	LEAD-PB						
		RAW WATER	0	2	0	0	4
		AERATION INF	0	1	2	0	22
		DISCH. POTW	0	1	2	0	13
		FINAL EFF	0	1	2	0	12
123	MERCURY						
		RAW WATER	0	2	0	0	3
		AERATION INF	0	3	0	0	<1
		DISCH. POTW	0	3	0	0	5
		FINAL EFF	0	3	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	1	1	0	6
		AERATION INF	0	0	3	0	23
		DISCH. POTW	0	3	0	0	2
		FINAL EFF	0	3	0	0	3
128	ZINC-ZN						
		RAW WATER	0	0	2	0	12
		AERATION INF	0	0	0	3	392
		DISCH. POTW	0	0	0	3	200
		FINAL EFF	0	0	3	0	52
130	ABIETIC ACID						
		AERATION INF	0	0	0	3	210

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
130	ABIETIC ACID	(CONT.)					
		DISCH. POTW	0	0	0	3	633
131	DEHYDROABIETIC ACID						
		RAW WATER	1	0	1	0	37
		AERATION INF	0	0	0	3	453
		DISCH. POTW	0	0	0	3	573
		FINAL EFF	2	0	0	1	57
132	ISOPIMARIC ACID						
		AERATION INF	0	0	3	0	48
		DISCH. POTW	0	0	2	1	94
133	PIMARIC ACID						
		AERATION INF	0	0	3	0	57
134	OLEIC ACID						
		AERATION INF	0	0	0	3	493
		DISCH. POTW	0	0	0	3	355
135	LINOLEIC ACID						
		AERATION INF	0	0	0	3	207
		DISCH. POTW	0	0	0	3	122
137	EPOXYSTEARIC ACID						
		AERATION INF	2	0	1	0	10
		FINAL EFF	2	0	1	0	9

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	1	99
		AERATION INF	0	0	0	3	105
		DISCH. POTW	0	0	1	2	88
		FINAL EFF	0	0	1	2	86
145	PHENOL D5						
		RAW WATER	0	0	1	0	64

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
145	PHENOL D5	(CONT.)					
		AERATION INF	0	0	3	0	59
		DISCH. POTW	0	0	1	2	89
		FINAL EFF	0	0	2	1	73
146	NAPTHALENE D8						
		RAW WATER	0	0	2	0	76
		AERATION INF	0	0	1	2	89
		DISCH. POTW	0	0	1	2	93
		FINAL EFF	0	1	2	0	60
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	1	1	96
		AERATION INF	0	0	3	0	61
		DISCH. POTW	0	0	1	2	92
		FINAL EFF	0	0	3	0	63

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	18
		AERATION INF	0	0	3	0	121
		DISCH. POTW	0	0	3	0	53
		FINAL EFF	0	0	2	1	302
151	COD (MG/LITER)						
		AERATION INF	0	0	3	0	291
		DISCH. POTW	0	0	0	3	693
		FINAL EFF	0	0	3	0	82

TABLE A-17

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 114 - WASTEPAPER CONSTRUCTION PRODUCTS

*Only those compounds detected at the raw water, clarifier influent, clarifier storage and discharge to POTW have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
4	BENZENE						
		DISCH. POTW	7	2	0	0	<1
11	1.1.1-TRICHLOROETHANE						
		RAW WATER	4	0	1	0	6
		DISCH. POTW	3	4	2	0	6
23	CHLOROFORM						
		RAW WATER	3	1	1	0	10
		DISCH. POTW	7	1	1	0	3
38	ETHYLBENZENE						
		RAW WATER	4	1	0	0	<1
		DISCH. POTW	7	1	1	0	1
44	METHYLENE CHLORIDE						
		RAW WATER	3	2	0	0	<1
		DISCH. POTW	6	3	0	0	<1
47	BROMOFORM						
		RAW WATER	4	0	1	0	14
48	DICHLOROBROMETHANE						
		RAW WATER	4	0	1	0	6
		DISCH. POTW	8	0	1	0	2
49	TRICHLOROFLUOROMETHANE						
		DISCH. POTW	8	1	0	0	<1
51	DIBROMOCHLOROMETHANE						
		RAW WATER	4	0	1	0	2
		DISCH. POTW	8	1	0	0	<1
64	PENTACHLOROPHENOL						
		RAW WATER	4	0	1	0	6
		DISCH. POTW	4	0	4	1	35

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
65	PHENOL						
		RAW WATER	4	0	1	0	17
		CLARIF. INF	0	0	0	3	1233
		CLARIF.WTR.STOR	0	0	0	3	1433
		DISCH. POTW	1	0	5	3	102
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	3	0	2	0	20
		DISCH. POTW	1	2	6	0	30
67	BUTYL BENZYL PHTHALATE						
		RAW WATER	4	1	0	0	2
		DISCH. POTW	6	2	1	0	3
68	DI-N-BUTYL PHTHALATE						
		RAW WATER	4	1	0	0	<1
		DISCH. POTW	2	4	3	0	16
70	DIETHYL PHTHALATE						
		RAW WATER	4	1	0	0	<1
		DISCH. POTW	3	3	2	1	29
85	TETRACHLOROETHYLENE						
		DISCH. POTW	8	1	0	0	<1
86	TOLUENE						
		RAW WATER	4	0	1	0	14
		DISCH. POTW	2	4	2	1	81
87	TRICHLOROETHYLENE						
		RAW WATER	4	1	0	0	<1
		DISCH. POTW	4	3	2	0	7
106	P.C.B. 1242						
		CLARIF. INF	2	1	0	0	<1
		CLARIF.WTR.STOR	2	1	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
107	P.C.B. 1254						
		CLARIF. INF	2	1	0	0	<1
		DISCH. POTW	7	2	0	0	<1
110	P.C.B. 1248						
		DISCH. POTW	7	2	0	0	1
119	CHROMIUM-CR						
		RAW WATER	0	4	0	1	24
		CLARIF.WTR.STOR	0	0	0	3	337
		DISCH. POTW	0	0	8	1	81
120	COPPER-CU						
		RAW WATER	0	1	3	1	40
		CLARIF.WTR.STOR	0	0	0	3	202
		DISCH. POTW	0	0	3	6	145
121	CYANIDE						
		RAW WATER	0	6	6	1	21
		CLARIF.WTR.STOR	0	0	1	2	108
		DISCH. POTW	0	1	1	7	352
122	LEAD-PB						
		RAW WATER	0	4	0	1	38
		CLARIF.WTR.STOR	0	0	0	3	273
		DISCH. POTW	0	0	2	7	264
123	MERCURY						
		RAW WATER	0	4	0	0	<1
		CLARIF.WTR.STOR	0	3	0	0	<1
		DISCH. POTW	0	9	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	3	1	1	29
		CLARIF.WTR.STOR	0	0	2	1	115
		DISCH. POTW	0	0	9	0	40

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. [illegible]/L
128	ZINC-ZN						
		RAW WATER	0	0	3	2	238
		CLARIF.WTR.STOR	0	0	0	3	2800
		DISCH. POTW	0	1	0	8	998
130	ABIETIC ACID						
		DISCH. POTW	1	0	0	8	4179
131	DEHYDROABIETIC ACID						
		RAW WATER	4	0	0	1	94
		CLARIF. INF	0	0	0	3	143
		CLARIF.WTR.STOR	0	0	2	1	117
		DISCH. POTW	1	0	0	8	899
132	ISOPIMARIC ACID						
		RAW WATER	4	0	0	1	42
		DISCH. POTW	1	0	1	7	958
133	PIMARIC ACID						
		RAW WATER	4	0	1	0	14
		DISCH. POTW	1	0	3	5	471
134	OLEIC ACID						
		RAW WATER	4	0	0	1	108
		DISCH. POTW	0	0	0	9	1307
135	LINOLEIC ACID						
		RAW WATER	4	0	0	1	50
		DISCH. POTW	1	0	0	8	850
143	XYLENES						
		RAW WATER	4	0	1	0	3
		CLARIF. INF	2	0	1	0	5
		CLARIF.WTR.STOR	1	0	2	0	16
		DISCH. POTW	1	5	3	0	16

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	1	1	2	87

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID	(CONT.)					
		DISCH. POTW	0	2	2	1	55
145	PHENOL D5						
		RAW WATER	0	2	2	1	62
		CLARIF. INF	0	2	1	0	45
		CLARIF.WTR.STOR	0	2	1	0	44
		DISCH. POTW	1	3	5	0	44
146	NAPTHALENE D8						
		RAW WATER	0	1	3	1	61
		CLARIF. INF	0	1	2	0	58
		CLARIF.WTR.STOR	0	0	2	1	87
		DISCH. POTW	1	3	1	1	37
148	DI-AMYL PHTHALATE						
		RAW WATER	0	1	1	2	77
		DISCH. POTW	1	4	4	0	46

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	1	339
		CLARIF.WTR.STOR	0	0	0	3	8000
		DISCH. POTW	0	0	2	7	936
151	COD (MG/LITER)						
		CLARIF.WTR.STOR	0	0	0	3	16667
		DISCH. POTW	1	0	0	8	3487

TABLE A-18

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 201 - NONINTEGRATED-FINE

*Only those compounds detected at the raw water, raw wastewater, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		RAW WATER	2	1	0	0	<1
		RAW WASTEWATER	2	1	0	0	<1
		FINAL EFF	7	2	0	0	<1
10	1,2,-DICHLOROETHANE						
		AERATION INF	5	1	0	0	<1
		FINAL EFF	6	3	0	0	<1
23	CHLOROFORM						
		RAW WASTEWATER	0	3	0	0	7
		AERATION INF	3	2	1	0	6
		FINAL EFF	3	6	0	0	3
44	METHYLENE CHLORIDE						
		RAW WASTEWATER	1	1	1	0	7
		AERATION INF	5	1	0	0	<1
		FINAL EFF	5	4	0	0	2
65	PHENOL						
		RAW WATER	2	1	0	0	<1
		RAW WASTEWATER	0	0	2	1	94
		AERATION INF	2	3	1	0	6
		FINAL EFF	6	0	3	0	13
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	2	1	0	0	1
		RAW WASTEWATER	0	0	0	3	1193
		AERATION INF	3	2	1	0	3
		FINAL EFF	2	3	3	1	294
86	TOLUENE						
		RAW WATER	2	1	0	0	<1
		FINAL EFF	6	3	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	3	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
119	CHROMIUM-CR	(CONT.)					
		RAW WASTEWATER	0	3	0	0	5
		AERATION INF	0	6	0	0	3
		FINAL EFF	0	9	0	0	1
120	COPPER-CU						
		RAW WATER	0	1	2	0	9
		RAW WASTEWATER	0	1	2	0	43
		AERATION INF	0	1	5	0	13
		FINAL EFF	0	4	5	0	18
122	LEAD-PB						
		RAW WATER	0	2	1	0	6
		RAW WASTEWATER	0	2	1	0	5
		AERATION INF	0	6	0	0	3
		FINAL EFF	0	7	2	0	6
123	MERCURY						
		RAW WATER	0	2	0	0	<1
		RAW WASTEWATER	0	3	0	0	<1
		AERATION INF	0	6	0	0	<1
		FINAL EFF	0	9	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	3	0	0	4
		RAW WASTEWATER	0	2	1	0	5
		AERATION INF	0	5	1	0	5
		FINAL EFF	0	8	1	0	4
128	ZINC-ZN						
		RAW WATER	0	1	2	0	26
		RAW WASTEWATER	0	0	3	0	71
		AERATION INF	0	2	3	1	55
		FINAL EFF	0	1	6	2	51
130	ABIETIC ACID						
		AERATION INF	2	0	2	2	205

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
131	DEHYDROABIETIC ACID						
		RAW WATER	2	1	0	0	3
		RAW WASTEWATER	0	0	0	3	483
		AERATION INF	0	0	0	6	443
		FINAL EFF	2	0	6	1	52
132	ISOPIMARIC ACID						
		AERATION INF	2	0	3	1	40
133	PIMARIC ACID						
		AERATION INF	3	0	3	0	12
134	OLEIC ACID						
		AERATION INF	4	0	2	0	19
135	LINOLEIC ACID						
		AERATION INF	5	0	0	1	33

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	1	1	0	62
		RAW WASTEWATER	0	2	1	0	24
		AERATION INF	0	0	2	3	89
		FINAL EFF	2	2	2	3	53
145	PHENOL D5						
		RAW WATER	0	1	0	1	67
		RAW WASTEWATER	0	1	0	2	95
		AERATION INF	1	0	4	1	61
		FINAL EFF	1	2	5	1	56
146	NAPTHALENE D8						
		RAW WATER	0	1	1	0	52
		RAW WASTEWATER	0	3	0	0	37
		AERATION INF	0	0	2	1	84
		FINAL EFF	0	3	3	0	51

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
148	DI-AMYL PHTHALATE	(CONT.)					
		AERATION INF	0	0	1	2	82
		FINAL EFF	0	0	3	0	79

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	83
		RAW WASTEWATER	0	0	2	1	311
		AERATION INF	0	0	6	0	5
		FINAL EFF	0	0	9	0	15
151	COD (MG/LITER)						
		RAW WATER	0	0	1	0	9
		RAW WASTEWATER	0	0	2	1	433
		AERATION INF	0	0	6	0	168
		FINAL EFF	0	0	9	0	66

TABLE A-19

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 202 - NONINTEGRATED TISSUE

*Only those compounds detected at the raw water, flotation influent, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
23	CHLOROFORM						
		FLOTATION INF	0	3	0	0	3
		FINAL EFF	3	3	0	0	2
38	ETHYLBENZENE						
		FLOTATION INF	0	0	1	2	13081
		FINAL EFF	3	0	1	2	74
65	PHENOL						
		RAW WATER	1	1	0	0	3
		FLOTATION INF	1	2	0	0	1
		AERATION INF	0	2	1	0	5
		FINAL EFF	2	4	0	0	3
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	1	1	0	18
		FLOTATION INF	0	2	1	0	8
		AERATION INF	0	1	2	0	30
		FINAL EFF	1	2	3	0	15
67	BUTYL BENZYL PHTHALATE						
		FLOTATION INF	0	0	0	3	797
		FINAL EFF	5	0	1	0	3
68	DI-N-BUTYL PHTHALATE						
		FLOTATION INF	2	1	0	0	<1
70	DIETHYL PHTHALATE						
		FLOTATION INF	2	0	1	0	12
85	TETRACHLOROETHYLENE						
		FINAL EFF	3	3	0	0	4
86	TOLUENE						
		FLOTATION INF	0	2	0	1	130
		FINAL EFF	3	2	1	0	3

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
87	TRICHLOROETHYLENE						
		RAW WATER	1	1	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	1	1	0	0	<1
		FLOTATION INF	1	0	2	0	15
		AERATION INF	0	3	0	0	2
		FINAL EFF	2	4	0	0	2
120	COPPER-CU						
		RAW WATER	1	1	0	0	4
		FLOTATION INF	1	0	2	0	45
		AERATION INF	0	0	3	0	19
		FINAL EFF	2	0	4	0	15
122	LEAD-PB						
		RAW WATER	1	1	0	0	<1
		FLOTATION INF	1	1	1	0	11
		AERATION INF	0	3	0	0	2
		FINAL EFF	2	4	0	0	1
123	MERCURY						
		RAW WATER	0	2	0	0	<1
		FLOTATION INF	0	3	0	0	<1
		AERATION INF	0	3	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	1	1	0	0	<1
		FLOTATION INF	1	2	0	0	1
		AERATION INF	0	3	0	0	2
		FINAL EFF	2	4	0	0	2
128	ZINC-ZN						
		RAW WATER	0	0	2	0	32
		FLOTATION INF	0	0	2	1	92

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
128	ZINC-ZN (CONT.)						
		AERATION INF	0	0	0	3	53333
		FINAL EFF	0	0	5	1	56
130	ABIETIC ACID						
		FLOTATION INF	0	0	3	0	53
131	DEHYDROABIETIC ACID						
		FLOTATION INF	0	0	0	3	213
		FINAL EFF	3	0	2	1	49
132	ISOPIMARIC ACID						
		FLOTATION INF	0	0	3	0	37
		FINAL EFF	5	1	0	0	<1
133	PIMARIC ACID						
		FLOTATION INF	1	0	2	0	10
134	OLEIC ACID						
		FLOTATION INF	0	0	0	3	260
		AERATION INF	0	2	1	0	13
		FINAL EFF	2	0	4	0	27
143	XYLENES						
		FLOTATION INF	0	0	0	3	13547
		FINAL EFF	3	0	0	3	400

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	1	0	1	78
		FLOTATION INF	0	0	2	1	77
		AERATION INF	0	1	2	0	46
		FINAL EFF	0	2	1	3	81
145	PHENOL D5						
		RAW WATER	0	0	1	0	58
		FLOTATION INF	0	0	3	0	77

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
145	PHENOL D5	(CONT.)					
		AERATION INF	0	2	1	0	43
		FINAL EFF	0	1	4	1	70
146	NAPTHALENE D8						
		RAW WATER	0	2	0	0	38
		FLOTATION INF	0	2	1	0	46
		AERATION INF	0	0	3	0	60
		FINAL EFF	0	1	4	1	60
148	DI-AMYL PHTHALATE						
		RAW WATER	0	1	1	0	51
		FLOTATION INF	0	1	2	0	52
		AERATION INF	0	3	0	0	41
		FINAL EFF	0	2	4	0	65

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	5
		FLOTATION INF	0	0	3	0	5
		AERATION INF	0	0	3	0	5
		FINAL EFF	0	0	6	0	5
151	COD (MG/LITER)						
		FLOTATION INF	0	0	2	1	395
		AERATION INF	0	0	3	0	18
		FINAL EFF	0	0	6	0	111

TABLE A-20

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

NONINTEGRATED-MISCELLANEOUS

*Only those compounds detected at the raw water, clarifier influent, and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		RAW WATER	2	1	0	0	<1
		CLARIF. INF	7	2	0	0	<1
		FINAL EFF	8	1	0	0	<1
11	1,1,1-TRICHLOROETHANE						
		RAW WATER	2	0	1	0	4
		CLARIF. INF	3	4	2	0	7
		FINAL EFF	3	5	1	0	4
21	2,4,6-TRICHLOROPHENOL						
		RAW WATER	2	1	0	0	<1
		CLARIF. INF	6	1	2	0	6
		FINAL EFF	6	1	2	0	6
23	CHLOROFORM						
		CLARIF. INF	6	2	1	0	3
		FINAL EFF	6	3	0	0	1
38	ETHYLBENZENE						
		FINAL EFF	7	1	1	0	4
64	PENTACHLOROPHENOL						
		CLARIF. INF	7	0	1	1	24
		FINAL EFF	8	0	1	0	8
65	PHENOL						
		RAW WATER	1	1	0	1	58
		CLARIF. INF	3	5	1	0	5
		FINAL EFF	4	5	0	0	2
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	3	0	0	6
		CLARIF. INF	0	3	5	1	26
		FINAL EFF	1	6	2	0	6
86	TOLUENE						
		CLARIF. INF	8	1	0	0	<1

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
86	TOLUENE	(CONT.)					
		FINAL EFF	4	5	0	0	2
107	P.C.B. 1254						
		CLARIF. INF	6	1	0	0	1
		FINAL EFF	6	1	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	3	0	0	2
		CLARIF. INF	0	5	4	0	13
		FINAL EFF	1	8	0	0	2
120	COPPER-CU						
		RAW WATER	0	3	0	0	6
		CLARIF. INF	0	3	6	0	46
		FINAL EFF	1	4	4	0	8
121	CYANIDE						
		RAW WATER	0	1	0	0	9
		CLARIF. INF	0	3	0	0	9
		FINAL EFF	0	3	0	0	9
122	LEAD-PB						
		RAW WATER	0	2	1	0	14
		CLARIF. INF	0	4	5	0	14
		FINAL EFF	0	8	1	0	5
123	MERCURY						
		RAW WATER	0	3	0	0	<1
		CLARIF. INF	0	9	0	0	<1
		FINAL EFF	0	9	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	3	0	0	3
		CLARIF. INF	1	3	5	0	20
		FINAL EFF	0	8	1	0	5

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC., UG/L
128	ZINC-ZN						
		RAW WATER	0	1	2	0	16
		CLARIF. INF	0	0	5	4	543
		FINAL EFF	0	4	3	2	138
130	ABIETIC ACID						
		CLARIF. INF	6	0	0	3	59
131	DEHYDROABIETIC ACID						
		RAW WATER	2	1	0	0	3
		CLARIF. INF	1	1	4	3	121
		FINAL EFF	3	1	1	4	93
132	ISOPIMARIC ACID						
		CLARIF. INF	6	0	2	1	28
		FINAL EFF	8	0	1	0	2
133	PIMARIC ACID						
		CLARIF. INF	7	0	2	0	11
135	LINOLEIC ACID						
		RAW WATER	2	0	1	0	19
		CLARIF. INF	8	0	1	0	9
143	XYLENES						
		CLARIF. INF	6	2	1	0	3
		FINAL EFF	6	1	1	1	49

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	0	1	1	89
		CLARIF. INF	0	1	5	3	82
		FINAL EFF	0	2	4	3	77
145	PHENOL D5						

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
145	PHENOL D5	(CONT.)					
		FINAL EFF	1	1	6	1	60
146	NAPTHALENE D8						
		RAW WATER	0	0	0	2	113
		CLARIF. INF	0	0	7	2	74
		FINAL EFF	0	0	5	4	77
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	2	114
		CLARIF. INF	0	1	4	4	84
		FINAL EFF	0	0	4	5	97

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	3	0	5
		CLARIF. INF	0	0	9	0	5
		FINAL EFF	0	0	9	0	5
151	COD (MG/LITER)						
		CLARIF. INF	0	0	7	2	287
		FINAL EFF	0	0	9	0	62

TABLE A-21

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 204 - NONINTEGRATED LIGHTWEIGHT

*Only those compounds detected at the raw water, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
23	CHLOROFORM						
		AERATION INF	0	0	3	0	27
		FINAL EFF	0	3	0	0	3
44	METHYLENE CHLORIDE						
		RAW WATER	0	1	0	0	2
		AERATION INF	2	1	0	0	<1
		FINAL EFF	1	2	0	0	<1
65	PHENOL						
		RAW WATER	0	1	0	0	7
		AERATION INF	2	2	0	0	2
		FINAL EFF	1	2	0	0	2
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	0	1	0	0	4
		AERATION INF	0	3	0	0	5
		FINAL EFF	0	3	0	0	7
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	2	1	0	0	<1
		FINAL EFF	2	1	0	0	2
86	TOLUENE						
		AERATION INF	1	2	0	0	2
		FINAL EFF	1	2	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	1	0	0	2
		AERATION INF	1	2	0	0	2
		FINAL EFF	1	2	0	0	2
120	COPPER-CU						
		RAW WATER	0	0	1	0	23
		AERATION INF	1	0	2	0	19
		FINAL EFF	1	1	1	0	4

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<10	RANGE 10-100	>100	AVERAGE CONC. UG/L
121	CYANIDE						
		RAW WATER	0	1	2	0	10
		AERATION INF	0	3	0	0	9
		FINAL EFF	0	3	0	0	9
122	LEAD-PB						
		RAW WATER	0	1	0	0	4
		AERATION INF	1	1	1	0	6
		FINAL EFF	1	2	0	0	<1
123	MERCURY						
		RAW WATER	0	1	0	0	<1
		AERATION INF	0	3	0	0	<1
		FINAL EFF	0	3	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	1	0	0	2
		AERATION INF	1	2	0	0	1
		FINAL EFF	1	2	0	0	<1
128	ZINC-ZN						
		RAW WATER	0	1	0	0	5
		AERATION INF	0	0	3	0	16
		FINAL EFF	1	2	0	0	4
143	XYLENES						
		AERATION INF	1	2	0	0	5

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	1	0	0	32
		AERATION INF	0	2	1	0	43
		FINAL EFF	0	2	1	0	43
145	PHENOL D5						

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<50	RANGE 50-85	>85	AVERAGE % RECOVERY
145	PHENOL D5	(CONT.)					
		FINAL EFF	0	0	3	0	72
146	NAPTHALENE D8						
		RAW WATER	0	0	1	0	74
		AERATION INF	0	0	3	0	60
		FINAL EFF	0	0	2	1	77
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	1	0	84
		AERATION INF	0	0	2	1	79
		FINAL EFF	0	0	3	0	82

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	<5	RANGE 5-500	>500	VERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	1	0	5
		AERATION INF	0	0	3	0	5
		FINAL EFF	1	0	2	0	3
151	COD (MG/LITER)						
		AERATION INF	0	0	3	0	313
		FINAL EFF	0	0	3	0	69

TABLE A-22

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 205 - NONINTEGRATED FILTER AND NONWOVEN

*Only those compounds detected at the raw water, clarifier influent, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		RAW WATER	1	1	0	0	2
		FINAL EFF	5	1	0	0	<1
38	ETHYLBENZENE						
		AERATION INF	2	1	0	0	<1
65	PHENOL						
		RAW WATER	1	1	0	0	2
		AERATION INF	0	1	1	1	65
		FINAL EFF	3	1	2	0	6
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	1	0	1	0	39
		AERATION INF	0	0	2	1	85
		FINAL EFF	2	1	3	0	16
86	TOLUENE						
		AERATION INF	2	1	0	0	2
107	P.C.B. 1254						
		RAW WATER	1	1	0	0	<1
		CLARIF. INF	0	1	1	0	15
		FINAL EFF	4	1	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	1	1	0	0	<1
		CLARIF. INF	0	3	0	0	<1
		AERATION INF	0	3	0	0	6
		FINAL EFF	1	5	0	0	2
120	COPPER-CU						
		RAW WATER	1	1	0	0	4
		CLARIF. INF	0	0	3	0	19
		AERATION INF	0	1	1	1	61
		FINAL EFF	1	3	2	0	7

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	RANGE 10-100	RANGE >100	AVERAGE CONC. UG/L
121	CYANIDE						
		RAW WATER	0	1	2	0	10
		AERATION INF	0	1	2	0	11
		FINAL EFF	0	3	0	0	9
122	LEAD-PB						
		RAW WATER	1	1	0	0	<1
		CLARIF. INF	0	2	1	0	8
		AERATION INF	0	3	0	0	4
		FINAL EFF	1	4	1	0	3
123	MERCURY						
		RAW WATER	0	2	0	0	<1
		CLARIF. INF	0	3	0	0	<1
		AERATION INF	0	3	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	1	1	0	0	<1
		CLARIF. INF	0	3	0	0	<1
		AERATION INF	0	3	0	0	2
		FINAL EFF	1	5	0	0	2
128	ZINC-ZN						
		RAW WATER	0	2	0	0	3
		CLARIF. INF	0	0	3	0	13
		AERATION INF	0	0	0	3	159
		FINAL EFF	0	2	4	0	34
131	DEHYDROABIETIC ACID						
		AERATION INF	1	0	2	0	33
135	LINOLEIC ACID						
		FINAL EFF	5	1	0	0	2

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	RANGE 50-85	RANGE >85	AVERAGE % RECOVERY

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID	(CONT.)					
		CLARIF. INF	0	0	3	0	63
		AERATION INF	0	1	1	1	68
		FINAL EFF	0	1	4	1	64
145	PHENOL D5						
		RAW WATER	0	1	1	0	63
		CLARIF. INF	0	2	1	0	48
		AERATION INF	0	0	1	2	87
		FINAL EFF	0	1	3	2	68
146	NAPTHALENE D8						
		RAW WATER	0	0	1	1	90
		CLARIF. INF	0	0	1	2	93
		AERATION INF	0	1	2	0	64
		FINAL EFF	0	1	2	3	82
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	0	1	93
		AERATION INF	0	0	3	0	69
		FINAL EFF	0	1	0	2	77

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	5-500	>500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	8
		CLARIF. INF	0	0	3	0	5
		AERATION INF	0	0	3	0	43
		FINAL EFF	0	0	6	0	8
151	COD (MG/LITER)						
		CLARIF. INF	0	0	3	0	104
		AERATION INF	0	0	3	0	240
		FINAL EFF	0	0	6	0	39

TABLE A-23

SUMMARY OF VERIFICATION ANALYSIS RESULTS*

SUBCATEGORY 211 - NONINTEGRATED PAPERBOARD

*Only those compounds detected at the raw water, oxidation influent, aeration influent and final effluent have been summarized.

The analysis results presented are preliminary, confirmation of the results are presently in progress.

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
4	BENZENE						
		OXID. INF	2	1	0	0	1
		AERATION INF	2	1	0	0	<1
		FINAL EFF	5	1	0	0	<1
38	ETHYLBENZENE						
		OXID. INF	0	3	0	0	3
		FINAL EFF	4	2	0	0	<1
44	METHYLENE CHLORIDE						
		RAW WATER	1	1	0	0	3
		OXID. INF	2	1	0	0	<1
65	PHENOL						
		OXID. INF	0	2	1	0	7
		AERATION INF	0	3	0	0	6
		FINAL EFF	3	3	0	0	1
66	BIS(2-ETHYL HEXYL) PHTHALATE						
		RAW WATER	1	0	1	0	42
		OXID. INF	0	2	1	0	14
		AERATION INF	0	2	1	0	7
		FINAL EFF	3	3	0	0	2
68	DI-N-BUTYL PHTHALATE						
		AERATION INF	0	0	0	3	180
70	DIETHYL PHTHALATE						
		OXID. INF	2	0	1	0	4
		FINAL EFF	4	0	1	1	29
85	TETRACHLOROETHYLENE						
		AERATION INF	0	3	0	0	3
86	TOLUENE						
		OXID. INF	0	3	0	0	3

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
86	TOLUENE	(CONT.)					
		FINAL EFF	2	4	0	0	<1
119	CHROMIUM-CR						
		RAW WATER	0	2	0	0	2
		OXID. INF	0	0	0	3	1323
		AERATION INF	0	2	1	0	26
		FINAL EFF	0	5	1	0	6
120	COPPER-CU						
		RAW WATER	0	2	0	0	4
		OXID. INF	0	0	2	1	128
		AERATION INF	0	0	3	0	27
		FINAL EFF	0	5	1	0	4
121	CYANIDE						
		RAW WATER	0	4	2	0	9
		OXID. INF	0	0	1	2	610
		AERATION INF	0	3	0	0	9
		FINAL EFF	0	3	3	0	26
122	LEAD-PB						
		RAW WATER	0	2	0	0	2
		OXID. INF	0	0	0	3	6667
		AERATION INF	0	3	0	0	2
		FINAL EFF	0	4	2	0	9
123	MERCURY						
		RAW WATER	0	2	0	0	<1
		OXID. INF	0	3	0	0	<1
		AERATION INF	0	3	0	0	<1
		FINAL EFF	0	6	0	0	<1
124	NICKEL-NI						
		RAW WATER	0	2	0	0	3
		OXID. INF	0	2	1	0	8

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <10	10-100	>100	AVERAGE CONC. UG/L
124	NICKEL-NI	(CONT.)					
		AERATION INF	0	1	2	0	18
		FINAL EFF	0	4	2	0	5
128	ZINC-ZN						
		RAW WATER	0	1	1	0	15
		OXID. INF	0	0	1	2	147
		AERATION INF	0	0	0	3	1273
		FINAL EFF	0	3	1	2	72
130	ABIETIC ACID						
		OXID. INF	0	0	0	3	1477
		AERATION INF	2	0	1	0	7
131	DEHYDROABIETIC ACID						
		OXID. INF	0	0	0	3	667
		AERATION INF	0	0	0	3	160
		FINAL EFF	2	1	1	2	64
132	ISOPIMARIC ACID						
		OXID. INF	0	0	1	2	117
		AERATION INF	0	3	0	0	8
133	PIMARIC ACID						
		OXID. INF	0	0	3	0	25
134	OLEIC ACID						
		OXID. INF	0	0	0	3	260
143	XYLENES						
		OXID. INF	0	2	1	0	8
		FINAL EFF	3	3	0	0	2

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <50	50-85	>85	AVERAGE % RECOVERY
144	STEARIC ACID						
		RAW WATER	0	2	0	0	36
		OXID. INF	0	1	2	0	59

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION		RANGE <50	RANGE 50-85	RANGE >85	AVERAGE % RECOVERY
144	STEARIC ACID	(CONT.)					
		AERATION INF	0	1	2	0	51
		FINAL EFF	0	4	2	0	49
145	PHENOL D5						
		RAW WATER	0	1	0	1	65
		OXID. INF	0	2	1	0	46
		AERATION INF	0	0	2	1	86
		FINAL EFF	0	3	2	1	60
146	NAPTHALENE D8						
		RAW WATER	0	1	1	0	52
		OXID. INF	0	3	0	0	37
		AERATION INF	0	2	1	0	42
		FINAL EFF	0	3	3	0	47
148	DI-AMYL PHTHALATE						
		RAW WATER	0	0	1	1	80
		OXID. INF	0	0	2	1	70
		AERATION INF	0	0	2	1	79
		FINAL EFF	0	0	4	2	83

PRIORITY NUMBER	CHEMICAL-NAME	SAMPLE LOCATION	ND	RANGE <5	RANGE 5-500	RANGE >500	AVERAGE VALUE
149	COLOR(PLATINUM-COBALT UNITS)						
		RAW WATER	0	0	2	0	5
		OXID. INF	0	0	3	0	8
		AERATION INF	0	0	3	0	5
		FINAL EFF	0	0	6	0	16
151	COD (MG/LITER)						
		OXID. INF	0	0	3	0	185
		AERATION INF	0	0	3	0	220
		FINAL EFF	0	0	6	0	46

APPENDIX B

GLOSSARY OF PULP AND PAPERMAKING TERMS

APPENDIX B

GLOSSARY OF PULP AND PAPERMAKING TERMS

Abaca - A variety of plantain or banana native of the Philippine Islands. Fiber is prepared from the outer sheath of the stems. Principal usage is marine cordage. Also used for rope, papers, teabags, etc.

Active Alkali - A measure of the strength of alkaline pulping liquor indicating the sum of caustic soda and sodium sulfide expressed as Na_2O.

Activated Sludge Process - The process of using biologically active sewage sludge to hasten breakdown of organic matter in raw sewage during secondary waste treatment.

Aeration - The process of being supplied or impregnated with air. Aeration is used in wastewater treatment to foster biological and chemical purification.

Air Dry (AD) Ton - Measurement of production including a moisture content of 10 percent by weight.

Alkali - $NaOH + Na_2O$, expressed as Na_2O in alkaline cooking liquors.

Ash - The inorganic residue remaining after burning a piece of pulp or paper.

Available Chlorine - The oxidizing power of a bleaching agent expressed in terms of elemental chlorine.

Bagasse - Crushed stalks of sugarcane after the sugar has been removed.

Bag Paper - Paper used in making grocers bags or sacks.

Bale - A standard bale of waste paper is 72 in. long, 32 in. wide, and 28 in. deep, with a content of about 37 cubic feet and weighing 900 to 1,000 lbs. The size and weight may vary with the grade of paper. A bale of pulp varies in weight from 400 to 500 lbs and is approximately 30x30x13 in. in size. A bale of rags varies in weight from 700 to 1,300 lbs and will vary in dimensions according to the press used. Typical dimensions are 26x30x72 in., 26x42x72 in., or 26x52x54 in. A bale of bags weighs 61 to 62 lbs.

Barometric Leg or Drop Leg - A pipe drawing water from a decker or similar piece of equipment discharging below the surface of the water in a receiving tank. A syphon action is created thus drawing a vacuum on the decker.

Bark - The protective covering of a tree.

Barker - A piece of equipment designed to remove the bark from a log.

Barking - The operation of removing bark from pulpwood prior to processing. This is carried out by means of a knife, drum, mechanical abrasion, hydraulic barker, or by chemical means.

Basis Weight - The weight of a sheet of paper of a given area. It is effected by the density and thickness of the sheet.

Beater - A machine consisting of a tank or "tub", usually with a partition or "midfeather", and containing a heavy roll revolving against a bedplate. Both roll and bedplate may contain horizontal metal bars set on edge. Pulp or waste papers are put into the tub of the beater and water added so that the mass may circulate and pass between the roll and the bedplate. This action separates the material and frees the fibers preparatory to further processing. Fillers, dyestuffs, and sizing materials may be added to the beater and thus incorporated with the paper stock. Many modifications in design have been developed without changing the basic principles. See also Refiner.

Biological Oxidation - The process by which bacterial and other microorganisms feed on complex organic materials and decompose them. Self-purification of waterways and activated sludge, and trickling filter wastewater treatment processes depend on this principle. The process is also called biochemical oxidation.

Black Liquor - The used cooking liquor recovered from the digester. It may also be referred to as spent cooking liquor. Strong black liquor refers to the liquor after it has been concentrated by an evaporator to a level suitable for combustion. Prior to evaporation, it is referred to as weak black liquor.

Bleaching - The brightening and delignification of pulp by the addition of oxidizing chemicals such as chlorine or reducing chemicals such as sodium hypochlorite.

Blow - Ejection of the chips from a digester, or waste solids from a boiler.

Blowdown - The liquid and solid waste materials ejected from a pressure vessel such as a boiler.

Biochemical Oxygen Demand (BOD5) - Quantity of dissolved oxygen utilized in the biochemical oxidation of organic matter in a specified time (5 days) and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, being determined entirely by the availability of the material as a biological load and by the amount of oxygen utilized by the microorganisms during oxidation.

Boil-out - A procedure, usually utilizing heat and chemicals, to clean equipment such as evaporators, heat-exchangers, and pipelines.

Bone Dry - See Oven Dry.

Break - A term used to denote a complete rupture of a web of paper or paperboard during manufacture or some subsequent operation which utilizes rolls of paper.

Breaker Stack - Two rolls, one above the other, placed in the dryer section of a papermachine to compact the sheet and smooth out its surface defects.

Breast Roll - A large diameter roll around which the fourdrinier wire passes at the machine headbox, just at or ahead of the point where the stock is admitted to the wire by the stock inlet. The roll is covered with corrosion-resistant metal or fiberglass and is usually driven by the fourdrinier wire.

Brightness - As commonly used in the paper industry, the reflectivity of a sheet of pulp, paper or paperboard for specified light measured under standardized conditions.

Broke - Partly or completely manufactured paper that does not leave the machine room as salable paper or paperboard; also paper damaged in finishing operations such as rewinding rolls, cutting, and trimming.

Brown Stock - Pulp usually kraft or groundwood not yet bleached or treated other than in the pulping process.

"C" Stage - An abbreviation for the chlorination stage of bleaching.

Calcium Hypochlorite - A chemical commonly used in the paper industry for bleaching pulp, and in water treatment as a germicide.

Calender Stack - Two or more adjacent and revolving rolls which provide even thickness control of the sheet and the final finishing of its surface.

Causticizing - Process of making white liquor from green liquor by addition of slaked lime. Most Na_2CO_3 is thereby converted to NaOH.

Capacity - Production of a unit usually in tons per day.

Cellulose - The fibrous constituent of trees which is the principal raw material of paper and paperboard.

Chemical Wood Pulp - Pulp obtained by digestion of wood with solutions of various chemicals. The principal chemical processes are the sulfite, sulfate (kraft), and soda processes.

Chest (or Stock Chest) - A tank used for storage of wet fiber or furnish.

Chips - Small pieces of wood used to make pulp.

Chipper - A machine consisting essentially of a revolving disk equipped with heavy radially-arranged knives, which cuts pulpwood and sawmill waste into slices or chips, diagonal to the grain.

Clay - In general, a natural, earthy, fine-grained material which develops plasticity when wetted, but is hard when baked or fired. Used as filler and coating paper sheets.

Cleaner - A device which creates a cyclone effect to remove dirt and other rejects from pulp using the differences in density to aid in separation.

Chlorine Dioxide - A chemical ClO_2 used in pulp bleaching as a water solution, usually in one or more of the latter stages of a multistage sequence. It is prepared by a variety of processes at the plant site usually from sodium chlorate, acid, and a reducing agent.

Clarifier - In wastewater treatment, a settling tank which mechanically removes settleable solids from wastewater.

Coated - A term applied to paper and paperboard, the surface of which has been treated with clay or some other pigment and adhesive mixture or other suitable material, to improve the finish with respect to printing quality, color, smoothness, opacity, or other surface properties. The term is also applied to lacquered and varnished papers.

Chemical Oxygen Demand (COD) - Amount of oxygen required to meet chemical requirements as well as BOD.

Color - Refers to standard APHA Platinum Cobalt Test, using standards for color intensity of water samples. Commonly, standards are prepared at various concentrations which later may be referenced as units of color, derived from flow and concentration standard.

Color Unit - A measure of color concentration in water using NCASI methods.

Color Plant - The portion of a fine papermill where pulp is dyed or colored prior to being made into paper.

Consistency - The percentage, by weight, of air dry (or oven dry) fibrous material in a stock or stock suspension. It is also called density or concentration.

Converting - Any operation in which paper is made into a product, not necessarily the final product to be made.

Cooking - Heating of wood, water, and chemicals in a closed vessel under pressure to a temperature sufficient to separate the fibrous portion of wood by dissolving lignin and other nonfibrous constituents.

Cooking Liquor - The mixture of chemicals and water used to dissolve lignin in wood chips.

Cord - A term used in the measurement of pulpwood. The usual definition is a pile 8 ft long, 4 ft wide, and 4 ft high, containing 128 cubic feet. See also Cunit.

Cotton Linters - Short fibers surrounding the cotton seed.

Couch Pit - A pit or catch basin located under the couch roll on a fourdrinier machine to receive water removed at the couch or wet broke in case of a wet end break.

Couch Roll - This term refers to a roll primarily involved in dewatering and picking off, or couching, of the newly formed paper web from the wire on which it was formed and partially dewatered. The couch roll is involved in the transfer of the web to the wet press felt for further dewatering.

Countercurrent Washing - Refers to a method of washing used on the bleach plant or brownstock washers where fresh water is applied on the last stage showers, and the effluent from each stage is used on the washer showers of the preceding stage. A variation used in the bleach plant is jump stage countercurrent washing. In this method fresh water is used on the last two stages. Then the filtrates from the acid stages are used on the preceding acid stage, and the filtrate from the final alkaline stage is used on the preceding alkaline stage.

Cunit - A term used for the measurement of pulpwood. It consists of 100 solid cubic feet of unbarked wood. In magnitude it corresponds quite closely to the cord.

Cylinder Machine - One of the principal types of papermaking machines, characterized by the use of wire-covered cylinders or molds on which a web is formed. These cylinders are partially immersed and rotated in vats containing a dilute stock suspension. The pulp fibers are formed into a sheet on the mold as the water drains through and passes out at the ends of the cylinders. The wet sheet is couched off the cylinder onto a felt, which is held against the cylinder by a couch roll. A cylinder machine may consist of one or several cylinders, each supplied with the same or different kinds of stock. In the case of a multicylinder machine, the webs are successively couched one upon the other before entering the press section. This permits wide variation in thickness or weight of the finished sheet, as well as a variation in the kind of stock used for the different layers of the sheet.

"D" Stage - This is an abbreviation for the chlorine dioxide stage.

"DC" Stage - A stage where chlorine dioxide and chlorine are applied sequentially.

Decker - A piece of equipment commonly used to thicken pulp. It consists of a wire covered drum in a pulp vat. A vacuum is applied to the center of the drum, commonly by a barometric leg, to pull water out of the stock slurry.

Deckle - 1) In handmade papermaking, the removable rectangular wooden frame that forms the raised edge to the wire cloth of the mold and holds the stock suspension on the wire. 2) On a fourdrinier papermaking machine, the stationary on the sides of the wire which keeps the stock suspension from flowing over the edges of the wire. The stationary deckle arrangement is a mechanical device for holding a thin and flexible strip of rubber or equivalent material on top of the wire and just inside the wire width. This rubber strip restricts the pond or sheet to a chosen width during the period of sheet formation and, therefore, varies in its length on different machines.

Deflaker - A high-speed mixing and agitating machine through which a fibrous stock suspension in water is pumped to obtain complete separation and dispersion of each individual fiber, and break up of any fiber lumps, knots, or bits of undefibered paper. An important design feature is to eliminate any chance for material to slip through without getting full exposure to the areas of maximum agitation or hydraulic shear. Since there is ordinarily no contact between working surfaces in a deflaker to directly rub or cut fibers, it is not classified as a refiner though it does do some mild work on the fibers. See Refiner.

Deinking - The operation of reclaiming fiber from waste paper by removing ink, coloring materials, and fillers.

Density - Weight per unit volume. Density should not be confused with porosity.

Diffusion Washing - Washing pulps with an open ended vessel by diffusing or passing the wash media through the pulp mass.

Digester - The vessel used to treat pulpwood, straw, rags or other such cellulosic materials with chemicals to produce pulp. The vessel is usually built to withstand elevated pressures and is made of materials designed to resist the chemical action of the cooking process. It may be cylindrical or spherical in shape. It may be designed for batch operation with discharge at the conclusion of a final cycle by release of internal pressure through a valved port, or by dumping. It may also be built for continuous operation by providing a means to transporting the raw material and cooking chemical from a fixed point at the charging end of the digester to the discharging end.

Dirt - Any foreign matter embodied in a sheet of paper, paperboard, or pulp which has a marked contrasting color to the rest of the material when viewed by reflected or transmitted light. In paper it is generally determined by reference to a standard dirt chart.

Disk Refiner - A motor-driven refiner whose working elements consist of one or more matched pairs of disks having a pattern of ribs machined into their faces and arranged so that one disk of the pair is rotated. The other disk is usually stationary, but may be driven in the opposite direction of rotation. Precision controls are provided for adjusting the clearance between the disk faces and applying pressure between them. The disks are enclosed in a case arranged so that a suspension of paper stock can be pumped in and caused to flow radially from the center out, or vice versa, between the rapidly moving ribbed surfaces of the disks, thus resulting in refining. The refining action on the fiber material is dependent upon such variables as pressure between the two disks, the exact pattern of ribs on the disks, speed of rotation, and consistency of the pulp suspension.

Dissolved Oxygen - Amount of oxygen, expressed in parts per million, dissolved in water.

Dissolved Solids - The total amount of dissolved material, organic and inorganic, contained in water or wastes. Excessive dissolved solids make water unpalatable for drinking and unsuitable for industrial use.

Dissolving Pulp - A special grade of chemical pulp made from wood or cotton linters for use in the manufacture of regenerated cellulose (viscose rayon and cellophane) or cellulose derivatives such as acetate, nitrate, etc.

Doctor - A thin plate or scraper of wood, metal, or other hard substance placed along the entire length of a roll or cylinder to keep it free from the paper, pulp, size, etc., and thus maintain a smooth, clean surface.

Dregs - The inert rejects from the green liquor clarifier of a pulp mill.

Dregs Washer - A piece of equipment used to wash the green liquor (Na_2CO_3) off the dregs prior to their disposal.

Dry End - The mill term for the drying section of the papermachine, consisting mainly of the driers, calenders, reels, and slitters.

"E" Stage - An abbreviation for the caustic extraction stage of the bleaching sequence.

Evaporators - Process equipment used to concentrate spent pulping liquors prior to burning. Usually three to seven are operated in a series.

Extended Aeration - A modification of the activated sludge process that employs aeration periods of 18 hours or more.

Extraction Water - Water removed during a pulp manufacturing process.

Felt - The endless belt of wood or plastic used to convey and dewater the sheet during the papermaking process.

Fiber - The cellulosic portion of the tree used to make pulp, paper, and paperboard.

Filler - 1) A material, generally nonfibrous, added to the fiber furnish of paper, 2) In paperboard, the inner ply or plies of a multiple layer product.

Fines - Very short pulp fibers or fiber fragments and ray cells. They are sometimes referred to as flour or wood flour.

Finishing - The various operations in the manufacture and packaging of paper performed after it leaves the papermachine. Finishing operations include supercalendering, plating, slitting, rewinding, sheeting, trimming, sorting, counting, and packaging. Ruling, punching, pasting, folding, and embossing are also sometimes considered as finishing operations.

Flour - 1) A term applied to the fine fibers or fiber fragments of a pulp. They are also known as fines. 2) Wood flour is derived by grinding or milling waste wood. The fine, dust-like material is used as a filler in coarse products.

Flume - A sloped trough with water flowing through used to transfer pulpwood from one point to another.

Fourdrinier Machine - The fourdrinier machine, named after its sponsor, with its modifications and the Cylinder machine comprise the machines normally employed in the manufacture of all grades of paper and paperboard. The fourdrinier machine, for descriptive purposes, may be divided into four sections, the wet end, the press section, the drier section, and the calendar section.

Freeness - A measure of the rate with which water drains from a stock suspension through a wire mesh screen or a perforated plate. It is also known as slowness or wetness, according to the type of instrument used in its measurement and the method of reporting results.

Furnish - The mixture of fibers and chemicals used to manufacture paper.

Gland - A device utilizing a soft wear-resistant material used to minimize leakage between a rotating shaft and the stationary portion of a vessel such as a pump.

Gland Water - Water used to lubricate a gland. Sometimes called "packing water".

Grade - The type of pulp or paper product manufactured.

Green Liquor - Liquor made by dissolving the smelt from the recovery furnace in water and weak liquor preparatory to causticizing.

Green Liquor Clarifier - A piece of equipment used to separate the dregs from the green liquor, allowing recovery of the green liquor for processing into white "cooking" liquor.

Grinder - A machine for producing mechanical wood pulp or groundwood. It is essentially a rotating pulpstone against which logs are pressed and reduced to pulp.

Grits - Unreactive materials, generally inherent in lime, mechanically removed from the causticizing of kraft and soda green liquor, and disposed of as solid waste.

Groundwood Papers - A general term applied to a variety of papers, other than standard newsprint, made with substantial proportions of mechanical wood pulp together with chemical wood pulps, and used mainly for printing and converting purposes.

"H" Stage - Abbreviation for the hypochlorite stage of bleaching.

Hardwood - A term applied to wood obtained from trees of the angio-sperm class. The hardwoods are obtained from dicotyledonous trees such as birch, gum, maple, oak, and poplar. The leaves are broad except in rare instances and are usually deciduous in the temperate zones. The seeds are enclosed in a fruit which is either fleshy or dry at maturity. Hardwoods are also designated as porous woods.

Headbox - The area of the papermachine that uniformly spreads and distributes the dilute stock suspension and from which the stock flows through a slice onto the wire.

Impregnation - 1) The process of treating a sheet or web of paper or paperboard with a liquid. This may be a molten material such as hot asphalt or wax, a solution of some material in a volatile solvent, or a liquid such as an oil. Pressure may or may not be used in the operation. 2) A term used to describe a treatment in which fibrous raw materials are infused with a chemical solution prior to a digesting or fiberizing process. Sometimes called pre-impregnation.

Integrated - A term used to describe a pulp and papermill operation in which all or some of the pulp is processed into paper at the mill.

Jackladder - An inclined conveyor, usually chain, for moving logs to a higher elevation in the woodroom. Generally used to bring the logs to a debarker.

Jordan - A refiner whose working elements consist of a conical plug rotating in a matching conical shell. The outside of the plug and the inside of the shell are furnished with knives or bars commonly called tackle. In operation, the rotating conical plug is pushed into the shell to press against the shell knives or bars, and gives a macerating action on the fibrous material in water suspension that is passed between them. Stock is usually introduced into the small end of the jordan and withdrawn from the large end, though it may also be pumped through in the other direction.

Kappa Numbers - The permanganate number of a pulp measured under controlled conditions and corrected to be the equivalent of 50 percent consumption of the permanganate solution in contact with the specimen. It gives the degree of delignification of pulp through a wider range than does the older permanganate number test.

Kiln - A piece of equipment used to burn lime and calcium carbonate to produce CaO, which is used again with green liquor to form white liquor.

Knots - An imperfection in paper or lumps in paper stock resulting from: 1) incompletely defibered textile materials; the term applies especially to rag paper manufacture; 2) small undefibered clusters of wood pulp; and 3) the basal portion of a branch or limb which has become incorporated in the body of the tree.

Knotter - A mechanical device, usually a screen for removing knots from wood pulp.

Kraft - A term descriptive of the (alkaline) sulfate pulping process, the resulting pulp, and paper or paperboard made therefrom.

Lap - See wet lap.

Lignin - A non-degradable organic compound of wood which is removed during pulping.

Linerboard - A paperboard made on a fourdrinier or cylinder machine and used as the facing material in the production of corrugated and solid fiber shipping containers. Linerboard is usually classified according to furnish and method of wet formation, as for example fourdrinier kraft linerboard, cylinder kraft linerboard, jute linerboard.

Mathieson Process - A process of producing chlorine dioxide, using SO_2 as a reducing agent.

Mechanical Pulp - Pulp produced by physical means without the use of chemicals or heat, often referred to as groundwood.

Molded Pulp Products - Contoured products such as egg packaging items, food trays, plates, bottle protectors, etc., made by depositing fibers from a pulp slurry onto a forming mold of the contour and shape desired in the product. To achieve fiber deposition, either pressure or vacuum may be applied to the pulp slurry.

Mud Filter - A piece of equipment used to thicken and wash lime mud prior to burning it in the lime kiln.

Mud Washer - A piece of equipment used to wash the sodium base chemicals from the lime mud prior to burning it in the lime kiln. The filtrate from this process is called weak wash, and is used for smelt dissolving.

NCASI - National Council of the paper industry for Air and Stream Improvement. An organization of the pulp and paper industry concerning itself with environmental affairs pertaining to the industry.

Newsprint - Paper, made largely from groundwood pulp with a small percentage of chemical pulp added for strength, used chiefly in the printing of newspapers.

Nip - The point at which two adjacent rolls come together.

Neutral Sulfite Semi-Chemical Pulp - (NSSC) - Usually made from hardwoods, although softwoods which are low in resin content can also be used. The active cooking agent is sodium sulfite with sufficient sodium carbonate added to ensure that the cooking liquor remains slightly alkaline until blown. When pulping for bleachable grades, the cooking is carried out to a yield in the range of 62 to 68 percent. For unbleached grades, yields as high as 75 to 80 percent may be attained. Higher yield pulps, which account for the major NSSC production, are notable for their stiffness and have wide application in corrugating medium.

Nutrients - Elements, or compounds, essential as raw materials for organism growth and development (as in activated sludge process).

Oven Dry - Containing no moisture. A pulp or paper which has been dried to a constant weight at a temperature of 100 to 105°C (212 to 221°F).

Oxidation Pond - A man-made pond in which organic wastes are reduced by bacterial action. Often oxygen is bubbled through the pond to speed the process.

Paper - 1) (General term). The name for all kinds of matted or felted sheets of fiber (usually vegetable, but sometimes mineral, animal or synthetic) formed on a fine screen from a water suspension. Paper derives its name from papyrus, a sheet made by pasting together thin sections of an Egyptian reed (Cyperus papyrus) and used in ancient times as a writing material. 2) (Specific term). One of the two broad subdivisions of paper (general term), the other being paperboard. The distinction between paper and paperboard is not sharp but, generally speaking, paper is lighter in basis weight, thinner, and more flexible than paperboard. Its largest uses are for printing, writing, wrapping, and sanitary purposes, although it is also employed for a very wide variety of other uses.

Paperboard - One of the two broad subdivisions of paper products. Paperboard is heavier in basis weight, thicker, and more rigid than paper. In general, all sheets 12 points (0.012 in.) or more in thickness are classified as paperboard. There are a number of exceptions based upon traditional nomenclature. For example, blotting paper, felts, and drawing paper in excess of 12 points are classified as paper while corrugating medium, chipboard, and linerboard less than 12 points are classified as paperboard. Paperboard is made from a wide variety of furnishes on a number of types of machines, principally cylinder and fourdrinier. The broad classes are: 1) container board, which is used for corrugated cartons; 2) boxboard which is further divided into, a) Folding boxboard, b) special food board, and c) setup boxboard; and 3) all other special types such as automobile board, building board, etc.

Permanganate Number (K-No.) - This method (T-214-TAPPI Std.) is used to determine the relative "hardness" or bleach requirements of pulp. With suitable modification it may be used for most types of chemical pulps. By definition it is the number of milliliters of 0.1 N potassium permanganate solution absorbed by 1 gram of moisture-free pulp under specified control conditions.

Peroxide - A chemical used in bleaching of wood pulps, usually groundwood pulps.

Precipitators - Equipment used to remove ash and other fine solids from gases exiting the boilers and furnaces in a mill.

Prehydrolysis - Pre-steaming of chips in the digester prior to cooking; usually associated with improved bleaching of kraft pulps.

Press - In a papermachine a pair of rolls between which the paper web is passed for one of the following reasons: 1) water removal at the wet press; 2) smoothing and leveling of the sheet surface at the smoothing press; and 3) application of surface treatments to the sheet at the size press.

Pulp - Cellulosic fibers after conversion from wood chips.

Pulper - A mechanical device resembling a large-scale kitchen blender used to separate fiber bundles in the presence of water prior to papermaking.

Pulping - The operation of reducing a cellulosic raw material, such as pulpwood, rags, straw, reclaimed paper, etc., into a pulp suitable for papermaking.

Pulpwood - Those woods which are suitable for the manufacture of chemical or mechanical wood pulp. The wood may be in the form of logs as they come from the forest or cut into shorter lengths suitable for the chipper or the grinder.

Ray Cells - Cells which carry stored food (protein, starch, and fats) from the bark to the wood of a tree and appear as impurities in the pulping process, especially unbleached operations.

Recovery Furnace or Recovery Boiler - A boiler which burns the strong black liquor. The organic material in the liquor is burned off, and the cooking chemical is recovered from the molten smelt after dissolving in water or weak wash liquors.

Red Stock - Sulfite pulp after the pulping process, prior to other treatments, such as bleaching.

Reel - 1) A term applied to the untrimmed roll of paper of full machine width wound on a large shaft at the dry end of the papermachine. 2) The shaft on which the paper is first wound when it leaves the driers. 3) A term for the operation of winding paper into a reel.

Refiner - A machine used to rub, macerate, bruise, and cut fibrous material, usually cellulose, in water suspension to convert the raw fiber into a form suitable for formation into a web of desired characteristics on a papermachine. The many types of refiners differ in size and design features but most can be classified as either jordans or disk refiners. Beaters are not usually referred to as refiners, although in a broad sense they serve a similar function. Refiners may be used in various combinations of types and numbers of units depending on the type of stock to be treated and the capacity required. See also Deflaker, Disk Refiner, Jordan.

Refining - A general term applied to several operations, all of which involve the mechanical treatment of pulp in a water suspension to develop the necessary papermaking properties of the fibers and to cut the fibers to the desired length distribution. See Refiner.

Rejects - Material unsuitable for pulp or papermaking which has been separated in the manufacturing process.

Repulping - The operation of rewetting and fiberizing pulp or paper for subsequent sheet formation. See also Pulper.

Rewinder - See Winder. The term rewinder is often used for the winder in the finishing room, distinguishing it from the winder which follows the slitter at the end of the papermachine.

Rewinding - The operation of winding the paper accumulated on the reel of papermachine onto a core to give a tightly wound roll suitable for shipping or for use in the finishing or converting department. During rewinding, defective paper in the reel is usually removed and breaks in the sheet are spliced and marked.

Roundwood - Logs as received in the woodyard. The logs can be any length and usually have not been debarked.

Saltcake Loss - The loss of cooking chemical from the kraft cycle, primarily at the brownstock washers or screen room.

Saveall - A mechanical device used to recover papermaking fibers and other suspended solids from a wastewater or process stream.

Screening - 1) The operation of passing chips over screens to remove sawdust, slivers and oversize chips. 2) The operation of passing pulp or paper stock through a screen to reject coarse fibers, slivers, shives, knots, etc.

Scrubbers - Equipment for removing noxious gases from the exhaust of certain areas in the mill, such as the bleachery or washers. Generally a scrubber consists of a tower with water or some fluid flowing down through the tower while the gases are flowing up. Contact of the two phases causes the noxious gas to be absorbed by the fluid.

Sheet - A term used extensively in the paper industry meaning: 1) A single piece of pulp, paper or paperboard. 2) The continuous web of paper as it is being manufactured. 3) A general term for a paper or paperboard in any form and in any quantity which, when used with appropriate modifying words, indicates with varying degrees of specificity, attributes of the product such as quality, class, use, grade, or physical properties. Examples: a bright sheet, a kraft sheet, a folding boxboard sheet. 4) To cut paper or paperboard into sheets of desired size from roll or web.

Shive - A bundle of incompletely separated fibers which may appear in the finished sheet as an imperfection.

Showers - 1) On stock or pulp washers and deckers, showers are used to wash chemicals off the stock; 2) on the papermachine, showers are used to clean stock and filler off the wire, felts, and rolls in the machine.

Side-Hill Screens - Steeply sloped screens usually used to remove some water from suspensions of stock or other solids while retaining the solid on the screen surface. The water remaining with the solids washes the solids down the screen to a receiving tank.

Size - Any material used in the internal sizing or surface sizing of paper and paperboard. Typical agents are rosin, glue and gelatin, starch, modified celluloses, synthetic resins, latices, waxes, etc.

Sizing - 1) Relates to a property of paper resulting from an alteration of fiber surface characteristics. In terms of internal sizing it is a measure of the resistance to the penetration of water and various liquids. In terms of surface sizing it relates to the increase of such properties as water resistance, abrasion resistance, abrasiveness, creasibility, finish, smoothness, surface bonding strength, printability, and the decrease of porosity and surface fuzz. 2) The addition of materials to a papermaking furnish or the application of materials to the surface of paper and paperboard to provide resistance to liquid penetration and, in the case of surface sizing, to affect one or more of the properties listed in 1).

Slasher - A saw or set of saws used to cut long logs to desired length.

Slitter - A set of knives used to slit a reel of paper into the desired widths as the reel is rewound.

Sludge - Semi-fluid mixture of fine solid particles with a liquid. May contain fibrous and filler materials, and/or biological solids.

Slurry - A suspension of solid particles in a liquid.

Smelt - The molten inorganic cooking chemicals from the recovery boiler. The smelt is dissolved in the smelt tank with weak wash to form green liquor.

Softwood - The softwoods, otherwise known as coniferous woods, come from coniferous trees such as pines, spruces, and hemlocks.

Spent Cooking Liquor - Cooking liquor after digestion containing lignaceous, as well as chemical, materials.

Stock - 1) Pulp which has been beaten and refined, treated with sizing, color, filler, etc. and which after dilution is ready to be formed into a sheet of paper. 2) Wet pulp of any type at any stage in the manufacturing process. 3) Paper in inventory or in storage. 4) Paper or other material to be printed, especially the paper for a particular piece of work. 5) A term used to describe a paper suitable for the indicated use, such as coating raw stock, milk carton stock, tag stock, towel stock, etc.

Stock Preparation - A term for the several operations which occur between pulping (or bleaching) and formation of the web on a papermachine. It may include for example, repulping, beating, refining, cleaning, etc.

Stuff Box - A flow leveling device prior to the headbox of a papermachine. An excess of stock is pumped into a tank with a divider. The excess flows over the divider thus maintaining a constant level behind the divider to flow to the papermachine.

Suction Box - A rectangular box with holes or slots on its top surface, used to suck water out of a felt or paper sheet by the application of vacuum.

Suction Couch Roll - A rotating roll containing holes through which water is sucked out of a paper sheet on a fourdrinier machine by the application of vacuum.

Suction Press Roll - A rubber-covered perforated roll usually with a bronze or stainless steel shell equipped with an inside suction box. It is used as one of a pair of rolls, the second being a solid roll. The wet paper is carried through the nip of these rolls on an endless wet felt, which further reduces the water content.

Sulfidity - Sulfidity is a measure of the amount of sulfur in kraft cooking liquor. It is the percentage ratio of NaS, expressed as NaO, to active alkali.

Suspended Solids (TSS) - Small particles of solid pollutants in sewage that contribute to turbidity and that resist separation by conventional means. The examination of suspended solids and the BOD5 test constitute the two main determinations for water quality performed at mills and wastewater treatment facilities.

Unbleached - A term applied to paper or pulp which has not been treated with bleaching agents.

Unit - A term most frequently used in the southern states in the measurement of pulpwood. It refers to a pile of wood 8 ft long, 5 ft wide, and 4 ft high, containing 160 cubic feet, or 25 percent more volume than one Cord.

Vacuum Pump - A pump used to create suction on such equipment as the suction box, couch roll, or suction press roll.

Virgin Wood Pulp - Pulp made from wood, as contrasted to waste paper sources of fiber.

Washer - A piece of equipment usually either a decker type or side hill screen type equipped with showers to wash chemicals from pulp stock or reject solids.

Waste Paper - A general term used to specify various recognized grades such as No. 1 news, new kraft corrugated cuttings, old corrugated containers, manila tabulating cards, coated soft white shavings, etc. It is used as a principal ingredient in the manufacture of certain types of paperboard, particularly boxboard made on cylinder machines where the lower grades may go into filler stock, and the higher grades into one or both liners. Selected grades are also used in the manufacture of various papers.

Weak Green Liquor - The wash water from the dregs washer which may be reused elsewhere in the recovery process, commonly on the mud washer.

Weak Wash - The wash water from the mud washer. It may also be called weak white liquor.

Web - The sheet of paper coming from the papermachine in its full width or from a roll of paper in any converting operation.

Wet Broke - The undried waste stock taken off the papermachine at the presses or before entering the driers. See also Broke.

Wet End - That portion of the papermachine between the headbox and the drier section. See Fourdrinier machine.

Wet Laps - Rolls or sheets of pulp of 30 to 45 percent consistency prepared in a process similar to papermaking; facilitates transportation of market pulp.

Wet Lap Machine - A machine used to form pulp into thick rough sheets sufficiently dry to permit handling and folding into bundles (laps) convenient for storage or transportation.

Wet Press - The dewatering unit used on a papermachine between the sheet-forming equipment and the drier section. It applies pressure, or a combination of pressure and suction, to the sheet to remove as much water as practical from the sheet ahead of the driers. It consists of two or more pressure nips in various design arrangements. Each nip is formed by a pair of heavy rolls running against each other with provision for controlling the pressure to provide a graduated increase in pressure for each successive unit. One roll of each pair is usually rubber covered and may be perforated and fitted with an internal suction box for water removal at the nip by vacuum. The wet web is transported through the nip of each wet press unit on a felt which is bulky and porous to absorb water from the sheet under pressure, and allow this water to drain away or be removed by vacuum.

Wet Strength Additives - Chemicals such as urea and melanine formaldehydes used in papermaking to impart strength to papers used in wet applications.

White Liquor - The name applied to liquor made by causticizing green liquor. White liquors are used in the digesters for cooking wood chips. (Alkaline processes)

Whitewater - A general term for all papermill waters which have been separated from the stock or pulp suspension, either on the papermachine or accessory equipment, such as thickeners, washers, and savealls, and also from pulp grinders. It carries a certain amount of fiber and may contain varying amounts of fillers, dyestuffs, etc.

Winder - 1) The machine which winds into rolls the paper coming from the papermachine reel. 2) The machine which rewinds into rolls the paper coming from a papermachine winder. The paper may be slit in the rewinding process. See also Reel.

Wire - An endless moving belt made of metal or plastic, resembling a window screen, upon which a sheet of paper is formed on a fourdrinier machine.

Wire Pit - A pit under the wire of a fourdrinier machine. It receives some of the water drained or pulled out of the sheet through the wire and shower water spray.

Wood Flour - Finely ground wood or fine sawdust used chiefly as a filler in plastics, linoleum, etc., and an absorbent in dynamite.

Wood Pulp - A virgin or secondary stock derived from wood.

Woodroom - The area of a pulp mill that handles the barking, washing, and chipping or grinding of logs. Purchased chips are also processed through the woodroom.

Woodyard - The area of a mill where roundwood is received and stored prior to transport to the woodroom.

Yankee Machine - A papermachine using one large steam-heated drying cylinder for drying the sheet, instead of many smaller ones. Commonly used for manufacturing tissue.

APPENDIX C
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