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Group I, Phase II

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

BLEACHED KRAFT, GROUNDWOOD, SULFITE, SODA, DEINK AND NON-INTEGRATED PAPER MILLS

Vol. II

Segment of the

PULP, PAPER, AND PAPERBOARD

Point Source Category

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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DEVELOPMENT DOCUMENT
for
INTERIM FINAL AND PROPOSED
EFFLUENT LIMITATIONS GUIDELINES
and
NEW SOURCE PERFORMANCE STANDARDS
for the
BLEACHED KRAFT, GROUNDWOOD, SULFITE, SODA, DEINK, AND NON-INTEGRATED PAPER MILLS SEGMENT OF THE PULP, PAPER, AND PAPERBOARD MILLS POINT SOURCE CATEGORY

VOLUME II SECTIONS VIII - XV

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SECTION VIII

COSTS, ENERGY, NON-WATER QUALITY ASPECTS

RATIONALE FOR DEVELOPMENT OF COSTS

This section of the report summarizes the costs of internal and external effluent treatment associated with technology levels of BPCTCA, BATEA, and New Source Standards of Performance. The cost functions used for conventional treatment methods are based on industry experience with full scale installations and equipment suppliers' estimates. For more advanced processes, where full scale installations are few or nonexistent, the cost estimates are largely based on experience with pilot installations and on estimates from and discussions with equipment suppliers.

It should be recognized that actual treatment costs vary widely from mill to mill depending upon the design and operation of the production facilities and local conditions. Furthermore, effluent treatment costs reported by the industry vary greatly from one installation to another depending upon bookkeeping procedures. The estimates of effluent volumes and treatment methods described in this section are intended to represent those of the subcategories covered by this report. However, the industry is somewhat heterogeneous in that almost every installation has some uniqueness which could be of importance in assessing effluent treatment problems and their associated costs.

For each technology level, costs of both internal and external technology were established for various sizes of mills in each subcategory in order to reflect the significance of size of mill upon the costs of implementing the technology.

The number of mill sizes and their tonnage were selected from the size range of existing mills so that the ratio of one size to the next approximated 3:1. The selected mill sizes for each subcategory are shown in Table 130. In the case of NSPS, costs are presented only for the larger sizes because it is most unlikely, for economic reasons, that "small" or "very small" new mills will be built in the foreseeable future.

All costs in this document are expressed in terms of June 1974 prices which may be adjusted to current prices by using appropriate engineering cost indices.

All of the internal controls used in developing the costs are listed in Table 131 and Tables 132-148 present by subcategory the internal controls which were used to determine the costs of BPCTCA, BATEA, and BADT. Table 149 presents the external technologies used in determing the costs, and the raw waste and final effluent loads used to determine costs are shown in Table 150. The costs of internal and external treatment using aerated stabilization basins for each of the subcategories and the costs using activated sludge in place of ASB are

Table 130

MILL SIZES SELECTED FOR COSTING

kkg/day (tons/day)

Subcategory	Very Small	Small	Medium	Large
Sulfite		145(160)	480(530)	
Dissolving Sulfite			499(550)	
Deink		73(80)	209(230)	454(500)
Dissolving Kraft			544(600)	907(1000)
Market Kraft			318(350)	635(700)
BCT Kraft		227(250)	608(670)	1179(1300)
Fine Kraft		227(250)	608(670)	1179(1300)
Groundwood Chemi-Mech.		91(100)	272(300)	544(600)
Groundwood Thermo-Mech.		91(100)	272(300)	544(600)
Groundwood C-M-N		68(75)	136(150)	454(500)
Groundwood Fine		272(300)	635(700)	
Soda			272(300)	635(700)
Non-Integrated Fine		27(30)	91(100)	254(280)
Non-Integrated Tissue	14(15)	32(35)	100(110)	408(450)
Non-Integrated Tissue (FWP)	14(15)	32(35)	100(110)	408(450)

NO. OF PAPER MCHINES USED IN COSTING

Sulfite		3	7	
Dissolving Sulfite				
Deink		3	3	5
Dissolving Kraft				
Market Kraft				
BCT Kraft		2 Tissue 1 Board	3 Tissue 2 Board	4 Tissue 3 Board
Fine Kraft		5	5	9
Groundwood Chemi-Mech.		2	3	4
Groundwood Thermo-Mech.		2	3	4
Groundwood C-M-N		2	2	3
Groundwood Fine		3	4	6
Soda			2	5
Non-Integrated Fine		2	2	5
Non-Integrated Tissue	2	3	3	5
Non-Integrated Tissue (FWP)	2	3	3	5

Table 131

IDENTIFICATION OF INTERNAL TECHNOLOGY ITEMS

ITEM NO.	DESCRIPTION
1	Replace Flume with mechanical conveyor.
2	Use of steam in drum barkers.
3	Knots collection and disposal.
4	Fourth stage brown stock washer.
5	Decker filtrate for brown stock washer showers.
6	Close-up screen room.
7	Pulp mill spill collection from washers.
8	Pulp mill spill collection from tanks, equipment and drains.
9	Jump stage countercurrent washing.
10	Evaporator surface condenser.
11	Steam stripping condensates and reuse.
12	Evaporator boilout tank.
13	Black liquor storage tank spill collection.
14	Green liquor dregs filtering.
15	Causticizing area spill collection system.
16	Evaporator condensate for causticizing makeup.
17	Lime mud storage pond.
18	Alarms on chemical tanks.
19	Prehydrolysate disposal by burning.
20	MgO recovery system.
21	Paper machine vacuum saveall.
22	Paper machine flotation saveall.
23	Paper machine high pressure showers.
24	Paper machine white water showers.
25	Cyliner former white water showers.
26	Cooling water segregation and reuse.
27	Felt hair removal.
28	Vacuum pumps seal water reuse.
29	Paper mill stock spill collection system.

TAble 132

INTERNAL TECHNOLOGIES USED IN COSTING

Bleached Kraft Dissolving Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	90	X	X	X
4.			X	X
5.	35	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	75	X	X	X
10.	50	X	X	X
11.				
12.	33	X	X	X
13.	33	X	X	X
14.	33	X	X	X
15.			X	X
16.			X	X
17.			X	X
18.	33	X	X	X
19.	67	X	X	X
20.				
21.				
22.				
23.				
24.				
25.	50	X	X	X
26.			X	X
27.	33	X	X	X
28.				
29.				

Table 133

INTERNAL TECHNOLOGIES USED IN COSTING

Market Kraft Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	90	X	X	X
4.			X	X
5.	33	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	75	X	X	X
10.	50	X	X	X
11.				
12.	33	X	X	X
13.	33	X	X	X
14.	33	X	X	X
15.			X	X
16.			X	X
17.			X	X
18.	33	X	X	X
19.				
20.				
21.				
22.				
23.				
24.				
25.	50	X	X	X
26.			X	X
27.	40	X	X	X
28.				
29.				

Table 134
INTERNAL TECHNOLOGIES USED IN COSTING

BCT Kraft Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	90	X	X	X
4.			X	X
5.	33	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	75	X	X	X
10.	50	X	X	X
11.				
12.	33	X	X	X
13.	33	X	X	X
14.	33	X	X	X
15.			X	X
16.			X	X
17.			X	X
18.	33	X	X	X
19.				
20.				
21.	90	X	X	X
22.				
23.	20	X	X	X
24.	20	X	X	X
25.				
26.			X	X
27.				
28.	33	X	X	X
29.			X	X

Table 135

INTERNAL TECHNOLOGIES USED IN COSTING

Fine Kraft Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	90	X	X	X
4.			X	X
5.	33	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	X	X	X	X
10.	75	X	X	X
11.				
12.	50	X	X	X
13.	50	X	X	X
14.	33	X	X	X
15.			X	X
16.			X	X
17.			X	X
18.	33	X	X	X
19.				
20.				
21.				
22.	X	X	X	X
23.	X	X	X	X
24.				
25.				
26.			X	X
27.	40	X	X	X
28.	50	X	X	X
29.			X	X

Table 136

INTERNAL TECHNOLOGIES USED IN COSTING

Groundwood Chemi/Mech. Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.				
4.				
5.				
6.			X	X
7.			X	X
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	25	X	X	X
19.				
20.				
21.	40	X	X	X
22.				
23.	25	X	X	X
24.				
25.				
26.			X	X
27.				
28.	25	X	X	X
29.			X	X

Table 137

INTERNAL TECHNOLOGIES USED IN COSTING

Groundwood Thermo/Mech. Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.				
4.				
5.				
6.			X	X
7.			X	X
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	25	X	X	X
19.				
20.				
21.	40	X	X	X
22.				
23.	25	X	X	X
24.				
25.				
26.			X	X
27.				
28.	25	X	X	X
29.			X	X

Table 138

INTERNAL TECHNOLOGIES USED IN COSTING

Groundwood C-M-N Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.				
4.				
5.				
6.			X	X
7.			X	X
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	25	X	X	X
19.				
20.				
21.	40	X	X	X
22.				
23.	25	X	X	X
24.				
25.				
26.			X	X
27.				
28.	25	X	X	X
29.			X	X

Table 139

INTERNAL TECHNOLOGIES USED IN COSTING

Groundwood Fine Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.				
4.				
5.				
6.			X	X
7.			X	X
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	25	X	X	X
19.				
20.				
21.	75	X	X	X
22.				
23.	25	X	X	X
24.				
25.				
26.			X	X
27.				
28.	25	X	X	X
29.			X	X

Table 140

INTERNAL TECHNOLOGIES USED IN COSTING

Papergrade Sulfite Subcategory

Data are percentages of total item cost. X =100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	50	X	X	X
4.			X	X
5.	50	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	50	X	X	X
10.	50	X	X	X
11.				
12.	25	X	X	X
13.	33	X	X	X
14.				
15.				
16.				
17.				
18.	33	X	X	X
19.				
20.				
21.	75	X	X	X
22.				
23.	33	X	X	X
24.				
25.				
26.			X	X
27.	50	X	X	X
28.	33	X	X	X
29.			X	X

Table 141

INTERNAL TECHNOLOGIES USED IN COSTING

Market Sulfite Subcategory

Data are percentages of total item cost. X =100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	50	X	X	X
4.			X	X
5.	50	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	50	X	X	X
10.	50	X	X	X
11.				
12.	25	X	X	X
13.	33	X	X	X
14.				
15.				
16.				
17.				
18.	33	X	X	X
19.				
20.				
21.	75	X	X	X
22.				
23.	33	X	X	X
24.				
25.				
26.			X	X
27.	50	X	X	X
28.	33	X	X	X
29.			X	X

Table 142

INTERNAL TECHNOLOGIES USED IN COSTING

Low Alpha Sulfite Subcategory

Data are percentages of total item cost. X =100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	50	X	X	X
4.			X	X
5.	50	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	50	X	X	X
10.	50	X	X	X
11.				
12.	25	X	X	X
13.	33	X	X	X
14.				
15.				
16.				
17.				
18.	33	X	X	X
19.				
20.	50	X	X	X
21.				
22.				
23.				
24.				
25.	50	X	X	X
26.			X	X
27.	50	X	X	X
28.				
29.				

Table 143

INTERNAL TECHNOLOGIES USED IN COSTING

High Alpha Sulfite Subcategory

Data are percentages of total item cost. X =100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	50	X	X	X
4.			X	X
5.	50	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	50	X	X	X
10.	50	X	X	X
11.				
12.	25	X	X	X
13.	33	X	X	X
14.				
15.				
16.				
17.	33	X	X	X
18.				
19.	50	X	X	X
20.				
21.				
22.				
23.				
24.				
25.	50	X	X	X
26.			X	X
27.	50	X	X	X
28.				
29.				

Table 144

INTERNAL TECHNOLOGIES USED IN COSTING

Soda Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.			X	X
3.	90	X	X	X
4.			X	X
5.	33	X	X	X
6.			X	X
7.			X	X
8.			X	X
9.	75	X	X	X
10.	50	X	X	X
11.				
12.	33	X	X	X
13.	33	X	X	X
14.	33	X	X	X
15.			X	X
16.			X	X
17.			X	X
18.	33	X	X	X
19.				
20.				
21.				
22.	X	X	X	X
23.	50	X	X	X
24.				
25.				
26.			X	X
27.	50	X	X	X
28.	50	X	X	X
29.			X	X

Table 145
INTERNAL TECHNOLOGIES USED IN COSTING

Deink Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	33	X	X	X
19.				
20.				
21.	75	X	X	X
22.				
23.	40	X	X	X
24.				
25.				
26.			X	X
27.				
28.	50	X	X	X
29.			X	X

Table 146

INTERNAL TECHNOLOGIES USED IN COSTING

Non-Integrated Fine Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	25	X	X	X
19.				
20.				
21.				
22.	75	X	X	X
23.	33	X	X	X
24.				
25.				
26.			X	X
27.	33	X	X	X
28.	33	X	X	X
29.			X	X

Table 147
INTERNAL TECHNOLOGIES USED IN COSTING

Non-Integrated Tissue Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	25	X	X	X
19.				
20.				
21.	50	X	X	X
22.				
23.				
24.	25	X	X	X
25.				
26.			X	X
27.				
28.	33	X	X	X
29.			X	X

Table 148

INTERNAL TECHNOLOGIES USED IN COSTING

Non-Integrated Tissue (fwp) Subcategory

Data are percentages of total item cost. X = 100%

Item	Pre	BPCTCA	BATEA	NSPS
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.	25	X	X	X
19.				
20.				
21.	50	X	X	X
22.				
23.				
24.	25	X	X	X
25.				
26.			X	X
27.				
28.	33	X	X	X
29.			X	X

Table 149
EXTERNAL UNIT PROCESS USED IN COSTING

	Unit Process	Diss. Kraft				Market Kraft				BCT Kraft				Fine Kraft				Soda			
		73	77	83	NS	73	77	83	NS	73	77	83	NS	73	77	83	NS	73	77	83	NS
1.	Preliminary	X			X	X			X	X			X	X			X	X			X
2.	Pump Station	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X
3.	Primary Clarifier	X			X	X			X	X			X	X			X	X			X
4.	Sludge Lagoon	X			X	X			X	X			X	X			X	X			X
5.	Aerators		X		X		X		X		X		X		X		X		X		X
6.	ASB Basin		X		X		X		X		X		X		X		X		X		X
7.	Vacuum Filters		X		X		X		X		X		X		X		X		X		X
8.	Press		X		X		X		X		X		X		X		X		X		X
9.	Monitor	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10.	Outfall	X			X	X			X	X			X	X			X	X			X
11.	Diffuser	X			X	X			X	X			X	X			X	X			X
12.	Foam	X			X	X			X	X			X	X			X	X			X
13.	Neutralization																	X			X
14.	Black Liquor Lagoon	X	X		X	X	X		X	X	X		X	X	X		X	X	X		X
15.	Mixed Media			X				X				X				X				X	
16.	Air Flotation				X				X				X				X				X
17.	Secondary Clarifier				X				X				X				X				X
18.	Mini-Lime			X				X				X				X				X	

Table 149 (continued)
EXTERNAL UNIT PROCESS USED IN COSTING

	Unit Process	Groundwood Chemi/Mech				Groundwood Thermo/Mech				Groundwood Fine				Groundwood CMN				NI Fine			
		73	77	83	NS	73	77	83	NS	73	77	83	NS	73	77	83	NS	73	77	83	NS
1.	Preliminary	X			X		X		X	X			X	X			X		X		X
2.	Pump Station	X		X	X		X	X	X	X		X	X	X		X	X		X	X	X
3.	Primary Clarifier	X			X		X		X	X			X	X			X		X		X
4.	Sludge Lagoon	X			X		X		X	X			X	X			X		X		X
5.	Aerators		X		X		X		X		X		X		X		X			X	X
6.	ASB Basin		X		X		X		X		X		X		X		X			X	X
7.	Vacuum Filters		X		X		X		X		X		X		X		X		X		X
8.	Press		X		X		X		X		X		X		X		X				
9.	Monitor	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X
10.	Outfall	X			X		X		X	X			X	X			X		X		X
11.	Diffuser	X			X		X		X	X			X	X			X		X		X
12.	Foam	X			X		X		X												
13.	Neutralization																				
14.	Black Liquor Lagoon	X	X		X		X		X	X	X		X	X	X		X		X		X
15.	Mixed Media			X				X				X				X				X	
16.	Air Flotation				X				X				X				X				X
17.	Secondary Clarifier				X				X				X				X				X
18.	Mini-Lime																				

Table 149 (continued)
EXTERNAL UNIT PROCESS USED IN COSTING

	Unit Process	Papergrade Sulfite 73	77	83	NS	Market Sulfite 73	77	83	NS	Low Alpha Sulfite 73	77	83	NS	High Alpha Sulfite 73	77	83	NS	Deink 73	77	83	NS
1.	Preliminary	X			X	X			X	X			X	X			X	X			X
2.	Pump Station	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X
3.	Primary Clarifier	X			X	X			X	X			X	X			X	X			X
4.	Sludge Lagoon	X			X	X			X	X			X	X			X	X			X
5.	Aerators		X		X		X		X		X		X		X		X		X		X
6.	ASB Basin		X		X		X		X		X		X		X		X		X		X
7.	Vacuum Filters		X		X		X		X		X		X		X		X		X		X
8.	Press		X		X		X		X		X		X		X		X		X		X
9.	Monitor	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10.	Outfall	X			X	X			X	X			X	X			X	X			X
11.	Diffuser	X			X	X			X	X			X	X			X	X			X
12.	Foam	X			X	X			X	X			X	X			X				
13.	Neutralization	X			X	X			X	X			X	X			X				
14.	Black Liquor Lagoon	X	X		X	X	X		X	X	X		X	X	X		X	X	X		X
15.	Mixed Media			X				X				X				X				X	
16.	Air Flotation				X				X				X				X				X
17.	Secondary Clarifier				X				X				X				X				X
18.	Mini-Lime																				

Table 149 (continued)
EXTERNAL UNIT PROCESS USED IN COSTING

Unit Process	NI Tissue 73	77	83	NS	NI Tissue FWP 73	77	83	NS
1. Preliminary		X		X		X		X
2. Pump Station		X	X	X		X	X	X
3. Primary Clarifier		X		X		X		X
4. Sludge Lagoon		X		X		X		X
5. Aerators			X	X		X		X
6. ASB Basin			X	X		X		X
7. Vacuum Filters		X		X		X		X
8. Press								
9. Monitor		X	X	X		X	X	X
10. Outfall		X		X		X		X
11. Diffuser		X		X		X		X
12. Foam								
13. Neutralization								
14. Black Liquor Lagoon		X		X		X		X
15. Mixed Media			X				X	
16. Air Flotation				X				X
17. Secondary Clarifier				X				X
18. Mini-Lime								

Table 150

RAW (09) AND FINAL (79) WASTE CHARACTERISTICS

Data in kl/kkg (kgal/ton) For Flow
And kg/kkg (lb/ton) For All Others

PARAMETER	PRETREATMENT	BPCTCA	BATEA	NSPS
Papergrade Sulfite				
09 BOD	600 (1200)	115.5 (231)	68.5 (137)	91 (182)
09 TSS	100 (200)	82.0 (164)	75.0 (150)	73.5 (147)
Flow	332.8 (80)	208 (50)	176.8 (42.5)	112.32 (27)
79 BOD	468 (936)	9.1 (18.2)	3.85 (7.7)	2.45 (4.9)
79 TSS	15 (30)	13.15 (26.3)	1.95 (3.9)	2.45 (4.9)
Market Sulfite				
09 BOD	600 (1200)	123 (246)	105 (210)	105 (210)
09 TSS	100 (200)	32.5 (65)	30 (60)	30 (60)
Flow	332.8 (80)	243.36 (58.5)	187.2 (45)	187.2 (45)
79 BOD	468 (936)	11.7 (23.4)	5.65 (11.3)	5.65 (11.3)
79 TSS	15 (30)	14.65 (29.3)	1.9 (3.8)	3.75 (7.5)
Low Alpha Sulfite				
09 BOD	650 (1300)	132 (264)	125 (250)	125 (250)
09 TSS	100 (200)	92.5 (185)	85 (170)	85 (170)
Flow	416 (100)	271.23 (65.2)	249.6 (60)	249.6 (60)
79 BOD	507 (1014)	13.6 (27.2)	5.0 (10.0)	5.0 (10.0)
79 TSS	15 (30)	16.3 (32.6)	2.5 (5.0)	5.0 (10.0)
High Alpha Sulfite				
09 BOD	650 (1300)	243.5 (487)	232 (464)	232 (464)
09 TSS	100 (200)	92.5 (185)	85 (170)	85 (170)
Flow	416 (100)	246.27 (59.2)	128.54 (30.9)	128.54 (30.9)
79 BOD	507 (1014)	15.3 (30.6)	7.75 (15.5)	7.75 (15.5)
79 TSS	15 (30)	18.5 (37.0)	2.6 (5.2)	5.2 (10.4)
Deink				
09 BOD	92.5 (185)	68.5 (137)	68.5 (137)	68.5 (137)
09 TSS	300 (600)	204 (408)	204 (408)	204 (408)
Flow	124.8 (30)	94.02 (22.6)	74.88 (18)	74.88 (18)
79 BOD	55.5 (111)	4.2 (8.4)	1.5 (3.0)	2.25 (4.5)
79 TSS	45 (90)	7.85 (15.7)	1.5 (3.0)	2.25 (4.5)
Dissolving Kraft				
09 BOD	80 (160)	55 (110)	37.5 (75.0)	37.5 (75.0)
09 TSS	200 400)	150 (300)	85 (170)	85 (170)
Flow	332.8 (80)	241.28 (58)	216.32 (52)	216.32 (52)
79 BOD	73.28 (146.6)	7.75 (15.5)	3.25 (6.5)	3.25 (6.5)
79 TSS	67.6 (135.2)	9.65 (19.3)	2.15 (4.3)	4.35 (8.7)

Table 150 (continued)

PARAMETER	PRETREATMENT	BPCTCA	BATEA	NSPS
Market Kraft				
09 BOD	60 (120)	41 (82.0)	26.5 (53.0)	27.5 (55.0)
09 TSS	80 (160)	70 (140)	65 (130)	65 (130)
Flow	332.8 (80)	176.8 (42.5)	141.44 (34)	79.04 (19)
79 BOD	54.96 (109.92)	4.25 (8.5)	2.0 (4.0)	1.1 (2.2)
79 TSS	27.04 (54.08)	6.4 (12.8)	1.4 (2.8)	1.6 (3.2)
BCT - Kraft				
09 BOD	42.5 (85.0)	33.5 (67.0)	26.0 (52.0)	26.0 (52.0)
09 TSS	55.0 (110.0)	51.5 (103)	46.5 (93.0)	46.5 (93.0)
Flow	208 (50)	151.84 (36.5)	112.32 (27)	112.32 (27)
79 BOD	38.93 (77.85)	3.8 (7.6)	1.7 (3.4)	1.7 (3.4)
79 TSS	18.59 (37.18)	6.4 (12.8)	1.15 (2.3)	2.25 (4.5)
Fine Kraft				
09 BOD	40.0 (80.0)	30.0 (60.0)	23.5 (47.0)	23.5 (47.0)
09 TSS	90.0 (180.0)	84 (168)	46.5 (93.0)	46.5 (93.0)
Flow	166.4 (40)	108.16 (26)	95.68 (23)	95.68 (23)
79 BOD	36.64 (73.28)	2.8 (5.6)	1.15 (2.3)	1.15 (2.3)
79 TSS	30.42 (60.84)	4.55 (9.1)	0.95 (1.9)	1.9 (3.8)
GW-Chemi-Mechanical				
09 BOD	60 (120.0)	50.5 (101)	45 (90.0)	45 (90.0)
09 TSS	32.5 (65.0)	28 (97.0)	22.5 (45.0)	22.5 (45.0)
Flow	99.84 (24)	83.2 (20)	74.88 (18)	74.88 (18)
79 BOD	42 (84)	2.1 (4.2)	0.75 (1.5)	0.75 (1.5)
79 TSS	7.5 (13)	3.65 (7.3)	0.75 (1.5)	1.5 (3.0)
Groundwood Thermo Mechanical				
09 BOD	-	28.0 (56.0)	26.5 (53.0)	28.0 (56.0)
09 TSS	-	25.0 (97.0)	25.0 (50.0)	25.0 (50.0)
Flow	-	62.4 (15)	41.6 (10)	62.4 (15)
79 BOD	-	1.55 (3.1)	0.65 (1.3)	1.55 (3.1)
79 TSS	-	2.75 (5.5)	0.4 (0.8)	1.25 (2.5)
Groundwood - CMN Papers				
09 BOD	22.0 (44.0)	17.5 (35.0)	16.0 (32.0)	16.0 (32.0)
09 TSS	80 (160)	70 (140)	48.0 (96.0)	48.0 (96.0)
Flow	120.64 (29)	99 (23.8)	79.04 (19)	79.04 (19)
79 BOD	15.4 (30.8)	2.5 (5.0)	1.05 (2.1)	1.05 (2.1)
79 TSS	16 (32)	4.35 (8.7)	0.8 (1.6)	1.6 (3.2)

Table 150 (continued)

PARAMETER	PRETREATMENT	BPCTCA	BATEA	NSPS
GW-Fine Papers				
09 BOD	21.0 (42.0)	17.0 (34.0)	16.0 (32.0)	16.0 (32.0)
09 TSS	65 (130)	52 (104)	45.0 (90.0)	45.0 (90.0)
Flow	108.16 (26)	90.69 (21.8)	74.88 (18)	74.88 (18)
79 BOD_5	14.7 (29.4)	2.25 (4.5)	1.0 (2.0)	1.0 (2.0)
79 TSS	13 (26)	4.0 (8.0)	0.75 (1.5)	1.5 (3.0)
Soda				
09 BOD	55 (110)	42.5 (85.0)	30 (60)	30 (60)
09 TSS	150 (300)	105 (210)	65 (130)	65 (130)
Flow	208 (50)	122.7 (29.5)	95.7 (23)	95.7 (23)
79 BOD	46.75 (93.5)	3.45 (6.9)	1.45 (2.9)	1.45 (2.9)
79 TSS	33 (66)	5.15 (10.3)	0.95 (1.9)	1.9 (3.8)
NI Fine Papers				
09 BOD	17.5 (35.0)	10.75 (21.5)	9.5 (19.0)	9.5 (19.0)
09 TSS	75 (150)	31.0 (62.0)	30.0 (60.0)	30.0 (60.0)
Flow	108.16 (26)	62.4 (15)	38.27 (9.2)	38.27 (9.2)
79 BOD	17.5 (35.0)	2.5 (5.0)	0.75 (1.5)	0.75 (1.5)
79 TSS	75 (150)	2.65 (5.3)	0.4 (0.8)	0.75 (1.5)
NI Tissue				
09 BOD	17.5 (35.0)	11.5 (23.0)	10.0 (20.0)	10.0 (20.0)
09 TSS	62.5 (125)	34.0 (68.0)	28.0 (56.0)	28.0 (56.0)
Flow	141.44 (34)	95.68 (23)	60.32 (14.5)	60.32 (14.5)
79 BOD	17.5 (35.0)	2.8 (5.6)	1.2 (2.4)	1.2 (2.4)
79 TSS	62.5 (125)	2.9 (5.8)	0.6 (1.2)	1.2 (2.4)
NI Tissue (FWP)				
09 BOD	20.0 (40.0)	14.5 (29.0)	13.5 (27.0)	13.5 (27.0)
09 TSS	75 (150)	40.0 (80.0)	35.0 (70.0)	35.0 (70.0)
Flow	141.44 (34)	95.68 (23)	60.32 (14.5)	60.32 (14.5)
79 GOD	20.0 (40.0)	2.8 (5.6)	1.2 (2.4)	1.2 (2.4)
79 TSS	75 (150)	2.9 (5.8)	0.6 (1.2	1.2 (2.4)

shown in Tables 151 to 184. With the exception of NSPS, costs are cumulative. That is, the costs of BATEA include the capital and annual costs already shown in BPCTCA and the costs for BPCTCA include those already shown for pretreatment. Figures 77-103 present schematics of the internal controls used in determining the costs. Figures 104-118 are cost curves for pretreatment, BPCTCA, BATEA, and NSPS and relate the costs of achieving the above levels of technology to the size of mills for each subcategory. It should be noted that curves are not included for NSPS for those subcategories which included only one size of model mill. The internal treatment costs for NSPS in Tables 151-184 are the same as for BATEA, and no credit has been taken for the equipment or systems that would be installed if there were no effluent limitation requirements. Table 185, titled "Internal Effluent Treatment Costs for NSPS", takes into account the equipment or system that would be installed.

INTERNAL TECHNOLOGY COSTS

The internal technology systems identified are listed on Table 131, titled "Identification of Internal Technology Items". A brief description of each of these 29 systems will be found on the following pages, and schematic drawings of the internal controls are shown in Figures 77-103.

The operation and maintenance costs of internal controls were conservatively considered to be recovered by the mill in the forms of material and/or energy savings for the internal technologies at all levels. Therefore, the annual operating costs for the internal technologies is the depreciation and interest costs. The depreciation costs are the accounting charges which reflect the deterioration of the capital assets over a period of years. Straight line depreciation has been assumed in all annual cost calculations. The interest is the financial charges on the capital expenditures for pollution reduction. Depreciation and interest together are assumed to be 15 percent of the investment costs.

The cost of sulfite liquor incineration and/or recovery is not included in the cost tables for the sulfite and dissolving sulfite subcategory. The capital cost estimate for an MgO recovery system is included at the bottom of each table for reference.

The number of paper machines in the paper mills by each subcategory will be found in Table 130. A very brief description of what is included in each of the 29 internal technology items is as follows.

Table 151

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS

Bleached Kraft Dissolving Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 600 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	525	5,640	6,165	1,040	14,475	15,515	3,725	18,865	22,590			
2.	80	1,030	1,110	155	3,310	3,465	560	4,725	5,285			
3.	80	845	925	155	2,170	2,325	560	2,830	3,390			
4.	-	185	185	-	1,140	1,140	-	1,895	1,895			

Mill Size: 1000 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	740	8,055	8,795	1,460	20,135	21,595	5,210	26,210	31,420	5,210	22,775	27,985
2.	110	1,470	1,580	220	4,755	4,975	780	6,785	7,565	780	5,540	6,320
3.	110	1,210	1,320	220	3,020	3,240	780	3,930	4,710	780	3,415	4,195
4.	-	260	260	-	1,735	1,735	-	2,855	2,855	-	2,125	2,125

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 152

WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Bleached Kraft Dissolving Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 600 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	525	5,640	6,165	1,040	18,585	19,625	3,725	22,975	26,700			
2.	80	1,030	1,110	155	4,255	4,410	560	5,670	6,230			
3.	80	845	925	155	2,785	2,940	560	3,445	4,005			
4.	-	185	185	-	1,470	1,470	-	2,225	2,225			

Mill Size: 1000 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	740	8,055	8,795	1,460	25,750	27,210	5,210	31,825	37,035	5,210	22,415	27,625
2.	110	1,470	1,580	220	5,975	6,195	780	8,000	8,780	780	5,615	6,395
3.	110	1,210	1,320	220	3,865	4,085	780	4,775	5,555	780	3,365	4,145
4.	-	260	260	-	2,110	2,110	-	3,225	3,225	-	2,250	2,250

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 153
AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Market Kraft Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 350 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	360	3,430	3,790	705	8,745	9,450	2,570	11,210	13,780			
2.	55	645	700	105	1,880	1,985	385	2,660	3,045			
3.	55	515	570	105	1,315	1,420	385	1,690	2,075			
4.	-	130	130	-	565	565	-	970	970			

Mill Size: 700 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	565	5,610	6,175	1,115	13,630	14,745	3,980	17,265	21,245	3,980	11,560	15,540
2.	85	1,045	1,130	165	3,000	3,165	595	4,850	5,445	595	2,790	3,385
3.	85	845	930	165	2,050	2,215	595	2,600	3,195	595	1,735	2,330
4.	-	200	200	-	950	950	-	2,250	2,250	-	1,055	1,055

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 154
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Market Kraft Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 350 TPD

	1973				1977				1983				NSPS		
	Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total
1.	360	3,430	3,790	1.	705	10,865	11,570	1.	2,570	13,330	15,900	1.			
2.	55	645	700	2.	105	2,330	2,435	2.	385	3,110	3,495	2.			
3.	55	515	570	3.	105	1,635	1,740	3.	385	2,010	2,395	3.			
4.	-	130	130	4.	-	695	695	4.	-	1,100	1,100	4.			

Mill Size: 700 TPD

	1973				1977				1983				NSPS		
	Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total
1.	565	5,610	6,175	1.	1,115	17,140	18,255	1.	3,980	20,775	24,755	1.	3,980	10,235	14,215
2.	85	1,045	1,130	2.	165	3,810	3,975	2.	595	5,075	5,670	2.	595	2,600	3,195
3.	85	845	930	3.	165	2,575	2,740	3.	595	3,125	3,720	3.	595	1,535	2,130
4.	-	200	200	4.	-	1,235	1,235	4.	-	1,950	1,950	4.	-	1,065	1,065

Int: Internal Cost
Ext: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 155
AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
BTC Kraft Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 250 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	885	2,185	3,070	1,335	6,115	7,450	3,020	7,595	10,615			
2.	135	425	560	200	1,295	1,495	455	1,750	2,205			
3.	135	330	465	200	920	1,120	455	1,140	1.595			
4.	-	95	95	-	375	375	-	610	610			

Mill Size: 670 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,800	3,950	5,750	2,645	10,860	13,505	5,715	14,010	19,725	5,715	12,590	18,305
2.	270	740	1,010	395	2,360	2,755	860	3,340	4,200	860	2,895	3,755
3.	270	595	865	395	1,630	2,025	860	2,105	2,965	860	1,890	2,750
4.	-	145	145	-	730	730	-	1,235	1,235	-	1,005	1,005

Mill Size: 1300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	3,030	6,320	9,350	4,365	16,795	21,160	9,050	21,485	30,535	9,050	18,505	27,555
2.	455	1,175	1,630	655	3,790	4,445	1,360	5,215	6,575	1,360	4,455	5,815
3.	455	950	1,405	655	2,520	3,175	1,360	3,225	4,585	1,360	2,775	4,135
4.	-	225	225	-	1,270	1,270	-	1,990	1,990	-	1,680	1,680

Int.: Internal Cost
Ext.: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 156

WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS

BTC Kraft
(All Costs in Thousands of Dollars)

Mill Size: 250 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	885	2,185	3,070	1,335	7,475	8,810	3,020	8,955	11,975			
2.	135	425	560	200	1,645	1,845	455	2,100	2,555			
3.	135	330	465	200	1,125	1,325	455	1,345	1,800			
4.	-	95	95	-	520	520	-	755	755			

Mill Size: 670 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,800	3,950	5,750	2,645	13,870	16,515	5,715	17,010	22,733	5,715	11,260	16,975
2.	270	740	1,010	395	3,060	3,445	860	4,040	4,900	860	2,800	3,660
3.	270	595	865	395	2,085	2,480	860	2,560	3,420	860	1,690	2,550
4.	-	145	145	-	975	975	-	1,480	1,480	-	1,110	1,110

Mill Size: 1300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	3,030	6,320	9,350	4,365	21,715	26,080	9,050	26,402	35,452	9,050	17,225	26,275
2.	455	1,175	1,630	655	4,875	5,530	1,360	6,300	7,660	1,360	4,465	5,825
3.	455	950	1,405	655	3,260	3,915	1,360	3,965	5,325	1,360	2,585	3,945
4.	-	225	225	-	1,615	1,615	-	2,335	2,335	-	1,880	1,880

Int.: Internal Cost **Ext.:** External Cost 1. Total Investment Cost

2. Total Operating Cost 3. Depreciation & Interest 4. Operation & Maintenance

Table 157
AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Fine Kraft Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 250 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,030	1,930	2,960	1,235	5,470	6,705	2,920	7,040	9,960			
2.	155	385	540	185	1,200	1,385	440	1,660	2,100			
3.	155	290	445	185	820	1,005	440	1,060	1,500			
4.	-	95	95	-	380	380	-	600	600			

Mill Size: 670 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,970	4,425	6,395	2,365	10,690	13,055	5,410	13,510	18,920	5,410	11,565	16,975
2.	295	795	1,090	355	2,385	2,740	810	3,225	4,065	810	2,660	3,470
3.	295	665	960	355	1,605	1,960	810	2,030	2,840	810	1,735	2,545
4.	-	130	130	-	780	780	-	1,225	1,225	-	925	925

Mill Size: 1300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	3,200	5,845	9,045	3,820	15,140	18,960	8,505	19,455	27,960	8,505	17,160	25,665
2.	480	1,065	1,545	575	3,575	4,150	1,275	5,000	6,275	1,275	4,135	5,410
3.	480	875	1,355	575	2,270	2,845	1,275	2,920	4,195	1,275	2,575	3,850
4.	-	190	190	-	1,305	1,305	-	2,080	2,080	-	1,560	1,560

Int.: Internal Cost
Ext.: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 158
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Fine Kraft
(All Costs in Thousands of Dollars)

Mill Size: 250 TPD

	1973 Int.	1973 Ext.	1973 Total	1977 Int.	1977 Ext.	1977 Total	1983 Int.	1983 Ext.	1983 Total	NSPS Int.	NSPS Ext.	NSPS Total
1.	1,030	1,930	2,960	1,235	6,750	7,985	2,920	8,320	11,240			
2.	155	385	540	185	1,570	1,755	440	2,030	2,470			
3.	155	290	445	185	1,015	1,200	440	1,255	1,695			
4.	-	95	95	-	555	555	-	775	775			

Mill Size: 670 TPD

	1973 Int.	1973 Ext.	1973 Total	1977 Int.	1977 Ext.	1977 Total	1983 Int.	1983 Ext.	1983 Total	NSPS Int.	NSPS Ext.	NSPS Total
1.	1,970	4,425	6,395	2,365	13,140	15,505	5,410	15,960	21,370	5,410	10,305	15,715
2.	295	795	1,090	355	2,950	3,305	810	3,820	4,630	810	2,555	3,365
3.	295	665	960	355	1,975	2,330	810	2,400	3,210	810	1,545	2,355
4.	-	130	130	-	975	975	-	1,420	1,420	-	1,010	1,010

Mill Size: 1300 TPD

	1973 Int.	1973 Ext.	1973 Total	1977 Int.	1977 Ext.	1977 Total	1983 Int.	1983 Ext.	1983 Total	NSPS Int.	NSPS Ext.	NSPS Total
1.	3,200	5,845	9,045	3,820	19,100	22,920	8,505	23,415	31,920	8,505	15,985	24,490
2.	480	1,065	1,545	575	4,510	5,085	1,275	5,890	7,165	1,275	4,070	5,345
3.	480	875	1,355	575	2,865	3,440	1,275	3,515	4,790	1,275	2,400	3,675
4.	-	190	190	-	1,645	1,645	-	2,375	2,375	-	1,670	1,670

Int.: Internal Cost   Ext.: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 159

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Groundwood Chem/Mech. Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 100 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	160	845	1005	435	3040	3475	930	3460	4390	930	3625	4555
2.	25	190	215	65	645	710	140	785	925	140	780	920
3.	25	130	155	65	460	525	140	520	660	140	545	685
4.	-	60	60	-	185	185	-	265	265	-	235	235

Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	275	1690	1965	745	5665	6410	1725	6570	8295	1725	6930	8655
2.	40	340	380	110	1230	1340	260	1510	1770	260	1510	1770
3.	40	255	295	110	855	965	260	990	1250	260	1045	1305
4.	-	85	85	-	375	375	-	520	520	-	465	465

Mill Size: 600 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	465	2735	3200	1245	8755	10000	2735	10260	12995	2735	10305	13040
2.	70	515	585	185	1940	2125	410	2395	2805	410	2300	2710
3.	70	410	480	185	1315	1500	410	1540	1950	410	1545	1955
4.	-	105	105	-	625	625	-	855	855		755	755

Int.: Internal Cost   Ext.: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 160
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Groundwood Chem/Mech. Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 100 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	160	845	1,005	435	3,430	3,865	930	3,850	4,780	930	3,165	4,095
2.	25	190	215	65	810	875	140	950	1,090	140	775	915
3.	25	130	155	65	520	585	140	585	725	140	475	615
4.	-	60	60	-	290	290	-	365	365	-	300	300

Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	275	1,690	1,965	745	6,585	7,330	1,725	7,490	9,215	1,725	6,080	7,805
2.	40	335	375	110	1,535	1,645	260	1,815	2,075	260	1,485	1,745
3.	40	255	295	110	990	1,100	260	1,125	1,385	260	915	1,175
4.	-	80	80	-	545	545	-	685	685	-	570	570

Mill Size: 600 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	465	2,735	3,200	1,245	10,315	11,560	2,735	11,820	14,555	2,735	9,255	11,990
2.	70	510	580	185	2,415	2,600	410	2,870	3,280	410	2,280	2,690
3.	70	410	480	185	1,550	1,735	410	1,775	2,185	410	1,390	1,800
4.	-	100	100	-	865	865	-	1,095	1,095	-	890	890

Int.: Internal Cost
Ext.: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table **161**

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Groundwood Thermo/Mech. Subcategory

(All Costs in Thousands of Dollars)

Mill Size: 100 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	160	-	160	430	2300	2730	925	2585	3510	925	2300	3225
2.	25	-	25	65	500	565	140	605	745	140	500	640
3.	25	-	25	65	345	410	140	390	530	140	345	485
4.	-	-	-	-	155	155	-	215	215		155	155

Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	275	-	275	745	4270	5015	1725	4875	6600	1725	4270	5995
2.	40	-	40	110	925	1035	260	1120	1380	260	925	1185
3.	40	-	40	110	640	750	260	730	990	260	640	900
4.	-	-	-	-	285	285	-	390	390		285	285

Mill Size: 500 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	465	-	465	1245	6275	7520	2735	7255	9990	2735	6275	9010
2.	70	-	70	185	1395	1580	410	1700	2110	410	1395	1805
3.	70	-	70	185	945	1130	410	1095	1505	410	945	1355
4.	-	-	-	-	450	450	-	605	605	-	450	450

Int.: Internal Cost   Ext.: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 162
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS

Groundwood Thermo/Mech Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 100 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	160	--	160	430	2730	3160	925	3015	3940	925	2730	3655
2.	25	--	25	65	655	720	140	760	900	140	655	795
3.	25	--	25	65	410	475	140	455	595	140	410	550
4.	-	--	-	-	245	245	-	305	305	-	245	245

Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	275	--	275	745	5050	5795	1725	5655	7380	1725	5050	6775
2.	40	--	40	110	1165	1275	260	1360	1620	260	1165	1425
3.	40	--	40	110	760	870	260	850	1110	260	760	1020
4.	-	--	-	-	405	405	--	510	510	-	405	405

Mill Size: 600 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	465	--	465	1245	7700	8945	2735	8680	11,415	2735	7700	10,435
2.	70	--	70	185	1770	1955	410	2075	2,485	410	1770	2,180
3.	70	--	70	185	1155	1340	410	1305	1,715	410	1155	1,565
4.	-	--	-	-	615	615	--	770	770	--	615	615

Int.: Internal Cost Ext.: External Cost 1. Total Investment Cost

2. Total Operating Cost 3. Depreciation & Interest 4. Operation & Maintenance

Table 163

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Groundwood C-M-N Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 75 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	150	915	1065	410	2645	3055	830	3000	3830	830	3130	3960
2.	20	200	220	60	575	635	125	695	820	125	700	825
3.	20	140	160	60	400	460	125	455	580	125	470	595
4.	-	60	60	-	175	175	-	240	240	-	230	230

Mill Size: 150 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	175	1355	1530	480	3740	4220	1125	4325	5450	1125	4400	5525
2.	25	280	305	70	805	875	170	995	1165	170	950	1120
3.	25	205	230	70	560	630	170	650	820	170	660	830
4.	-	75	75	-	245	245	-	345	345	-	290	290

Mill Size: 500 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	380	2990	3370	1025	7425	8450	2360	8755	11,115	2360	8565	10,925
2.	55	555	610	155	1610	1765	350	2015	2,365	350	1960	2,310
3.	55	450	505	155	1115	1270	350	1315	1,665	350	1285	1,635
4.	-	105	105	-	495	495	-	700	700	-	675	675

Int.: Internal Cost

Ext.: External Cost

1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 164
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Groundwood C-M-N Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 75 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	150	915	1065	410	2990	3400	830	3345	4175	830	2505	3335
2.	20	200	220	60	690	750	125	815	940	125	605	730
3.	20	140	160	60	450	510	125	505	630	125	375	500
4.	-	60	60	-	240	240	-	310	310	-	230	230

Mill Size: 150 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	175	1355	1530	480	4370	4850	1125	4960	6085	1125	3735	4860
2.	25	280	305	70	990	1060	170	1180	1350	170	885	1055
3.	25	205	230	70	655	725	170	745	915	170	565	735
4.	-	75	75	-	335	335	-	435	435	-	320	320

Mill Size: 500 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	380	2990	3370	1025	8895	9920	2360	10,225	12,585	2360	7445	9805
2.	55	555	610	155	1955	2110	350	2,365	2,715	350	1760	2110
3.	55	450	505	155	1335	1490	350	1,535	1,885	350	1115	1465
4.	-	105	105	-	620	620	-	830	830	-	645	645

Int.: Internal Cost Ext.: External Cost 1. Total Investment Cost

2. Total Operating Cost 3. Depreciation & Interest 4. Operation & Maintenance

Table 165

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Groundwood Fine Subcategory

(All Costs in Thousands of Dollars)

Mill Size: 150 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	400	1230	1630	610	3435	4095	1244	4060	5315	1255	4290	5545
2.	60	255	315	90	745	835	190	930	1120	190	940	1130
3.	60	185	245	90	525	615	190	610	800	190	645	835
4.	-	70	70	-	220	220	-	320	320	-	295	295

Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	585	1945	2530	880	5110	5990	1860	6020	7880	1860	6295	8155
2.	90	380	470	130	1105	1235	280	1395	1675	280	1370	1650
3.	90	295	385	130	770	900	280	910	1190	280	945	1225
4.	-	85	85	-	335	335	-	485	485	-	425	425

Mill Size: 550 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	930	2935	3865	1385	7375	8760	2790	8755	11,545	2790	8925	11,715
2.	140	545	685	210	1585	1795	420	2005	2,425	420	1985	2,405
3.	140	440	580	210	1105	1315	420	1315	1,735	420	1340	1,760
4.	-	105	105	-	480	480	-	690	690	-	645	645

Int.: Internal Cost Ext.: External Cost 1. Total Investment Cost

2. Total Operating Cost 3. Depreciation & Interest 4. Operation & Maintenance

Table 166

WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Groundwood Fine Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 150 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	400	1230	1630	610	4005	4615	1,244	4580	5824	1,255	2865	4120
2.	60	255	415	90	1000	1090	190	1185	1375	190	835	1025
3.	60	285	345	90	705	795	190	790	980	190	530	720
4.	-	70	70	-	295	295	-	395	395	-	305	305

Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	585	1,945	2,530	880	6,010	6,890	1,860	6,920	8,780	1,860	5,340	7,200
2.	90	380	470	130	1,325	1,455	280	1,605	1,885	280	1,275	1,555
3.	90	295	385	130	905	1,035	280	1,040	1,320	280	800	1,080
4.	-	85	85	-	420	420	-	565	565	-	475	475

Mill Size: 550 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	930	2,935	3,865	1,385	8,705	10,090	2,790	10,085	12,875	2,790	7,685	10,475
2.	140	545	685	210	1,900	2,110	420	2,320	2,740	420	1,825	2,245
3.	140	440	580	210	1,305	1,515	420	1,515	1,935	420	1,155	1,575
4.	-	105	105	-	595	595	-	805	805	-	670	670

Int.: Internal Cost

Ext.: External Cost

1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

TAble 167

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS

Soda Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	825	3,150	3,975	1,195	7,525	8,720	3,070	9,200	12,270	3,070	7,555	10,625
2.	125	585	710	180	1,685	1,865	460	2,170	2,630	460	1,715	2,175
3.	125	470	595	180	1,125	1,305	460	1,380	1,840	460	1,135	1,595
4.	-	115	115	-	560	560	-	790	790	-	580	580

Mill Size: 700 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,705	5,615	7,320	2,355	12,640	14,995	5,500	15,295	20,795	5,500	12,395	17,895
2.	255	1,020	1,275	355	2,935	3,290	825	3,745	4,570	825	2,910	3,735
3.	255	845	1,100	355	1,900	2,255	825	2,300	3,125	825	1,860	2,685
4.	-	175	175	-	1,035	1,035	-	1,445	1,445	-	1,050	1,050

Int: Internal Cost Ext: External Cost 1. Total Investment Cost

2. Total Operating Cost 3. Depreciation & Interest 4. Operation & Maintenance

Table 168
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Soda Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 300 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	825	3,150	3,975	1,195	8,985	10,180	3,070	10,660	13,730	3,070	6,690	9,760
2.	125	585	710	180	2,060	2,240	460	2,545	3,005	460	1,645	2,105
3.	125	470	595	180	1,345	1,525	460	1,600	2,060	460	1,005	1,465
4.	-	115	115	-	715	715	-	945	945	-	640	640

Mill Size: 700 TPD

	1973			1977			1983			NSPS		
	Int	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,705	5,615	7,320	2,355	15,170	17,525	5,500	17,825	23,325	5,500	10,695	16,195
2.	255	1,020	1,275	355	3,545	3,900	825	4,355	5,180	825	2,610	3,435
3.	255	845	1,100	355	2,280	2,635	825	2,680	3,505	825	1,605	2,430
4.	-	175	175	-	1,265	1,265	-	1,675	1,675	-	1,005	1,005

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 169

Aerated Stabilization Basin
EFFLUENT TREATMENT COSTS
Papergrade Sulfite Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 160 TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	600	2,875	3,475	1,000	7,550	8,550	1,040	8,730	9,770	1,040	7,540	8,580
2.	90	550	640	150	1,685	1,835	155	2,040	2,200	155	1,690	1,845
3.	90	430	520	150	1,130	1,280	155	1,305	1,460	155	1,145	1,300
4.	-	120	120	-	555	555	-	740	740	-	545	545

Mill Size: 530 TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,430	6,390	7,820	2,310	15,800	18,110	4,500	18,335	22,835	4,500	15,330	19,820
2.	215	1,170	1,385	345	3,680	4,025	675	4,385	5,060	675	3,600	4,275
3.	215	960	1,175	345	2,370	2,715	675	2,730	3,405	675	2,300	2,975
4.	-	210	210	-	1,310	1,310	-	1,655	1,655	-	1,300	1,300

Int: Internal
Ext: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 170

ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Papergrade Sulfite Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 160 TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	600	2,875	3,475	1,000	8,980	9,980	1,040	10,160	11,200	1,040	6,520	7,560
2.	90	550	640	150	2,055	2,205	155	2,415	2,570	155	1,620	1,775
3.	90	430	520	150	1,345	1,495	155	1,520	1,675	155	980	1,135
4.	-	120	120	-	710	710	-	895	895	-	640	640

Mill Size: 530 TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,430	6,390	7,820	2,310	19,630	21,940	4,500	22,165	26,665	4,500	13,610	18,110
2.	215	1,170	1,385	345	4,540	4,885	675	5,245	5,920	675	3,565	4,240
3.	215	960	1,175	345	2,945	3,290	675	3,305	3,980	675	2,045	2,720
4.	-	210	210	-	1,595	1,595	-	1,940	1,940	-	1,520	1,520

Int: Internal Cost
Ext: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 171

Aerated Stabilization Basin

EFFLUENT TREATMENT COSTS

Market Sulfite Subcategory

(All Costs in Thousands of Dollars)

Mill Size: 160 **TPD**

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	600	2,875	3,475	1,000	7,585	8,585	1,040	8,815	9,855	1,040	8,745	9,785
2.	90	550	640	150	1,605	1,755	155	2,015	2,170	155	1,855	2,010
3.	90	430	520	150	1,135	1,285	155	1,320	1,475	155	1,315	1,470
4.	-	120	120	-	470	470	-	695	695	-	540	540

Mill Size: 530 **TPD**

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,430	6,390	7,820	2,310	16,190	18,500	4,500	19,020	23,520	4,500	13,610	18,110
2.	215	1,170	1,385	345	3,585	3,930	675	4,460	5,135	675	3,565	4,240
3.	215	960	1,175	345	2,430	2,775	675	2,855	3,530	675	2,045	2,720
4.	-	210	210	-	1,155	1,155	-	1,605	1,605	-	1,520	1,520

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 172

Activated Sludge

EFFLUENT TREATMENT COSTS

Market Sulfite Subcategory

(All Costs in Thousands of Dollars)

Mill Size: 160 **TPD**

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	600	2,875	3,475	1,000	9,135	10,135	1,040	10,365	11,405	1,040	7,965	9,005
2.	90	550	640	150	2,200	2,350	155	2,610	2,765	155	1,860	2,015
3.	90	430	520	150	1,370	1,520	155	1,555	1,710	155	1,195	1,350
4.	-	120	120	-	830	830	-	1,055	1,055	-	665	665

Mill Size: 530 **TPD**

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	1,430	6,390	7,820	2,310	20,030	22,340	4,500	22,860	27,360	4,500	17,340	21,840
2.	215	1,170	1,385	345	5,080	5,425	675	5,955	6,630	675	4,300	4,975
3.	215	960	1,175	345	3,005	3,350	675	3,430	4,105	675	2,600	3,275
4.	-	210	210	-	2,075	2,075	-	2,525	2,525	-	1,700	1,700

Int: Internal Cost Ext: External Cost 1. Total Investment Cost

2. Total Operating Cost 3. Depreciation & Interest 4. Operation & Maintenance

Table 173

Aerated Stabilization Basin
EFFLUENT TREATMENT COSTS
Low Alpha Sulphite
(All Costs in Thousands of Dollars)
Mill Size: 550 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	415	6880	7295	870	16695	17565	2940	19980	22920		19960	
2.	60	1320	1380	130	3925	4055	440	4940	5380		4955	
3.	60	1080	1140	130	2570	2700	440	3065	3505		2980	
4.	-	240	240	-	1355	1355	-	1875	1875		1975	

Mill Size:_____TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.												
2.												
3.												
4.												

Int: Internal Cost — Ext: External Cost — 1. Total Investment Cost

2. Total Operating Cost — 3. Depreciation & Interest — 4. Operation & Maintenance

NOTE: MgO Recovery System not included
Capital Cost: 35,000

Table 174

ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS

Low Alpha Sulfite
(All Costs in Thousands of Dollars)
Mill Size: 550 TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	415	6,880	7,295	870	20,775	21,645	2,940	24,060	27,000	2,940	18,740	21,680
2.	60	1,320	1,380	130	4,860	4,990	440	5,875	6,315	440	4,840	5,280
3.	60	1,080	1,140	130	3,165	3,295	440	3,660	4,100	440	2,810	3,250
4.	-	240	240	-	1,695	1,695	-	2,215	2,215	-	2,030	2,030

Mill Size: TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.												
2.												
3.												
4.												

Table 175

Aerated Stabilization Basin
EFFLUENT TREATMENT COSTS
High Alpha Sulfite Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 550 TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	415	6,880	7,295	870	21,290	22,160	2,940	23,440	26,380	2,940	20,830	23,770
2.	60	1,320	1,380	130	5,215	5,345	440	5,880	6,320	440	5,055	5,495
3.	60	1,080	1,140	130	3,240	3,370	440	3,560	4,000	440	3,125	3,565
4.	-	240	240	-	1,975	1,975	-	2,320	2,320	-	1,930	1,930

Mill Size: TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.												
2.												
3.												
4.												

Int: Internal Cost
Ext: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 176

Activated Sludge
EFFLUENT TREATMENT COSTS
High Alpha Sulfite Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 550 TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	415	6,880	7,295	870	25,135	26,005	2,940	27,285	30,225	2,940	19,710	22,650
2.	60	1,320	1,380	130	6,975	7,105	440	7,640	8,080	440	5,520	5,960
3.	60	1,080	1,140	130	3,820	3,950	440	4,140	4,580	440	2,955	3,395
4.	-	240	240	-	3,155	3,155	-	3,500	3,500	-	2,565	2,565

Mill Size: TPD

	1973			1977			1983			NSPC		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.												
2.												
3.												
4.												

Int: Internal Cost

Ext: External Cost

1. Total Investment Cost

2. Total Operating Cost

3. Depreciation & Interest

4. Operation & Maintenance

Table 177
AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Deink Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 80 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	400	1225	1625	600	3555	4155	745	3905	4650			
2.	60	255	315	90	855	945	110	980	1090			
3.	60	190	250	90	550	640	110	605	715			
4.	-	65	65	-	305	305	-	375	375			

Mill Size: 230 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	535	2350	2885	835	6405	7240	1110	7140	8250	1110	7670	8780
2.	80	445	525	125	1530	1655	165	1670	1835	165	1795	1960
3.	80	360	440	125	965	1090	165	1075	1240	165	1150	1315
4.	-	85	85	-	565	565	-	595	595	-	645	645

Mill Size: 500 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	965	4,050	5,015	1,485	10,135	11,620	1,930	11,405	13,335	1,930	11,795	13,725
2.	145	720	865	225	2,500	2,725	290	2,915	3,205	290	2,750	3,040
3.	145	610	755	225	1,530	1,755	290	1,715	2,005	290	1,770	2,060
4.	-	110	110	-	970	970	-	1,200	1,200	-	980	980

Int.: Internal Cost
Ext.: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 178
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Deink Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 80 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	400	1,225	1,625	600	4,115	4,715	745	4,465	5,210			
2.	60	225	315	90	1,010	1,100	110	1,135	1,245			
3.	60	190	250	90	625	715	110	680	790			
4.	-	65	65	-	385	385	-	455	455			

Mill Size: 230 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	535	2,350	2,885	835	7,405	8,240	1,110	8,140	9,250	1,110	6,675	7,785
2.	80	445	525	125	1,835	1,960	165	2,070	2,235	165	1,780	1,945
3.	80	360	440	125	1,120	1,245	165	1,230	1,395	165	1,005	1,170
4.	-	85	85	-	715	715	-	840	840	-	775	775

Mill Size: 500 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	965	4,050	5,015	1,485	11,985	13,470	1,930	13,255	15,185	1,930	10,755	12,685
2.	145	720	865	225	2,820	3,045	290	3,235	3,525	290	2,870	3,160
3.	145	610	755	225	1,635	1,860	290	1,820	2,110	290	1,615	1,905
4.	-	110	110	-	1,185	1,185	-	1,415	1,415	-	1,255	1,255

Int.: Internal Cost
Ext.: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 179

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS

Non-Integrated Fine Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 50 TPD

	1973 Int.	1973 Ext.	1973 Total	1977 Int.	1977 Ext.	1977 Total	1983 Int.	1983 Ext.	1983 Total	NSPS Int.	NSPS Ext.	NSPS Total
1.	165	-	165	300	675	975	400	1,010	1,410			
2.	25	-	25	45	180	225	60	290	350			
3.	25	-	25	45	105	150	60	155	215			
4.	-	-	-	-	75	75	-	135	135			

Mill Size: 100 TPD

	1973 Int.	1973 Ext.	1973 Total	1977 Int.	1977 Ext.	1977 Total	1983 Int.	1983 Ext.	1983 Total	NSPS Int.	NSPS Ext.	NSPS Total
1.	230	-	230	415	1,190	1,605	575	1,825	2,400	575	2,210	2,785
2.	35	-	35	60	290	350	85	460	545	70	515	585
3.	35	-	35	60	180	240	85	275	360	70	335	405
4.	-	-	-	-	110	110	-	185	185	-	180	180

Mill Size: 250 TPD

	1973 Int.	1973 Ext.	1973 Total	1977 Int.	1977 Ext.	1977 Total	1983 Int.	1983 Ext.	1983 Total	NSPS Int.	NSPS Ext.	NSPS Total
1.	540	-	540	935	2,060	2,995	1,245	3,275	4,520	1,245	3,740	4,985
2.	80	-	80	140	470	610	185	795	980	185	835	1,020
3.	80	-	80	140	310	450	185	495	680	185	560	745
4.	-	-	-	-	160	160	-	300	300	-	275	275

Int.: Internal Cost
Ext.: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 180
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS
Non-Integrated Fine Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 30 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	165	-	165	300	675	975	400	1,150	1,550			
2.	25	-	25	45	180	225	60	325	385			
3.	25	-	25	45	105	150	60	180	240			
4.	-	-	-	-	75	75	-	145	145			

Mill Size: 100 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	230	-	230	415	1,190	1,605	575	2,200	2,775	575	1,910	2,485
2.	35	-	35	60	290	350	85	555	640	70	480	550
3.	35	-	35	60	180	240	85	335	420	70	290	360
4.	-	-	-	-	110	110	-	220	220	-	190	190

Mill Size: 280 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	540	-	540	935	2,060	2,995	1,245	4,215	5,460	1,245	3,310	4,555
2.	80	-	80	140	470	610	185	980	1,165	185	795	980
3.	80	-	80	140	310	450	185	635	820	185	500	685
4.	-	-	-	-	160	160	-	345	345	-	295	295

Int.: Internal Cost
Ext.: External Cost
1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 181
AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS

Non-Integrated Tissue Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 15 TPD

	1973				1977				1983				NSPS		
	Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total
1.	190	-	190	1.	410	560	970	1.	490	745	1,235	1.			
2.	30	-	30	2.	60	150	210	2.	75	220	295	2.			
3.	30	-	30	3.	60	85	145	3.	75	115	190	3.			
4.	-	-	-	4.	-	65	65	4.	-	105	105	4.			

Mill Size: 35 TPD

	1973				1977				1983				NSPS		
	Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total		Int.	Ext.	Total
1.	290	-	290	1.	620	835	1,455	1.	720	1,155	1,875	1.			
2.	45	-	45	2.	95	210	305	2.	110	315	425	2.			
3.	45	-	45	3.	95	125	220	3.	110	175	285	3.			
4.	-	-	-	4.	-	85	85	4.	-	140	140	4.			

Int: Internal Cost Ext: External Cost 1. Total Investment Cost

2. Total Operating Cost 3. Depreciation & Interest 4. Operation & Maintenance

Table 181 (cont.)
AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Non-Integrated Tissue Subcategory (Continued)
(All Costs in Thousands of Dollars)
Mill Size: 110 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	335	-	335	720	1,495	2,2[illegible]5	890	2,215	3,105	890	2,375	3,265
2.	50	-	50	110	350	460	135	565	700	135	545	680
3.	50	-	50	110	225	335	135	335	470	135	355	490
4.	-	-	-	-	125	125	-	230	230	-	190	190

Mill Size: 450 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	855	-	855	1,860	3,350	5,210	2,275	5,130	7,405	2,275	5,220	7,495
2.	130	-	130	280	755	1,035	340	1,250	1,590	340	1,355	1,695
3.	130	-	130	280	505	785	340	770	1,110	340	950	1,290
4.	-	-	-	-	250	250	-	480	480	-	405	405

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 182

WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS

Non-Integrated Tissue Subcategory
(All Costs in Thousands of Dollars)

Mill Size: 15 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	190	-	190	410	560	970	490	910	1,400			
2.	30	-	30	60	150	210	75	260	335			
3.	30	-	30	60	85	145	75	135	210			
4.	-	-	-	-	65	65	-	125	125			

Mill Size: 35 TPD

	1973			1977			1983			NSPS		
	Int	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	290	-	290	620	835	1,455	720	1,440	2,160			
2.	45	-	45	95	210	305	110	390	500			
3.	45	-	45	95	125	220	110	220	330			
4.	-	-	-	-	85	85	-	170	170			

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 182 cont'd

WASTE ACTIVATED SLUDGE

EFFLUENT TREATMENT COSTS

Non-Intergrated Tissue Subcatetory Con't

(All Costs in Thousands of Dollars)

Mill Size: 110 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	335	-	335	720	1,495	2,215	890	2,870	3,760	890	2,265	3,155
2.	50	-	50	110	350	460	135	695	830	135	535	670
3.	50	-	50	110	225	335	135	430	565	135	340	475
4.				-	125	125	-	265	265	-	195	195

Mill Size: 450 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	855	-	855	1,860	3,350	5,210	2,275	6,910	9,185	2,275	5,220	7,495
2.	130	-	130	280	755	1,035	340	1,575	1,915	340	1,190	1,530
3.	130	-	130	280	505	785	340	1,040	1,380	340	785	1,125
4.	-	-	-	-	250	250	-	535	535	-	405	405

Int: Internal Cost | Ext: External Cost | 1. Total Investment Cost

2. Total Operating Cost | 3. Depreciation & Interest | 4. Operation & Maintenance

Table 183

AERATED STABILIZATION BASIN
EFFLUENT TREATMENT COSTS
Non-Integrated Tissue (fwp) Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 15 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	190	-	190	410	810	1,220	490	920	1,410			
2.	30	-	30	60	205	265	75	255	330			
3.	30	-	30	60	125	185	75	140	215			
4.	-	-	-	-	80	80	-	115	115			

Mill Size: 35 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	290	-	290	620	1,225	1,845	720	1,425	2,145			
2.	45	-	45	95	290	385	110	370	480			
3.	45	-	45	95	185	280	110	215	325			
4.	-	-	-	-	105	1^5	-	155	155			

Int: Internal Cost — Ext: External Cost — 1. Total Investment Cost

2. Total Operating Cost — 3. Depreciation & Interest — 4. Operation & Maintenance

Table 183 cont'd

AERATED STABILIZATION BASIN

EFFLUENT TREATMENT COSTS

Non-Integrated Tissue (fwp) Subcategory (Continued)

(All Costs in Thousands of Dollars)

Mill Size: 110 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	330	-	330	720	2,280	3,000	890	2,710	3,600	890	2,870	3,760
2.	50	-	50	110	515	625	135	660	795	135	635	770
3.	50	-	50	110	345	455	135	410	545	135	430	565
4.	-	-	-	-	170	170	-	250	250	-	205	205

Mill Size: 450 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	855	-	855	1,860	5,370	7,230	2,275	6,510	8,785	2,275	6,585	8,860
2.	130	-	130	280	1,180	1,460	340	1,525	1,865	340	1,475	1,815
3.	130	-	130	280	805	1,085	340	975	1,315	340	990	1,330
4.	-	-	-	-	375	375	-	550	550	-	485	485

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 184
WASTE ACTIVATED SLUDGE
EFFLUENT TREATMENT COSTS

Non-Integrated Tissue (fwp) Subcategory
(All Costs in Thousands of Dollars)
Mill Size: 15 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	190	-	190	410	1,070	1,480	490	1,180	1,670			
2.	30	-	30	60	280	340	75	330	405			
3.	30	-	30	60	160	220	75	175	250			
4.	-	-	-	-	120	120	-	155	155			

Mill Size: 35 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	290	-	290	620	1,615	2,235	720	1,815	2,535			
2.	45	-	45	95	395	490	110	475	585			
3.	45	-	45	95	245	340	110	275	385			
4.	-	-	-	-	150	150	-	200	200			

Int: Internal Cost   Ext: External Cost   1. Total Investment Cost

2. Total Operating Cost   3. Depreciation & Interest   4. Operation & Maintenance

Table 184 cont'd

WASTE ACTIVATED SLUDGE

EFFLUENT TREATMENT COSTS

Non-Integrated Tissue (fwp) Subcategory Con't

(All Costs in Thousands of Dollars)

Mill Size: 110 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	330	-	330	720	3,150	3,870	890	3,580	4,470	890	2,540	3,430
2.	50	-	50	110	710	820	135	855	990	135	645	780
3.	50	-	50	110	475	585	135	540	675	135	410	545
4.	-	-	-	-	235	235	-	315	315	-	235	235

Mill Size: 450 TPD

	1973			1977			1983			NSPS		
	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total	Int.	Ext.	Total
1.	855	-	855	1,860	7,230	9,090	2,275	8,370	10,645	2,275	5,935	8,210
2.	130	-	130	280	1,560	1,840	340	1,905	2,245	340	1,415	1,755
3.	130	-	130	280	1,085	1,365	340	1,255	1,595	340	890	1,230
4.	-	-	-	-	475	475	-	650	650	-	525	525

Int: Internal Cost

Ext: External Cost

1. Total Investment Cost
2. Total Operating Cost
3. Depreciation & Interest
4. Operation & Maintenance

Table 185

INTERNAL EFFLUENT TREATMENT COSTS FOR NSPS
(Costs in Thousands of Dollars)

Subcategory	Size of Mill Tons/Day	Capital Cost	Depreciation and Interest
Papergrade Sulfite	160	1165	175
	530	2565	385
Market Sulfite	160	1165	175
	530	2565	385
Low Alpha Sulfite	550	1385	210
High Alpha Sulfite	550	1385	210
Deink	80	555	85
	230	825	125
	500	1450	220
Dissolving Kraft	600	1935	290
	1000	2640	395
Market Kraft	350	1330	200
	700	1990	300
BCT Kraft	250	1745	260
	670	3250	485
	1300	5075	760
Fine Kraft	250	1730	260
	670	3110	465
	1300	4790	720
Groundwood Chemi/Mech	100	595	90
	300	1135	170
	600	1815	270
Groundwood Thermo/Mech	100	590	90
	300	1130	170
	600	1810	270
Groundwood C-M-N	75	525	80
	150	720	110
	500	1555	235
Groundwood Fine	150	820	125
	300	1235	185
	550	1865	280
Soda	300	1780	265
	700	3140	470
Non-Integrated Fine	30	295	45
	100	435	65
	280	940	140
Non-Integraged Tissue	15	370	55
	35	540	80
	110	675	100
	450	1735	250
Non-Integrated Tissue (fwp)	15	365	55
	35	540	80
	110	675	100
	450	1735	260

1. Replace Flume with Mechanical Conveyors

The base mill for this estimate processes 1200 cords per day of 4 to 8 foot rough pulpwood, hardwood and softwood, received by rail and truck. The flume, with coarse and fines removal system, is replaced by four (4) 3-chain log conveyors each 200 feet long, in tandem as shown on the flow diagram in Figure 77.

Most of the existing unloading facilities and the existing rough wood storage areas are maintained by installing the log haul conveyors over the flume structure. Unloading docks or impact areas are located on one side of the conveyors to reduce the shock of falling wood from cranes or rail car unloading. All conveyors are reversible.

It is assumed that the existing conveyor receiving wood from the flume will receive the wood from the new log conveyors. Some modification to the existing transfer section is included.

Debris (rocks, etc.) which were removed in the flume by a rock pit and grit chamber systems will be carried into the barking drums. Some removal takes place through the bark slots in the barking drums. A rock drop out station is included in the woodroom conveyor system, before the chippers, to remove large rocks.

The bark burned for fuel will have a higher concentration of non-combustible material using mechanical yard conveyors.

2. Use of Steam in Drum Barkers

This cost estimate is based on processing 1200 cords per day of rough 4 to 8 foot pulpwood, softwood and hardwood, in three barking drums (Figure 78).

In converting from use of hot water to steam in the barking drums, the bark conveyors under the drums were replaced. The bark press is modified to handle bark during the sap period.

It is assumed that the wood handling system preceeding and following the barking drums is the same whether steam or water is used in debarking.

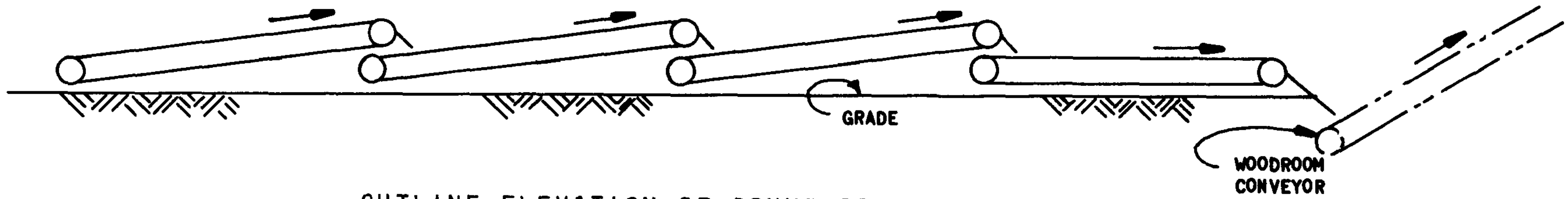
A steam header, from an existing steam main in the woodroom, is run in front of the inlet to each drum. Small branch lines inject steam into the drums. The drumming rate using steam will be slightly lower than with the use of hot water. Cutting bark slots in a solid inlet section is included.

3. Knots Collection and Disposal

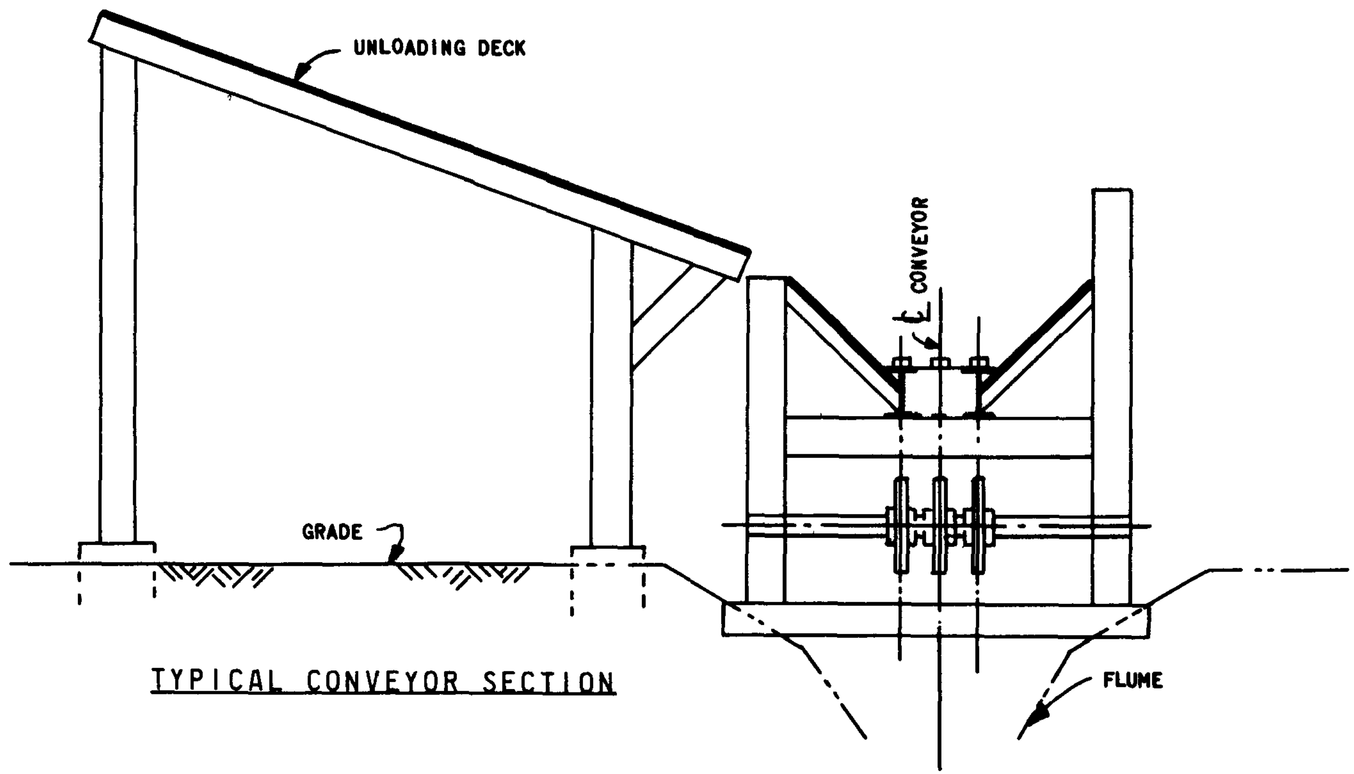
Most mills have a knot handling system and return the knots to the digester. The mills that cannot recycle the knots dispose of them through incineration with bark or haul to landfill. This estimate was based on conveying the knotter rejects to a vibrating screen with showers to recover loose fibers and liquor, then to a container for disposal by landfill (Figure 79).

Figure 77

FLUME REPLACED BY MECHANICAL CONVEYOR



OUTLINE ELEVATION OF CONVEYORS



TYPICAL CONVEYOR SECTION

Figure 78
USE OF STEAM IN DRUM BARKERS

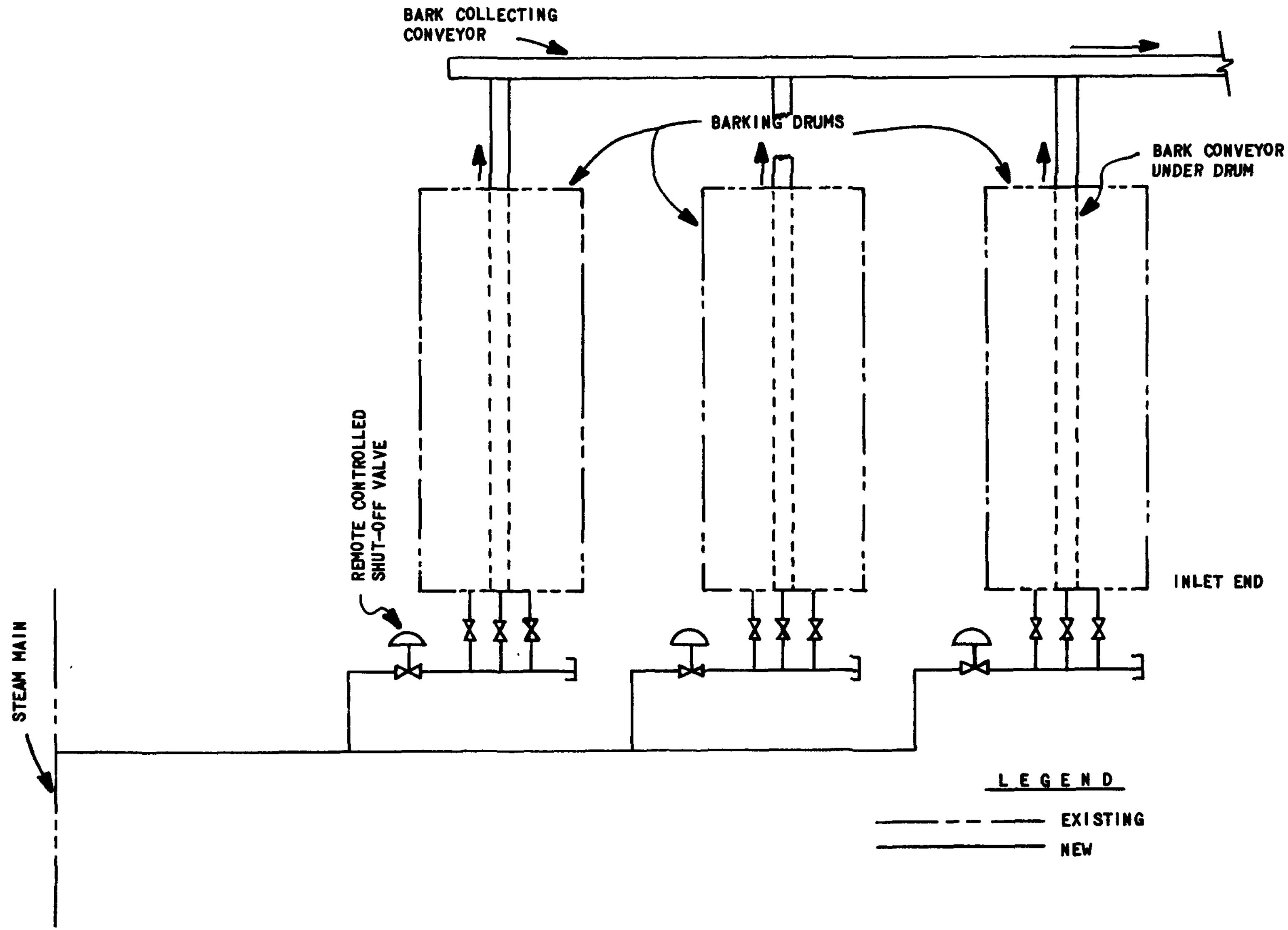
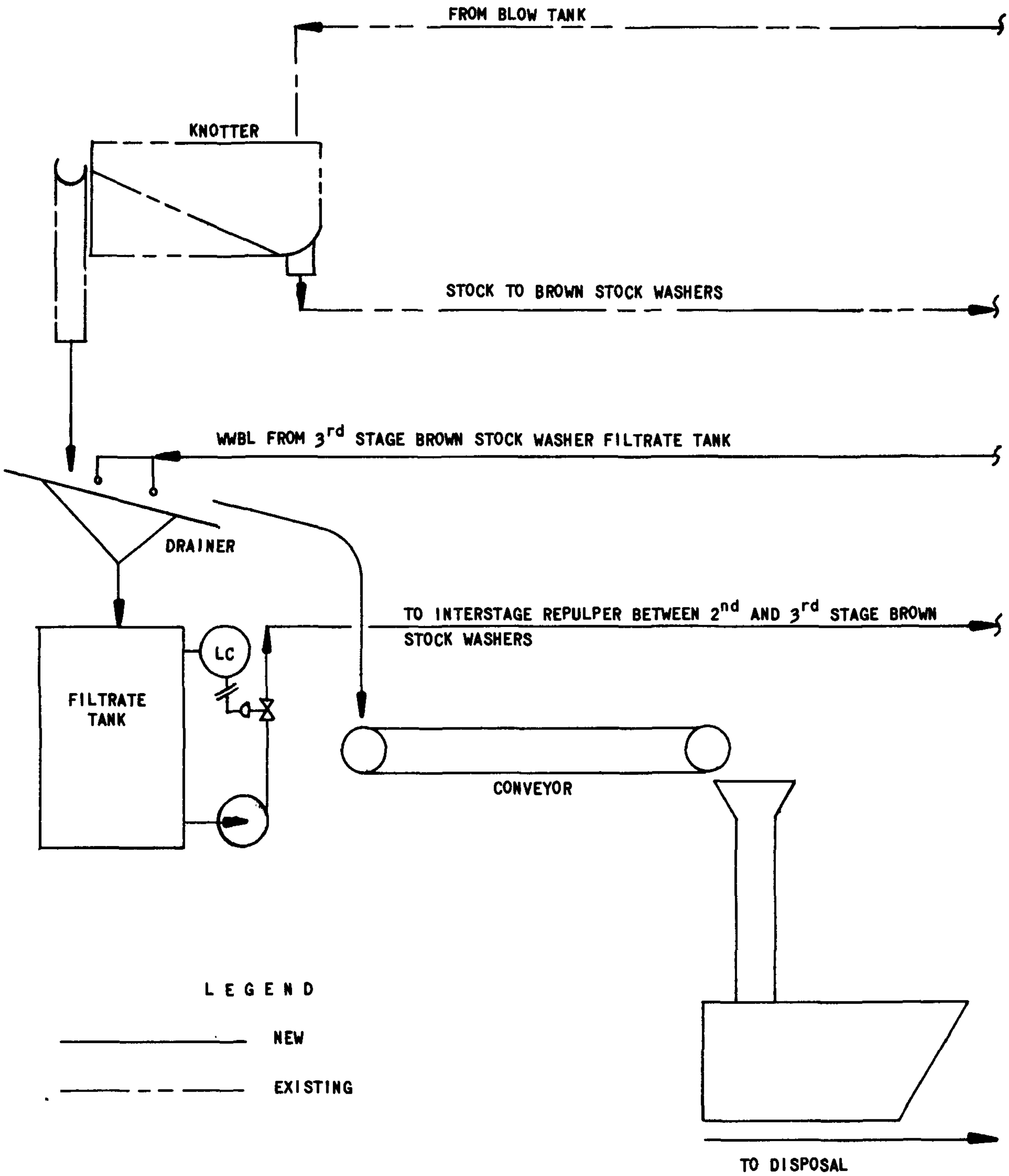


Figure 79
KNOTS COLLECTING AND DISPOSAL



4. Fourth Stage Brown Stock Washer

Essentially all kraft mills with recovery have an equivalence of three stages of brown stock drum washing. The amount of liquor held in the pulp after brown stock washing increases as bottlenecks are eliminated and production is pushed beyond design capacity. The liquor carried over is subsequently washed out of the pulp and sewered with the brown stock screen rejects and decker filtrate. The addition of a fourth stage of washing may be necessary to reduce the liquor lost to the sewer to an acceptable level. A vacuum filter washer was used in the estimate, and the system includes a submerged repulper, filtrate tank and pump, hood extension and exhaust fan and stock conveyor to storage. It was assumed that there is space available on the existing washer operating floor for the new washer.

5. Decker Filtrate for Brown Stock Washer Showers

To recover a portion of the fiber and caustic in the decker filtrate which overflows to the sewer, a pump is added to the existing decker filtrate tank and used to pump decker filtrate to the brown stock washers. A new heat exchanger is included in the estimate (Figure 80).

6. Close-up Screen Room

It was assumed that the base mill sewered its secondary screen rejects and its secondary cleaner rejects.

In closing up the screen room, a third stage of cleaning was added and the existing atmospheric screens were replaced with pressure screens. The equipment required to refine the secondary screen rejects and return them to the secondary screen is included. The new screens are located on a new mezzanine inside the existing building. A new primary screens supply pump is included also (Figure 81).

7. Pulp Mill Spill Collection from Washers

The spill collection system collects any overflow that occurs at the brown stock washers, brown stock decker, or bleach plant washers and pipe the overflows to a central collection point. A pump is installed at the collection tank to return the spills at a controlled rate back into the system as shown on the flow diagram; one tank is used for the bleach washers and one for brown stock decker and washers. Two separate tanks are required as the spills from the bleach washers cannot be put back into the brown stock for fear of getting chlorides into the black liquor recovery system. The system is designed for a CEDED bleach sequence. Vat overflows are designed to handle 100% of production flows. The collection tanks are sized for 10 minute retention of production at 1% consistency (Figures 82-84).

8. Pulp Mill Spill Collection from Tanks, Equipment, and Drains

The spill collection system collects overflows from the washer seal tanks, digester area equipment and tanks, all of the floor drains in the pulp mill, and pipe them to a central collection area. Pumps at

Figure 80

DECKER FILTRATE FOR BROWN STOCK WASHERS SHOWERS

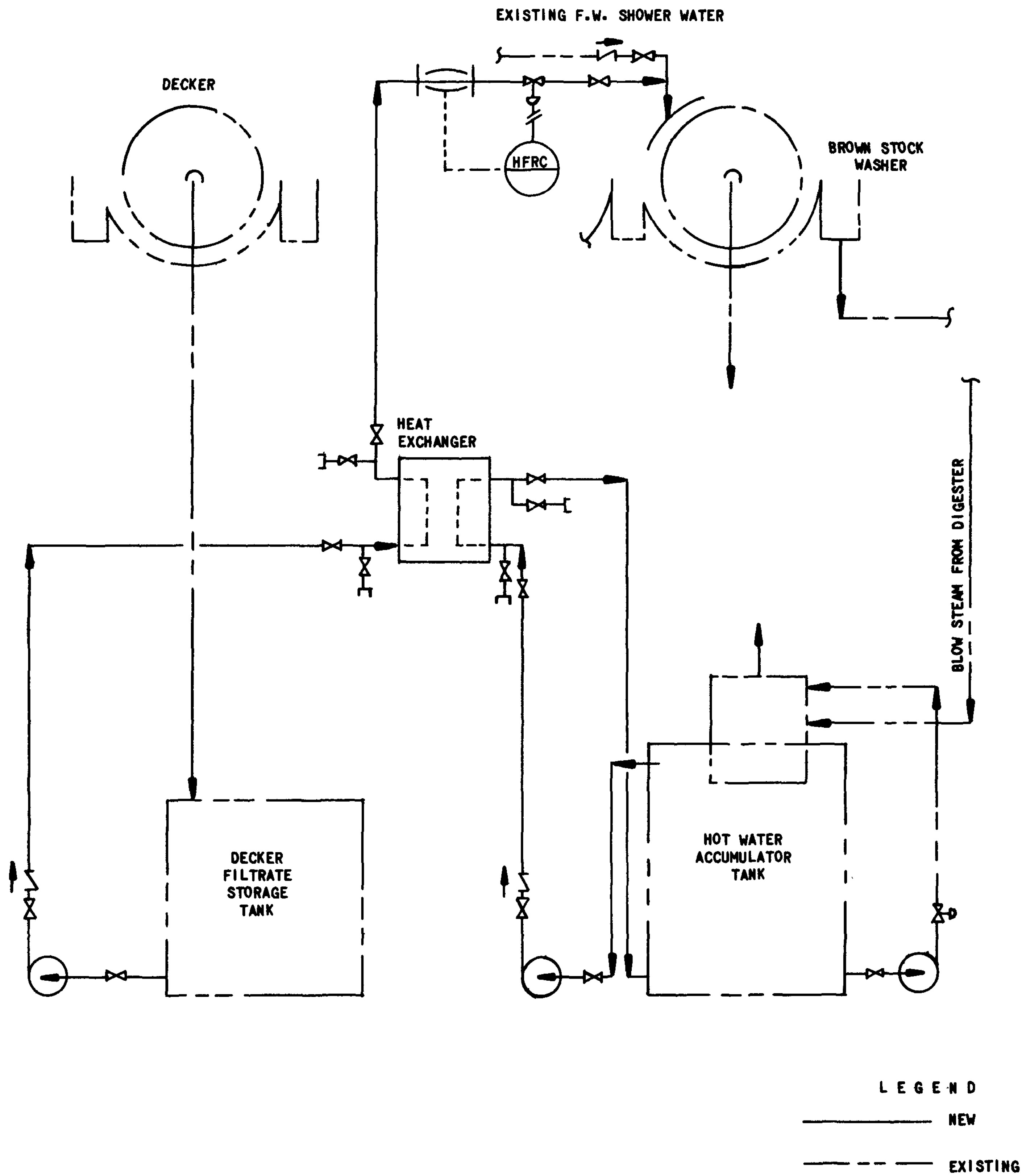


Figure 81

SCREEN ROOM CLOSE-UP

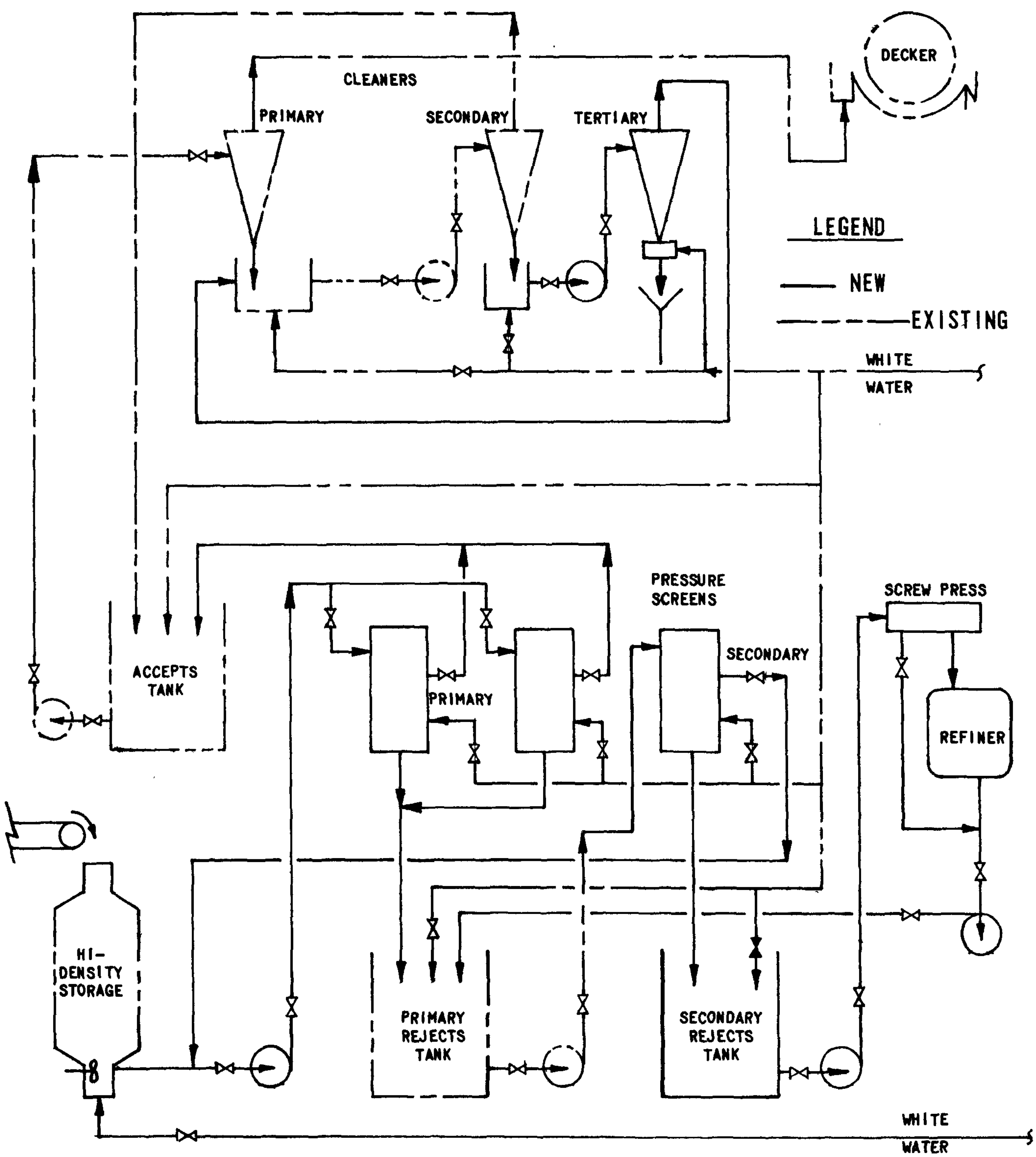


Figure 82

BLEACHED KRAFT MILL
SPILL COLLECTION AND REUSE

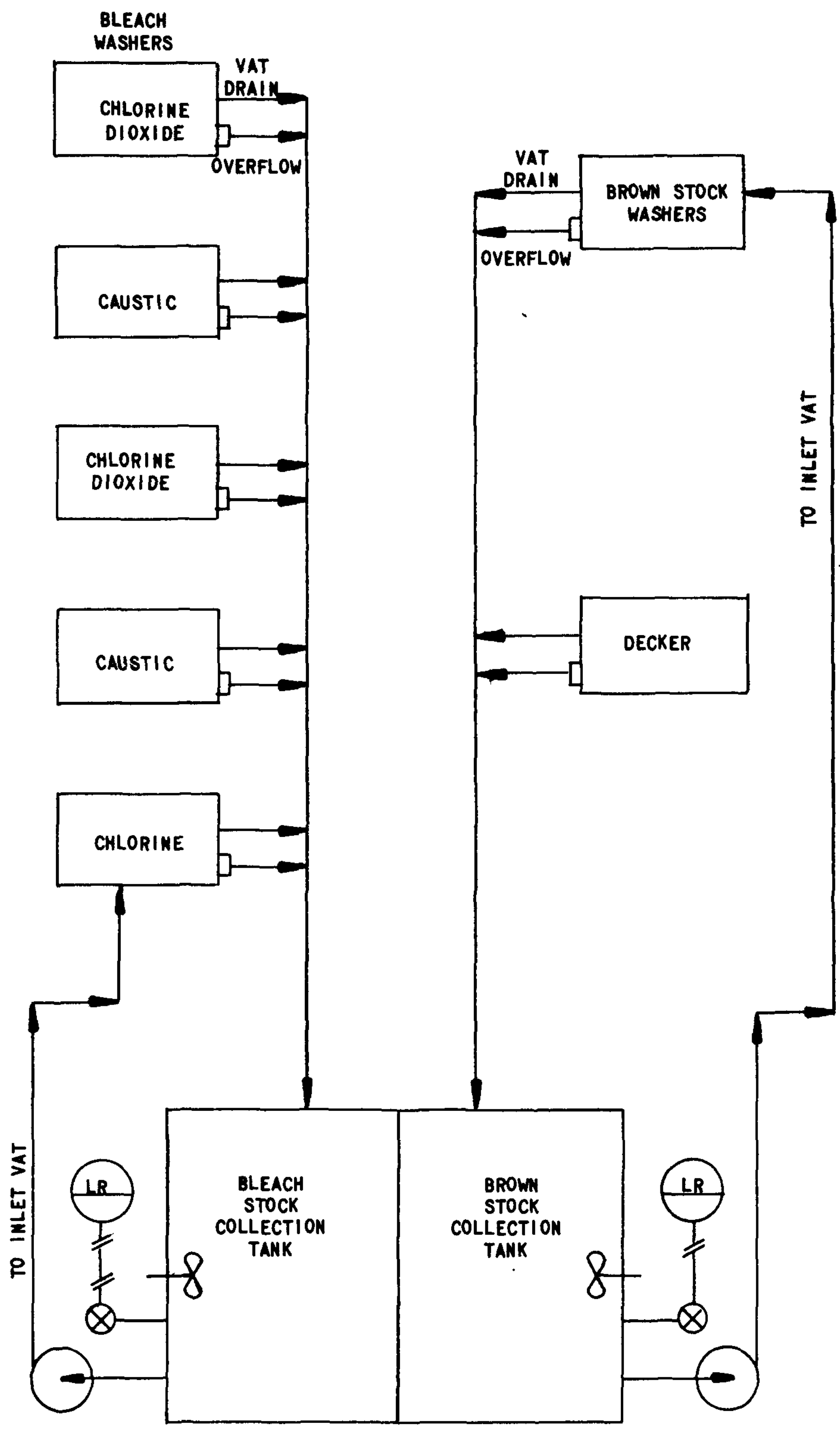


Figure 83

SULFITE PULP MILL SPILL
COLLECTION AND REUSE

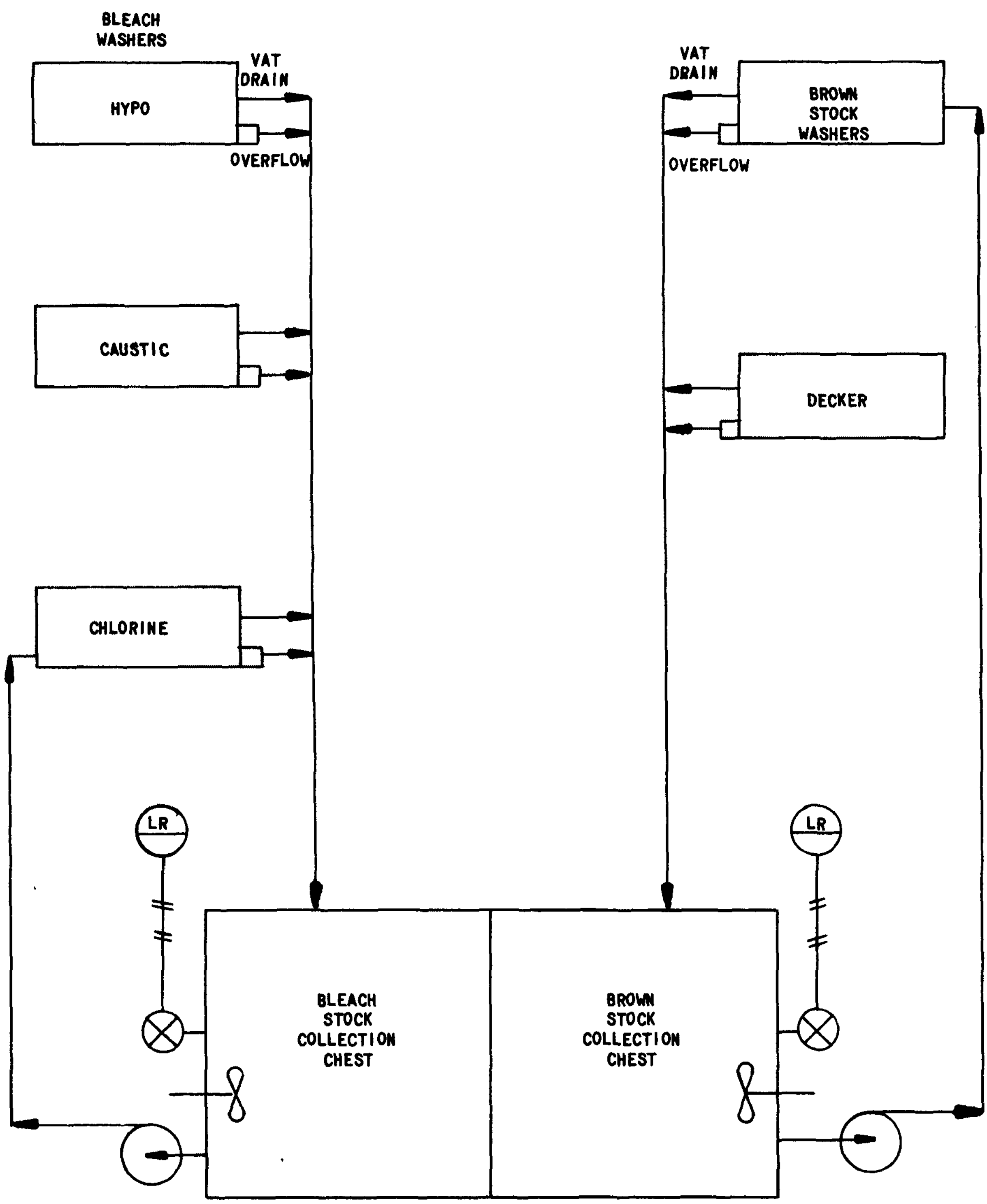


Figure 84

GROUNDWOOD PULP MILL SPILL
COLLECTION AND REUSE

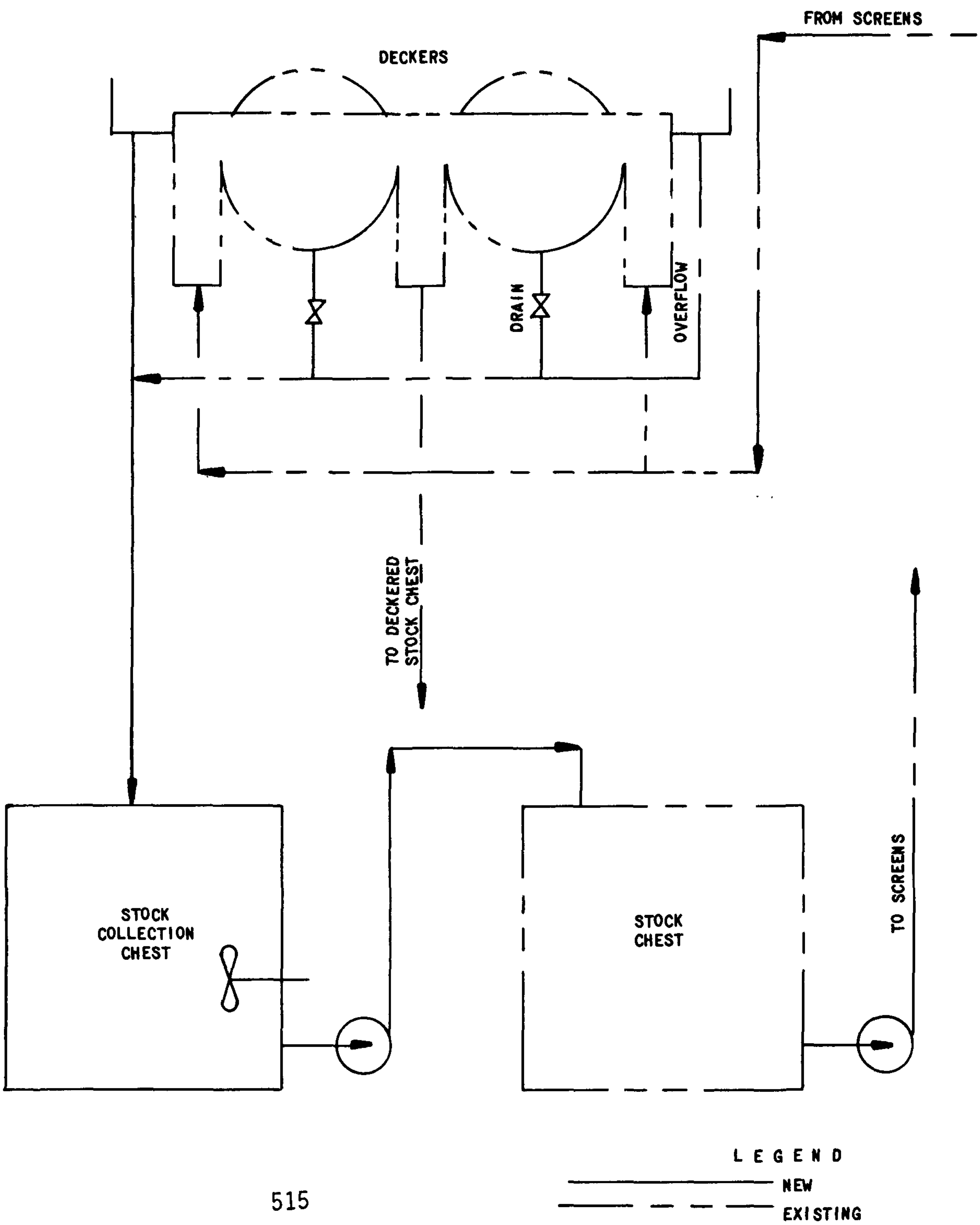
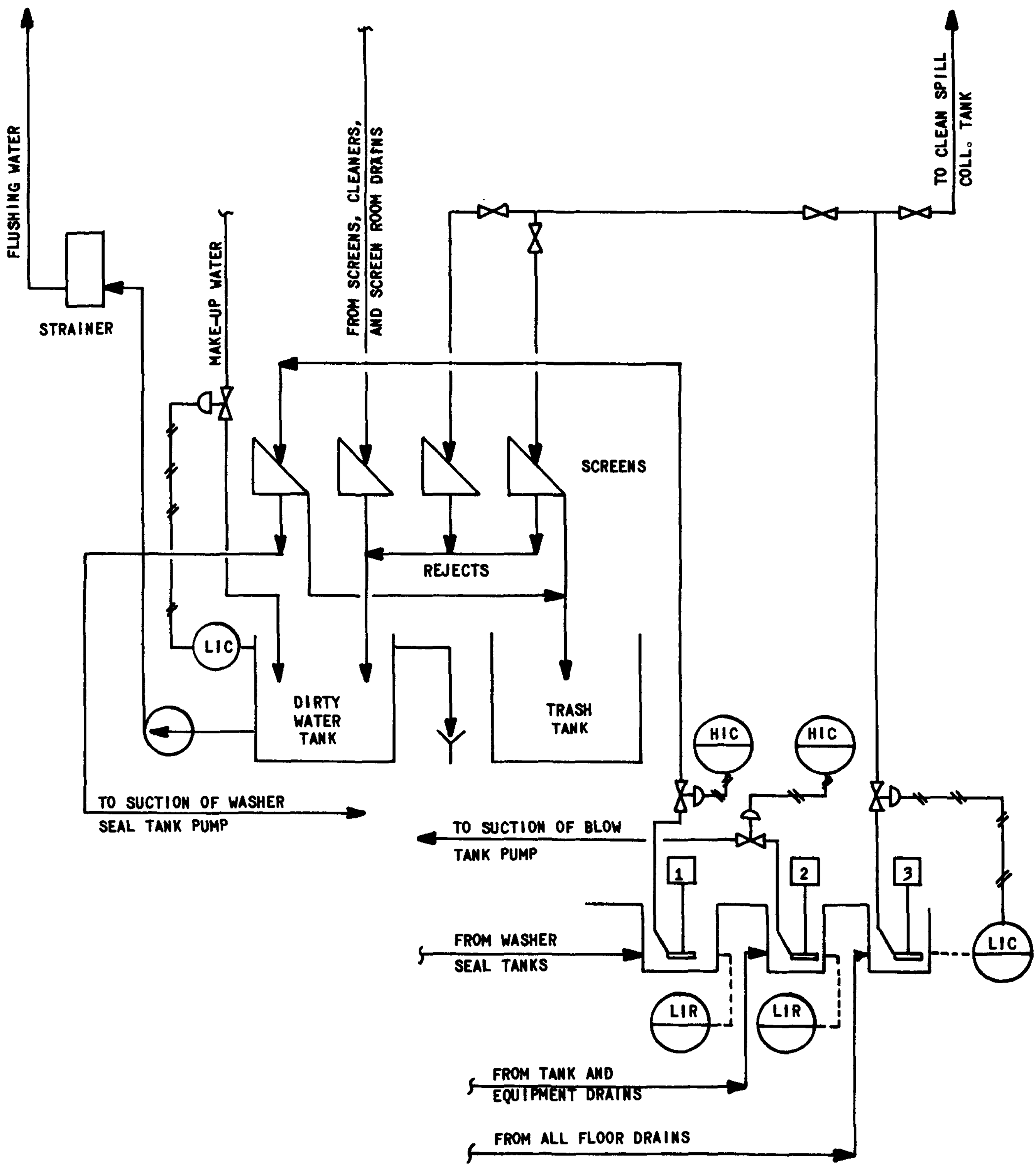


Figure 85

PULP MILL SPILL COLLECTION SYSTEMS



the collection tanks pump the spills back into the system at a controlled rate. Spills from the digester area are returned to the suction of the first stage washer recirculation pump as shown on the flow diagram. Spills collected from the floor drains are screened and piped to a dirty water tank which has fresh water made up for low level control. The solids go to a trash tank for hauling to landfill. Should a major stock spill occur, it is pumped to a spill collection tank (Figure 85).

9. Jump Stage Countercurrent Washing

A jump stage countercurrent washing system was estimated for reducing the effluent flow from the bleach plant (Figure 86). The basic mill bleaching sequence used for the kraft and soda subcategories was CEDED. The filtrate from the second chlorine dioxide washer is used on the showers for the first chlorine dioxide washer and the filtrate from the first chlorine dioxide washer is used on the showers for the chlorine washer. The filtrate from the second caustic washer is used on the first caustic washer. The overflow from the filtrate tanks are tied-in the same way, with only the first caustic and chlorination seal boxes overflowing to the sewer.

A displacement ratio of 1.2 to 1 is used on all washers and the consistency of the vat leaving the washers at 12%. The inlet washer vat consistency is 1%. Filtrate from chlorine washer is used for dilution after the brown stock decker.

10. Evaporator Surface Condenser

In this installation, the existing barometric seal tank is reused as a surface condenser seal tank. The barometric air ejectors are retained as standby and for start-up of the system (Figure 87).

The new surface condenser and two-stage steam air ejector set with intercondenser are mounted on a steel structure, outdoors, adjacent to the evaporator building. The level at which the ejectors are located is enclosed and roofed over for weather protection.

A new cooling water pump will pump mill process water through the condenser and return it to the process water main. In summer, the cooling water may become too hot to return to process. The system is on temperature control to keep the process water main temperature within bounds by sewering all or part of the cooling water. Piping is provided to return the sewered water to a mill clean warm water outfall. A new condensate pump is used to pump condensate from the seal tank to the mill sewer.

11. Steam Stripping Condensates and Reuse

The system estimated (Figure 88) is designed to treat the digester contaminated condensates and half of the evaporators' combined condensate from the concentrated liquor end. The stripping column for a 400 TPD mill was estimated to be 5 foot diameter with 10 plates. A product cooler or condensate supply heater is included. The stripped gases are incinerated in the lime kiln, and the steam supply line is

Figure 86

JUMP STAGE COUNTERCURRENT
WASHING IN BLEACH PLANT

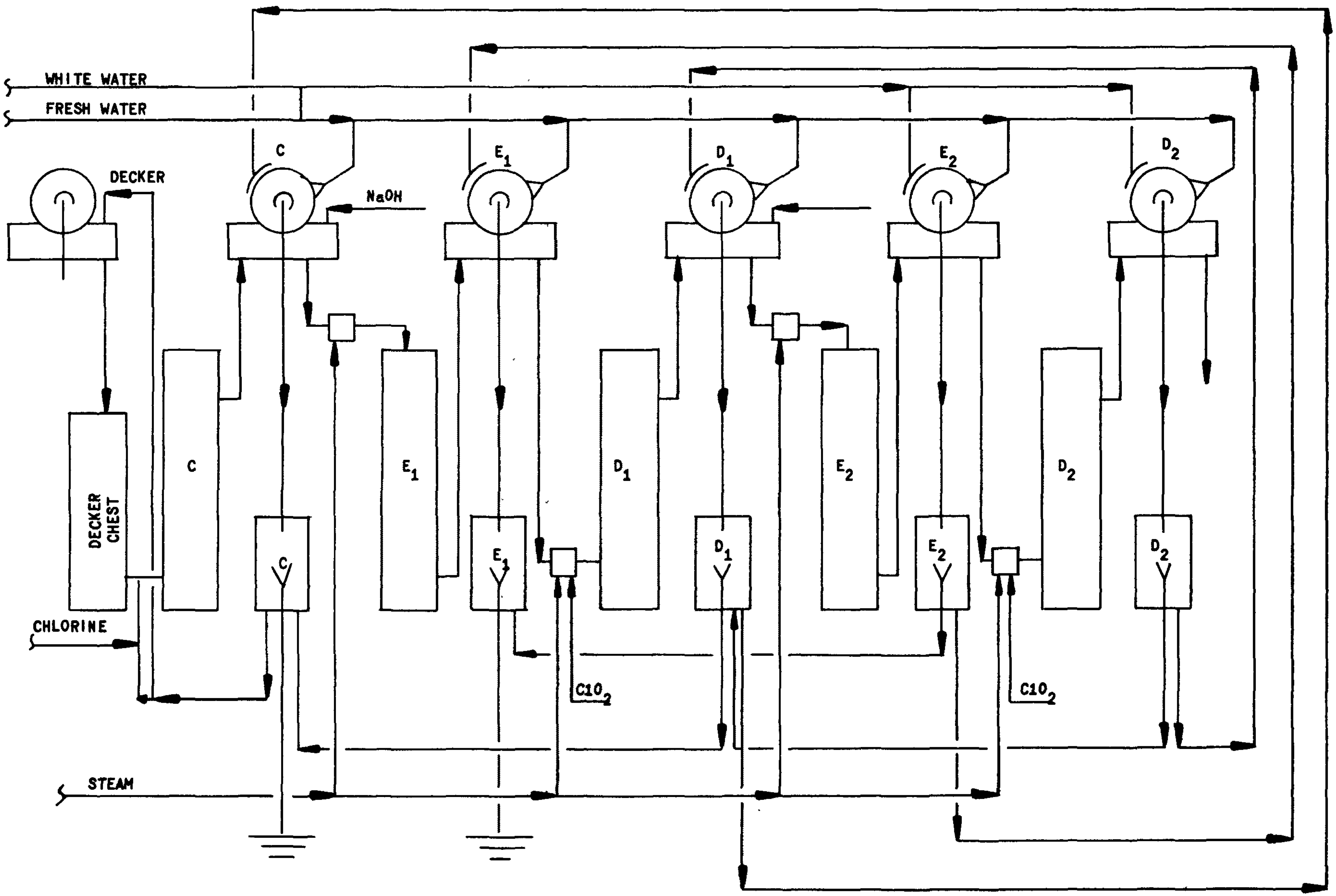


Figure 87

SURFACE CONDENSER

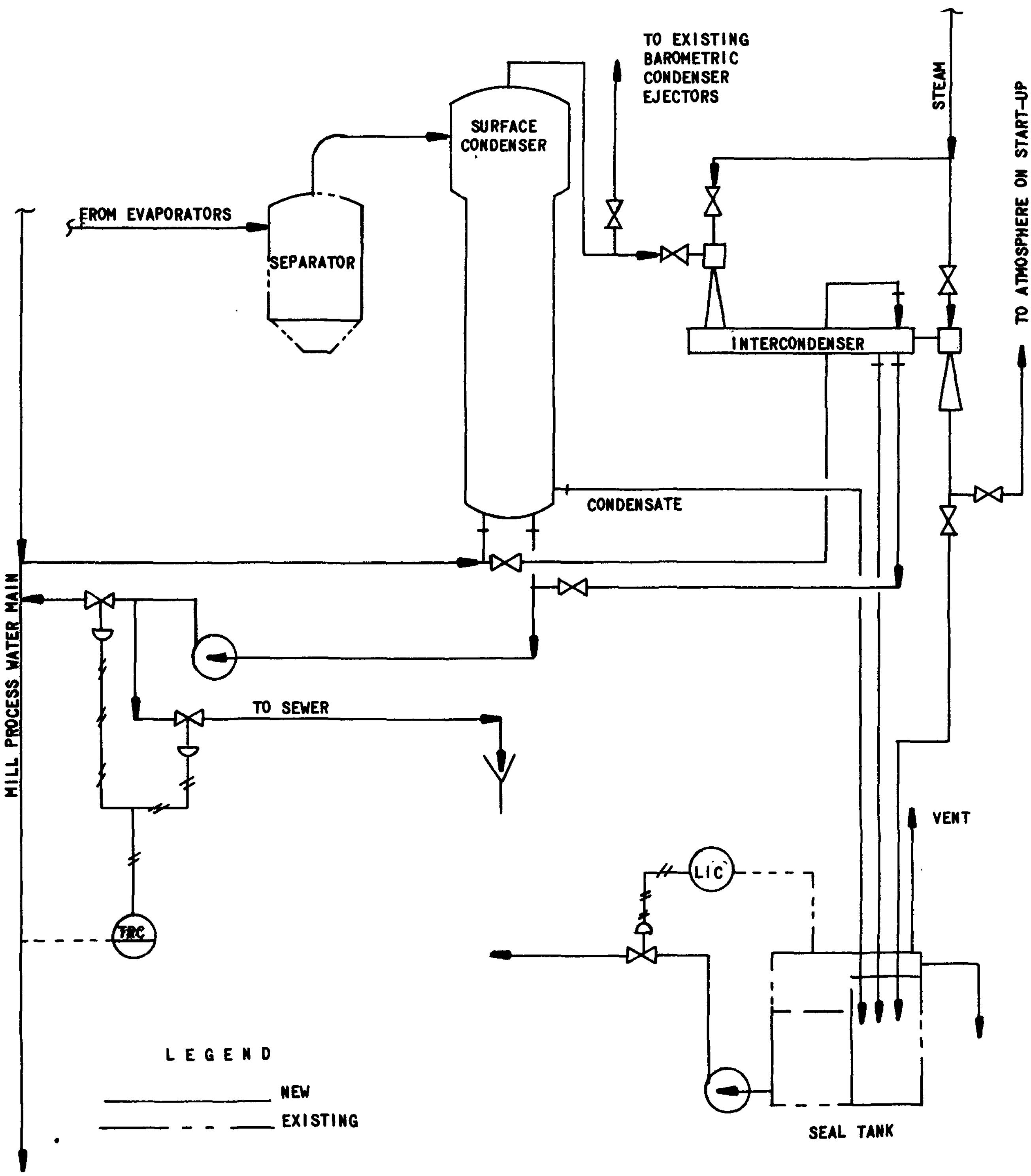
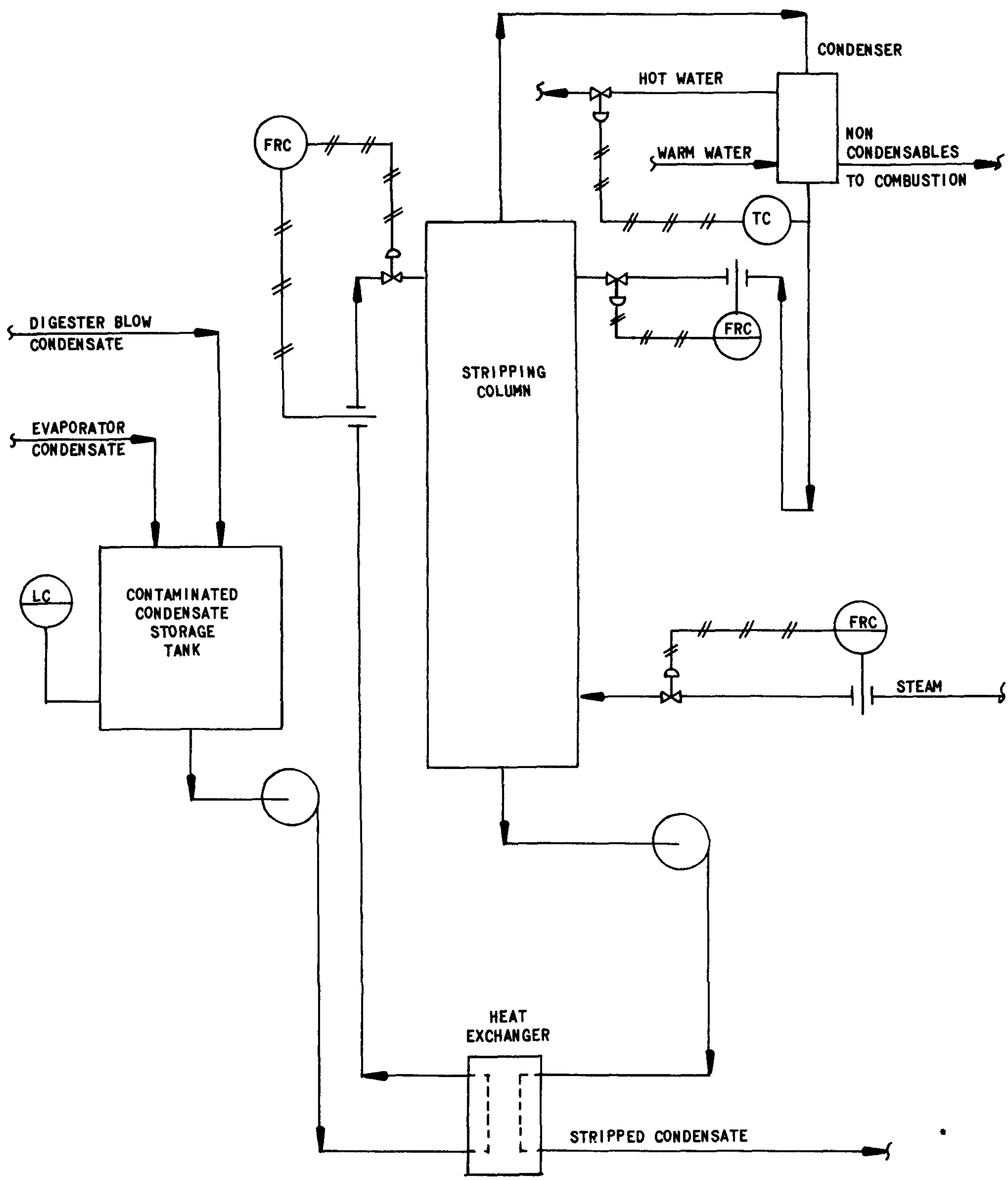


Figure 88

STEAM STRIPPING AND REUSE
OF BLOW STEAM AND
EVAPORATORS CONDENSATE



sized for an average of 10% steam requirement. The stripped condensate is pumped to storage. Use of the condensate is not included as part of this estimate.

12. Evaporators Boil Out Tank

During evaporator boil out in the basic kraft and soda mills the liquor was returned to the weak black liquor storage tank until the concentration got down to about 8% or 1°Be, with the remaining liquor discharged to the sewer. This system was designed to collect the weak black liquor from about 10% down to approximately 2%, with the remainder below 2% going to sewer. During normal operation, the liquor is slowly metered back to the weak black liquor ahead of the evaporators (Figure 89).

13. Black Liquor Storage Tank Spill Collection

This system (Figure 90) is to run all of the black liquor storage tank overflows to the evaporator bailout tank included in another estimate. The piping is arranged so that the weak liquor in the boilout tank would overflow to the sewer first.

14. Green Liquor Dregs Filtering

The basic mill takes the dregs from the green liquor clarifier, dilutes the dregs in a dregs mixer and reconcentrates the dregs in the dregs washer. The dregs from the washer are severed and the dilute liquor sent to weak wash storage. This system (Figure 91) includes a vacuum dregs filter, with vacuum pump. The solids are collected in a container for disposal by land fill. The diluted green liquor goes to weak wash storage.

15. Causticizing Area Spill Collection System

The causticizing area liquor spill collection system includes a tank sized to hold the liquor from any clarifier or storage tank in the causticizing area (Figure 92). A transfer pump is used to pump to and from green liquor storage, white liquor storage, weak wash storage, green liquor clarifier, white liquor clarifier, and mud washer, as shown on the flow diagram.

16. Evaporator Condensate for Causticizing Makeup

Evaporator condensate from the second, third, and fourth effects are pumped to a holding tank for use in the causticizing and lime recovery area. Evaporator condensate is used at the kiln scrubber, lime mud dilution from storage, mud filter shower, dregs filter showers, and mud washer dilution. A conductivity probe is used to detect liquor carry over so that black liquor is kept out of the causticizing and lime recovery system. The holding tank uses fresh water for low level control (Figure 93).

17. Lime Mud Storage Pond

Figure 89

EVAPORATORS BOIL OUT TANK

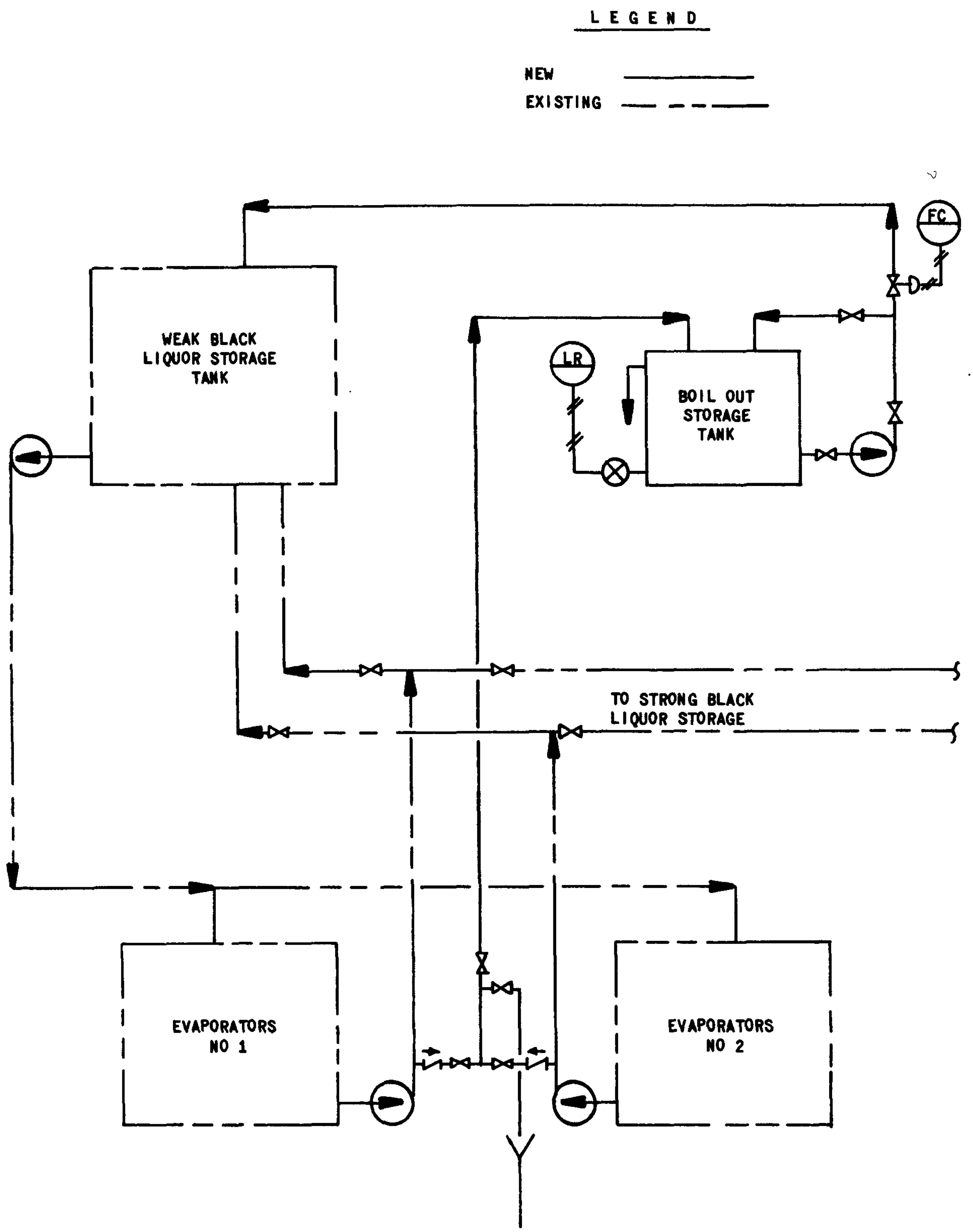


Figure 90

BLACK LIQUOR STORAGE TANK
SPILL COLLECTION AND REUSE

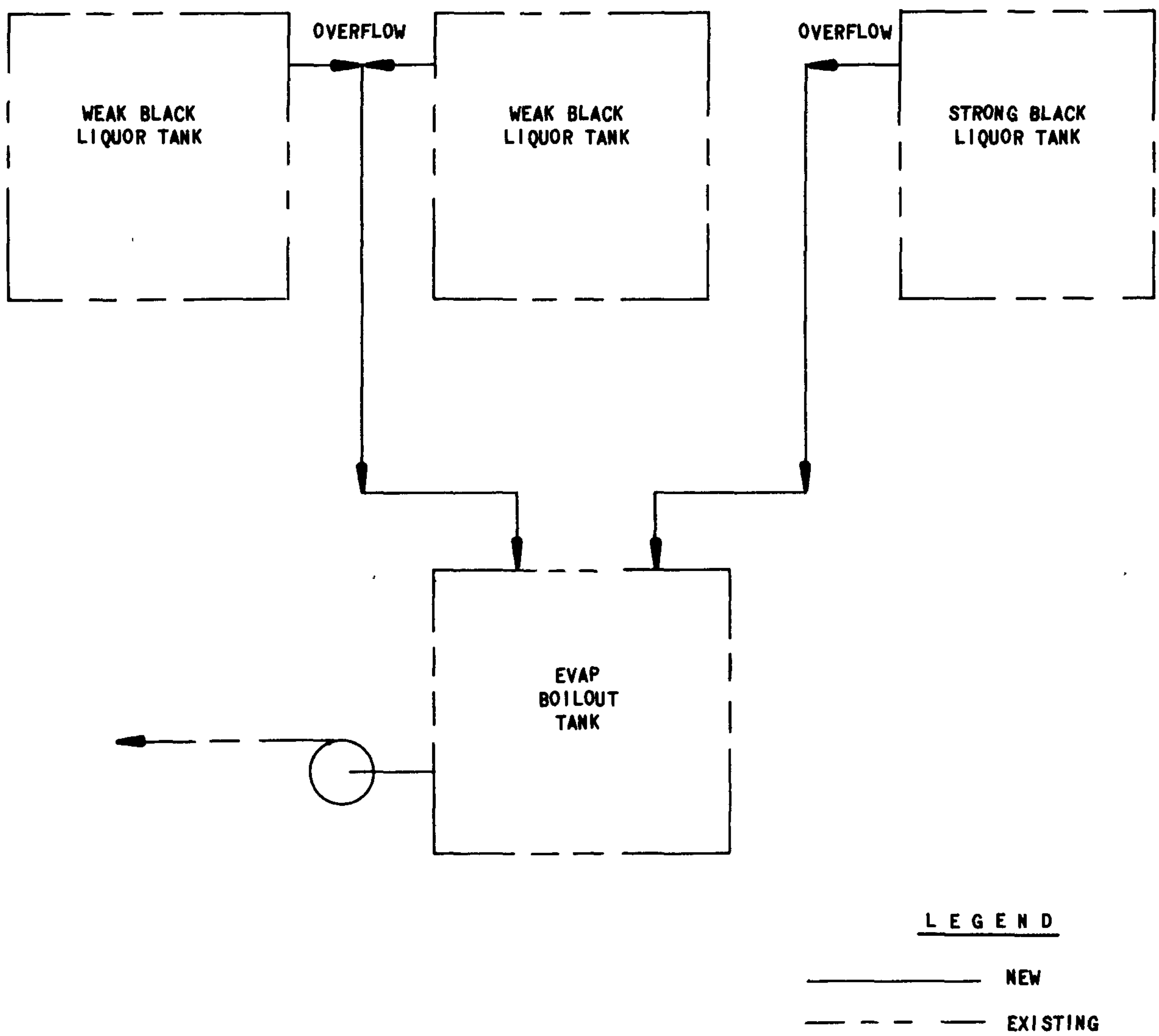


Figure 91

GREEN LIQUOR DREGS FILTER

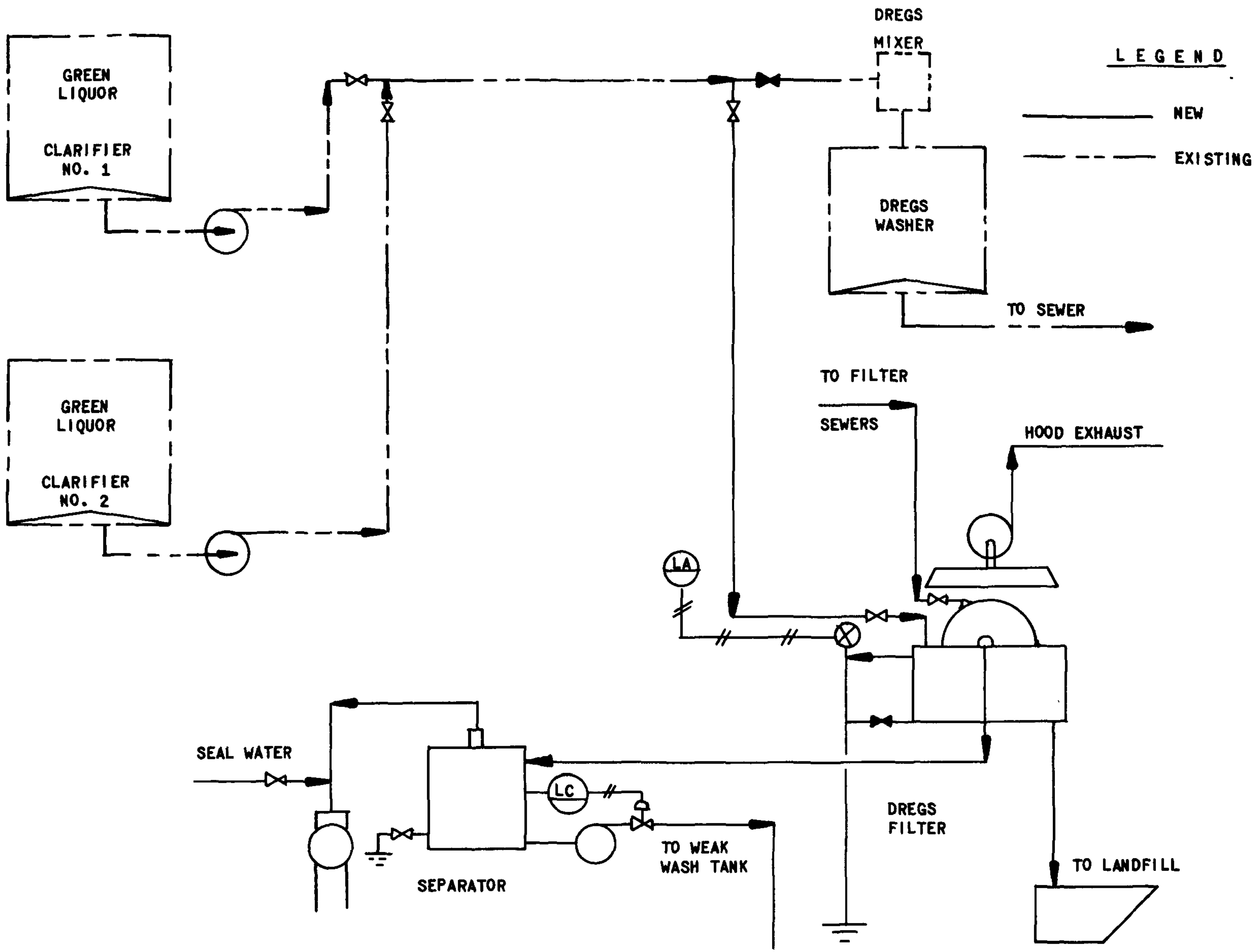


Figure 92

CAUSTICIZING AREA SPILL COLLECTION SYSTEM

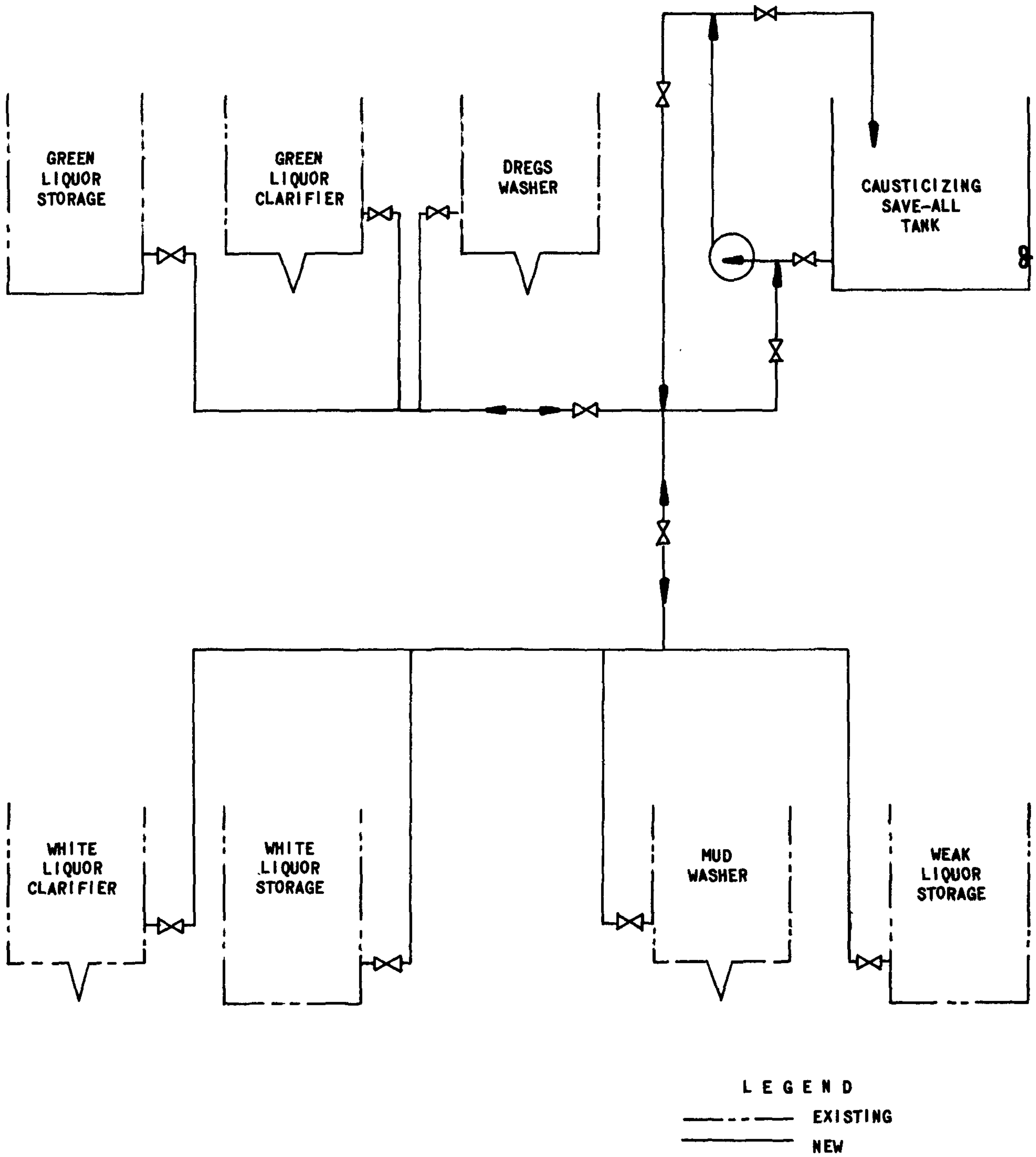
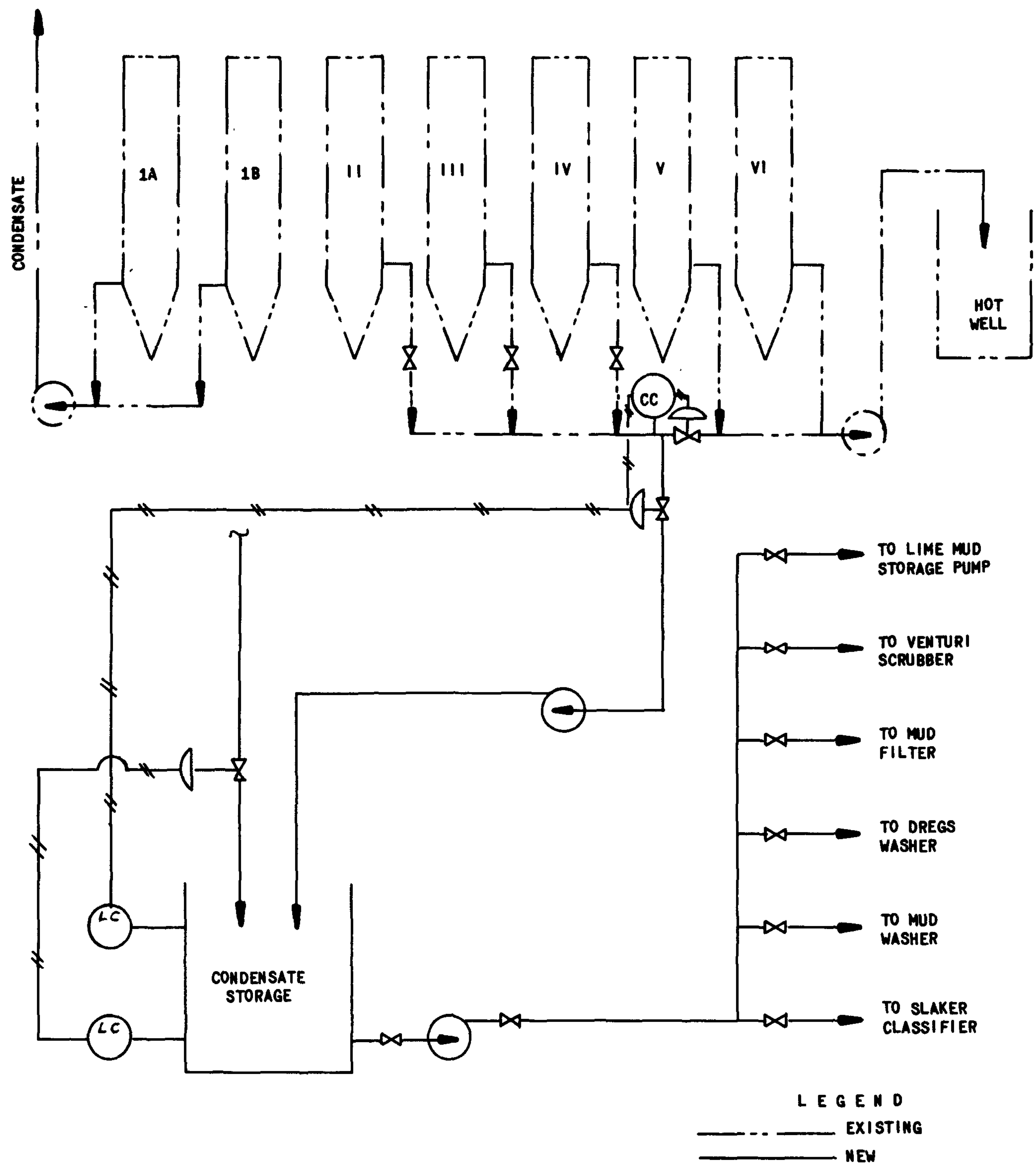


Figure 93

EVAPORATOR CONDENSATE USED FOR CAUSTICIZING MAKE-UP



A concrete lime mud holding tank is located 800 feet from the lime kiln. The tank is 55' x 130' x 10' high for a bleached kraft pump mill producing 670 TPD. With a 12' free board, the tank holds 480,000 gallons (Figure 94).

The lime mud pond provides storage when the kiln is down and the mill continues to run on purchased lime. The mud is reclaimed with a floating "Mud-Cat".

18. Alarms for Chemical Tanks

High level alarms are installed on all pulp mill and paper mill chemical tanks so that the operator is alerted as soon as a tank is ready to overflow to the sewer, so that the duration of the spill is kept as short as possible. The small bleached kraft soda and sulfite mills required 20 alarms and each paper machine required three.

19. Prehydrolysate Disposal by Burning

Each system is unique and includes proprietary information. Therefore, the system used to arrive at the cost estimates will not be described.

20. Magnesium Bisulfite Liquor Recovery System

The magnesium bisulfite liquor recovery estimate includes brown stock drum washing, evaporators, incineration with chemical recovery and liquor reconstitution, to include make-up sulfur and magnesium oxide systems.

21. Paper Machine Vacuum Saveall

To properly cover all of the segments with some accuracy, estimates were prepared for the installation of vacuum disc filters on tissue machines, newsprint machines, and board machines (Figures 95-97). To establish an exponential factor to vary the cost from small to large machines, two tissue machine saveall estimates were prepared. Some of the smaller machines may install deckers since the cost would be considerably less and there may not be room for a vacuum saveall; however, all of the estimates are based on disc filters. It was also estimated that the smallest installation would cost in the range of $150,000.

22. Paper Machine Flotation Saveall

Most of the savealls being installed today are vacuum disc filters. It was noted that more than half of the savealls on fine paper machines in the mill surveyed were flotation savealls. At least a partial reuse of white water is practiced on most fine paper machines without savealls because of the relatively expensive additives and fillers used in the manufacture of many grades of fine papers. The cost of addition flotation savealls to fine paper machines was estimated on this basis (Figure 98).

23. Paper Machine High Pressure Showers

Figure 94

LIME MUD STORAGE POND

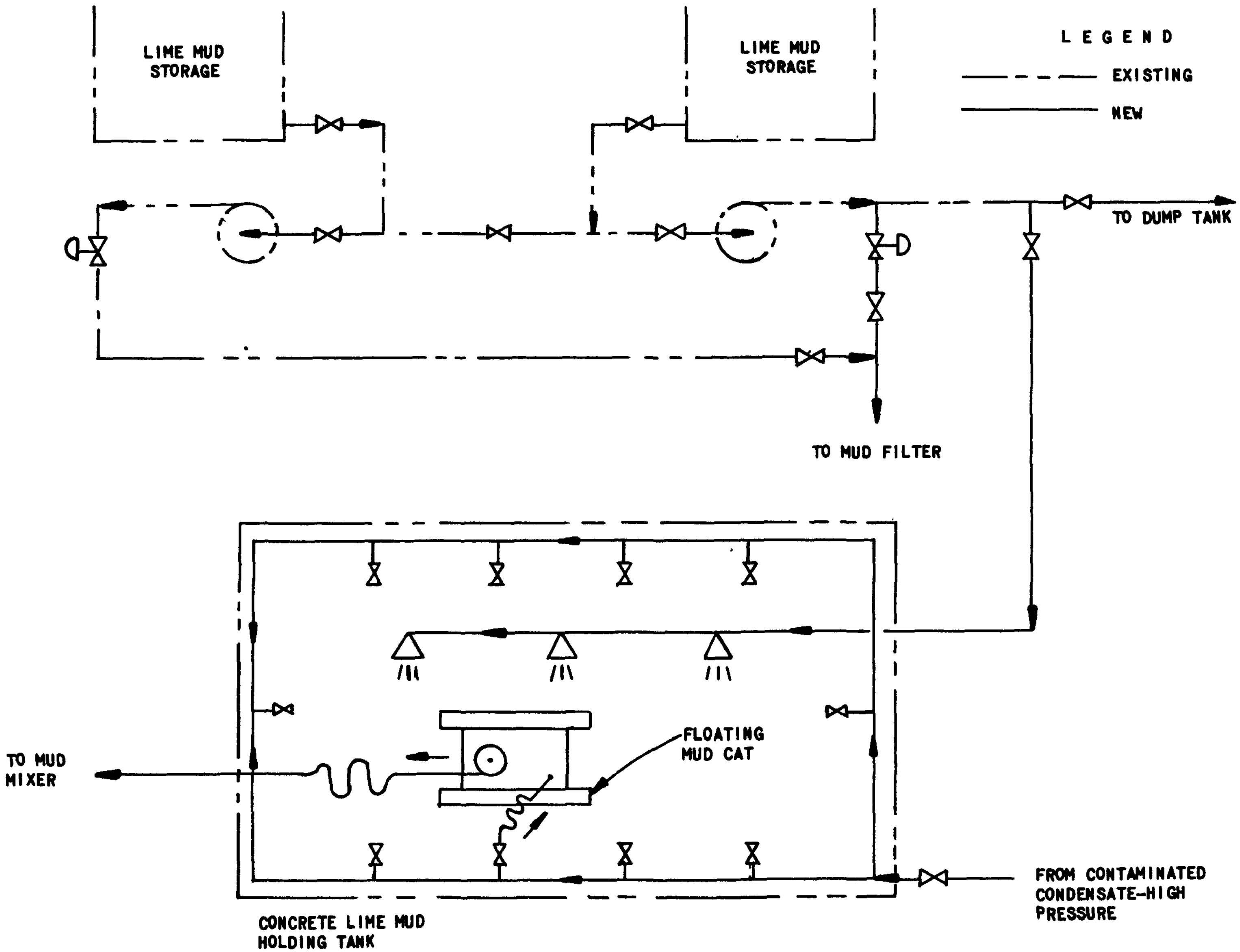


Figure 95

PAPER MACHINE
VACUUM SAVEALL
ALTERNATE I

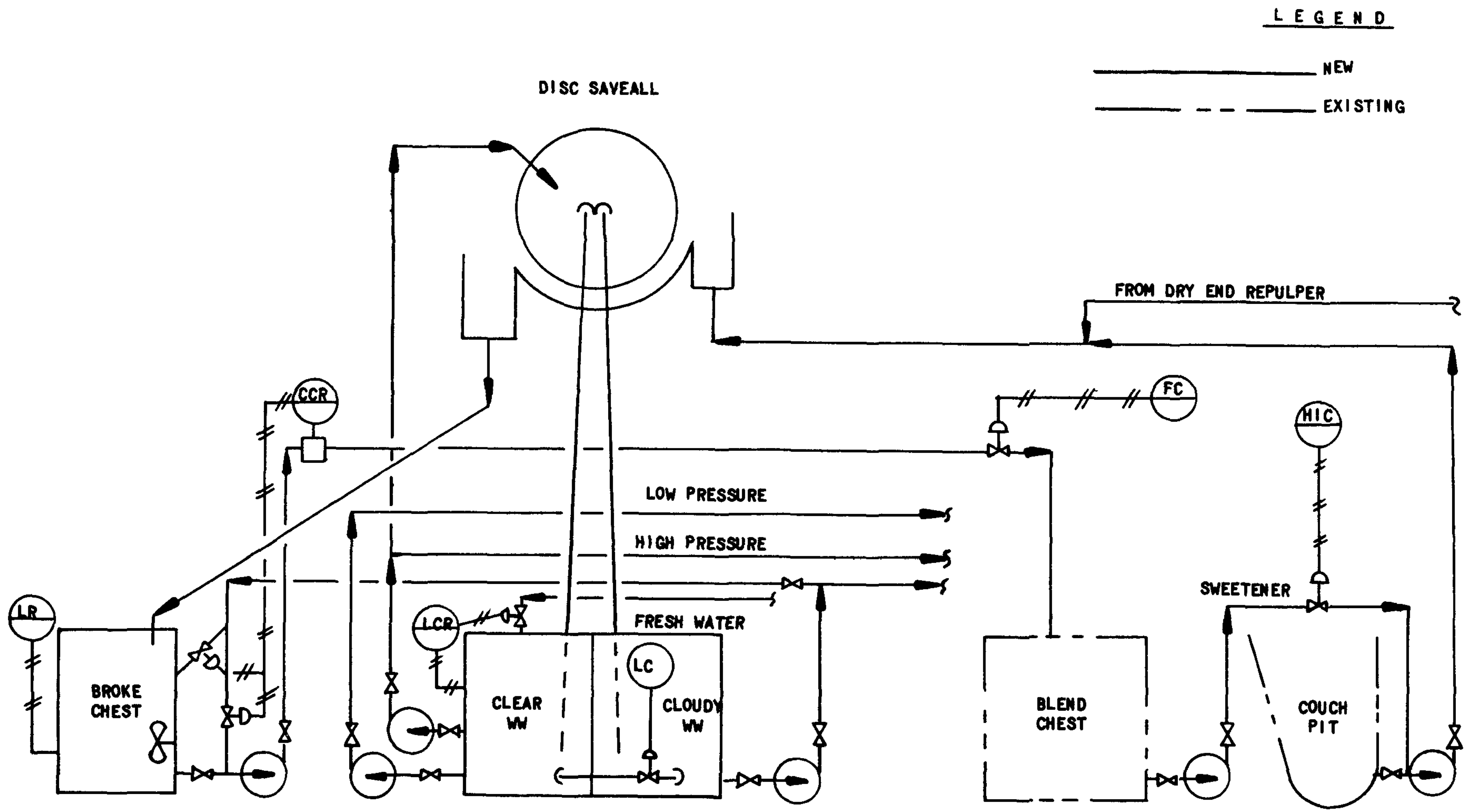


Figure 96

PAPER MACHINE
VACUUM SAVEALL
ALTERNATE II

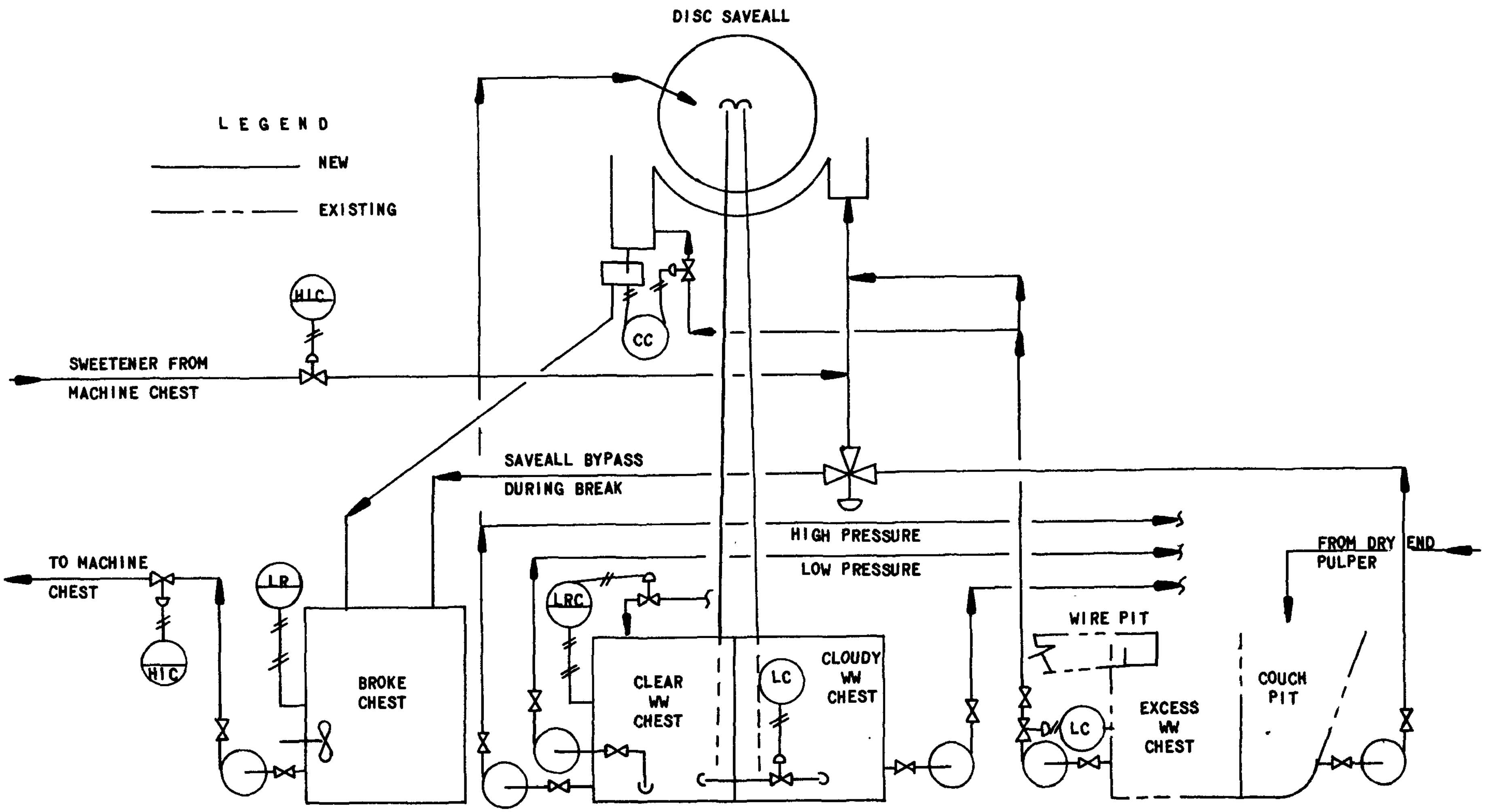


Figure 97

PAPER MACHINE
VACUUM SAVEALL
ALTERNATE III

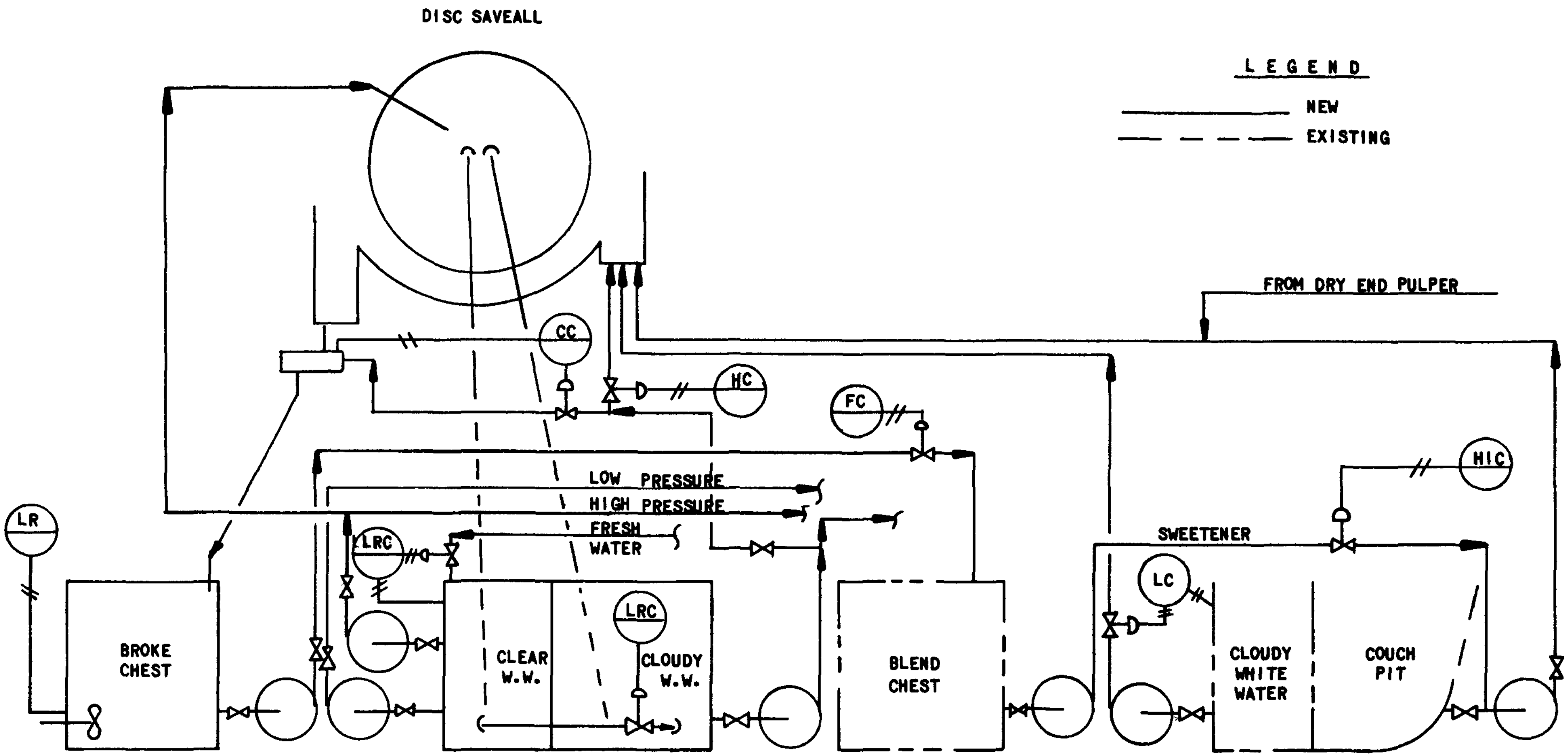
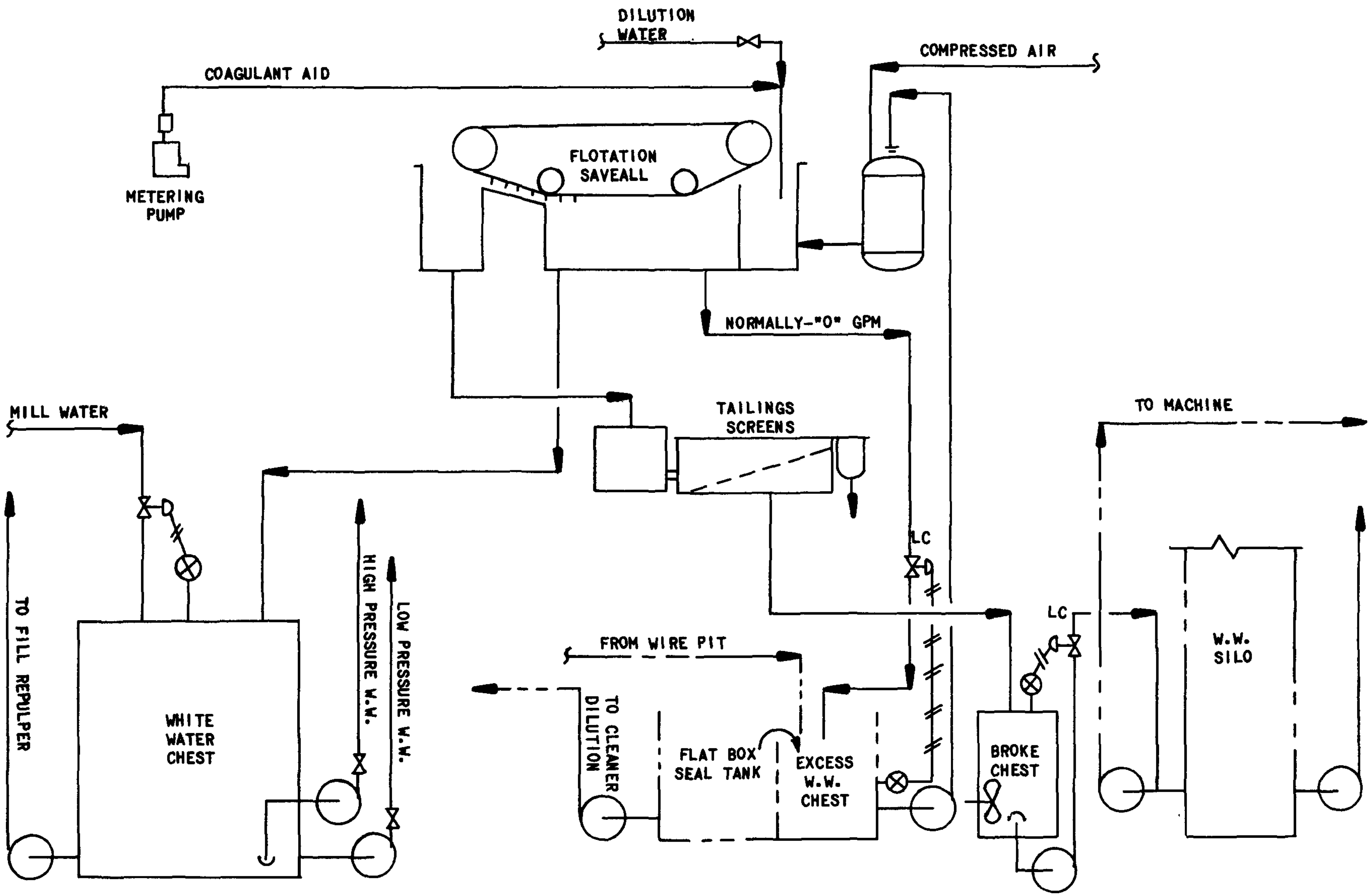


Figure 98

PAPER MACHINE FLOTATION SAVEALL



The fresh water used for headbox shower, fourdrinier section cleaning and sheet knock off, and in the press section can be significantly reduced by the installation of high pressure showers. The high pressure showers used on the fourdrinier are designed to operate at 300 psi and the showers on the felts at 500 psi. Each system includes a stand-by high pressure pump (Figure 99).

24. Paper Machine White Water Showers

When the paper machine white water does not contain many additives and fillers, self cleaning white water showers can be installed. On tissue machines, the higher shower water volume will help to work in new felts in a much shorter time, resulting in increased production. The system includes a single white water supply pump, with fresh water back-up on supply header low pressure control (Figure 100).

25. Cylinder Former White Wash Shower

Where a pulp dryer has a cylinder former in place of a fourdrinier section, the fresh water showers are replaced by filtered white water showers.

26. Cooling Water Segregation and Reuse

The indirect cooling water collected includes evaporator surface condenser, air compressor cooling, compressed air aftercooler, dryer drainage condensate cooling and blow through steam condenser, lube oil cooler, rewinder brake cooling, and stream chiller condensing water. The warm water is collected in a central tank, but is not reused in this estimate. The water could be used for high pressure showers, in the pulp mill, for pulper dilution, etc. Separate cost estimates for collecting the cooling water from bleached pulping operations and from non-integrated mills are included.

Figure 99

HIGH PRESSURE FRESH WATER
CLEANING SHOWERS FOR PAPER MACHINES

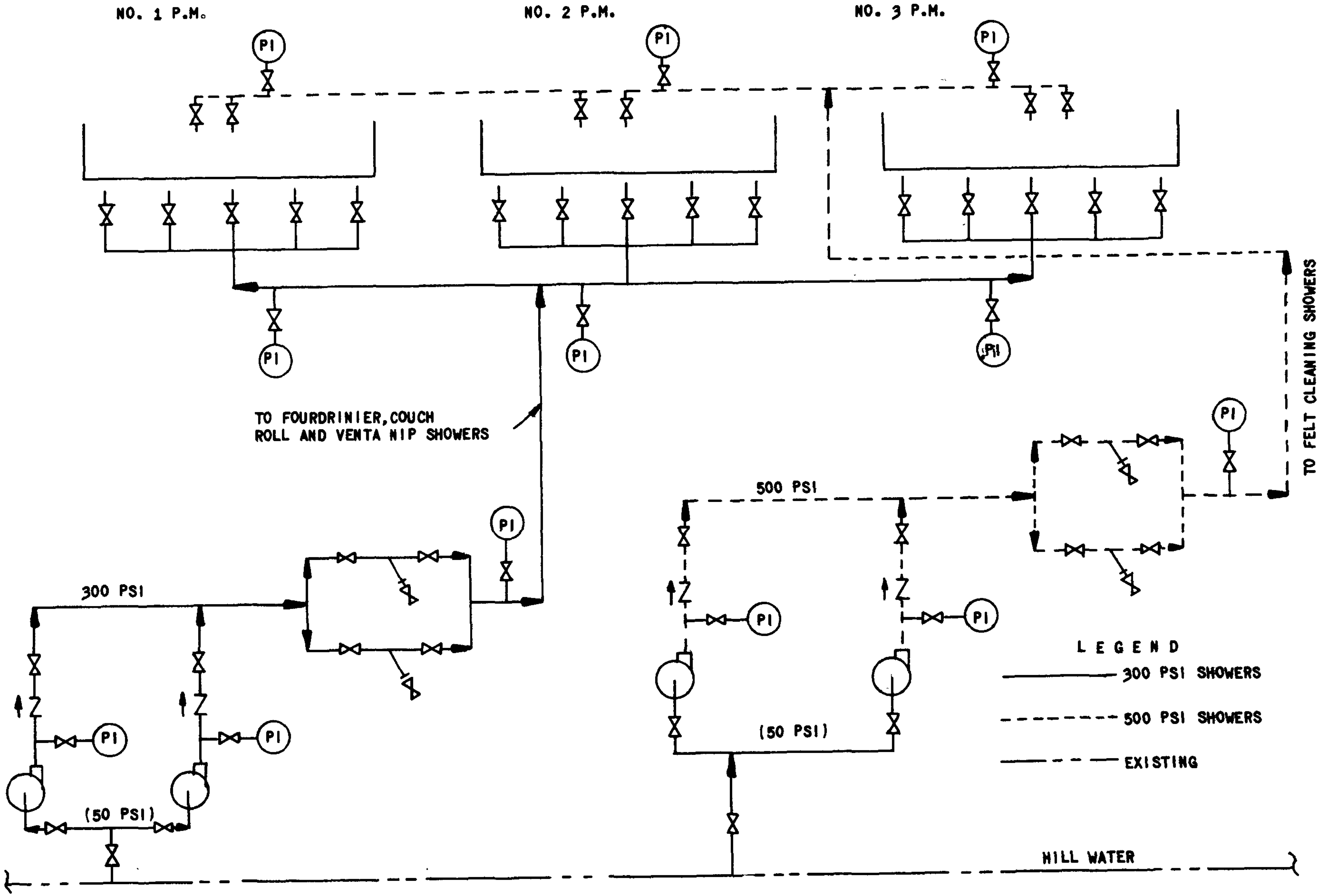
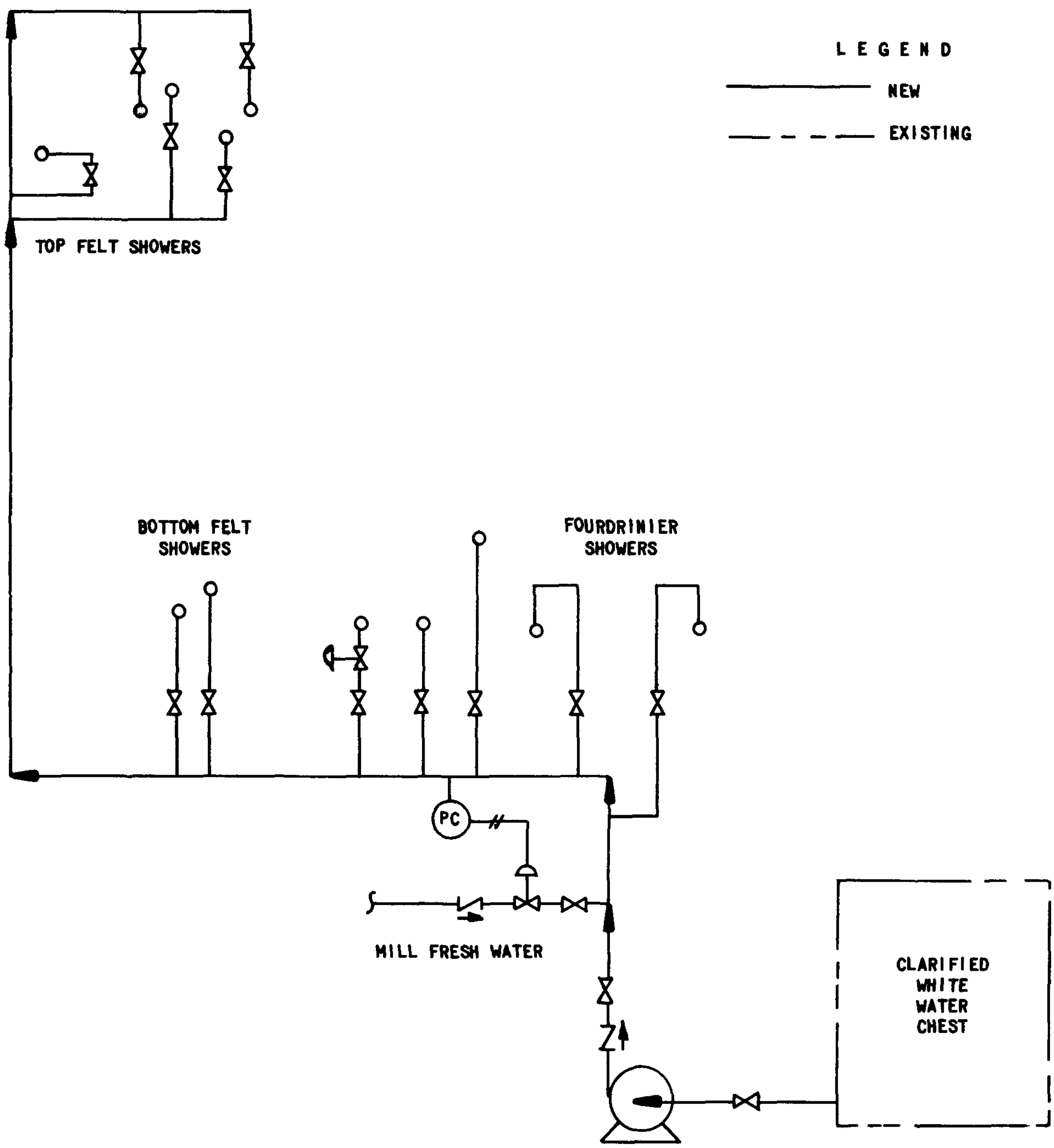


Figure 100

PAPER MACHINE WHITE WATER SHOWERS



27. Felt Hair Removal.

There are certain operations that cannot tolerate the recycling of felt hairs to the stock furnish, such as on fine papers to be coated. This estimate includes the additional pump head required above the system included for vacuum pump seal water reuse, along with a sidehill strainer for removal of felt hairs so that the clean water can be recycled (Figure 101).

28. Vacuum Pumps Seal Water Reuse

Two estimates are included for reuse of vacuum pump seal water (Figure 102). For large integrated mills, the vacuum pumps are mounted side by side on an elevated foundation with a covered trench. The system includes cascading from the high vacuum pumps to the lower vacuum pumps, and then transfer to white water storage. For the small non-integrated mill, the vacuum pumps are located all over the basement and individual sumps and pumps are included for each vacuum pump. The seal water is pumped to white water storage.

29. Paper Mill Stock Spill Collection System

The paper mill stock spill collection system picks up stock spills from the floor drains (Figure 103), which is not possible when producing quality paper. The stock is thickened for storage on static screens, which also separates some of the sand from the reclaimed pulp. The overflow from the stock chests are run to the spill collection chest. To bleach colors out of the stock such as stock dumps for grade changes, a hypochlorite solution line from the chemical preparation area is included.

EXTERNAL EFFLUENT TREATMENT

The following is a brief description of the external treatment systems used to prepare external construction costs, operation and maintenance costs, chemical costs, and power requirements. It should be remembered that the costs presented in this section are for model mills within each of the subcategories, and costs for real mills may vary depending upon the differences between the model mill and the real mill. Some of the possible variations include differences in climate, topography, soils conditions, unit locations, and the design and operation of the particular waste treatment facilitiy.

Raw and final waste characteristics associated with each technology level have been developed for each of the 17 subcategories. The data presented in this section represents approximate annual averages, and may not be relatable in every case to the limitations and standards shown in other sections because of the different methodologies used. Any differences that do exist however are generally insignificant in determining the overall cost of achieving the effluent limitations and standards. In order to determine the impact of the limitations on the profitability of a mill's operation, "treatment trains" have been developed for each technology level.

Figure 101

FELT HAIR REMOVAL FROM PRESS SECTION VAC PUMP SEAL WATER

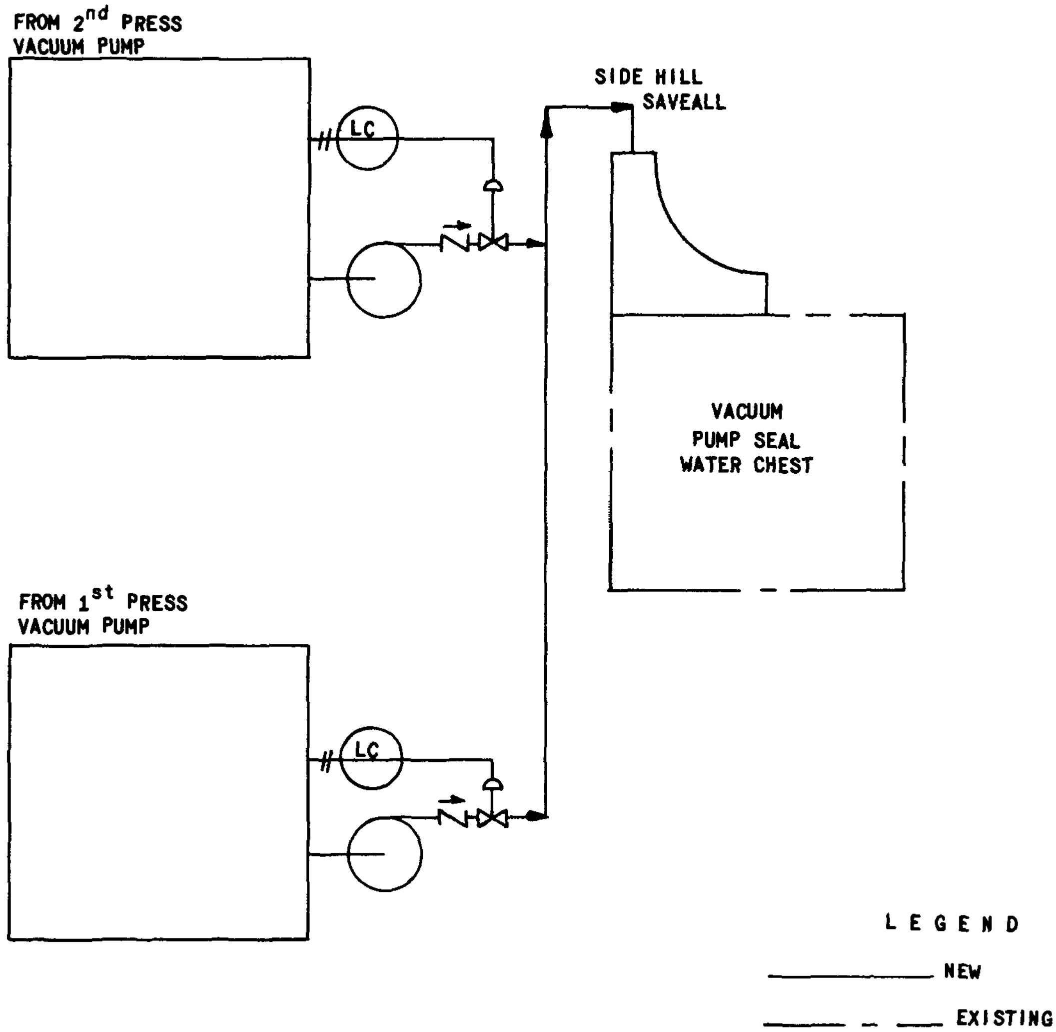


Figure 102

VACUUM PUMPS
SEAL WATER REUSE

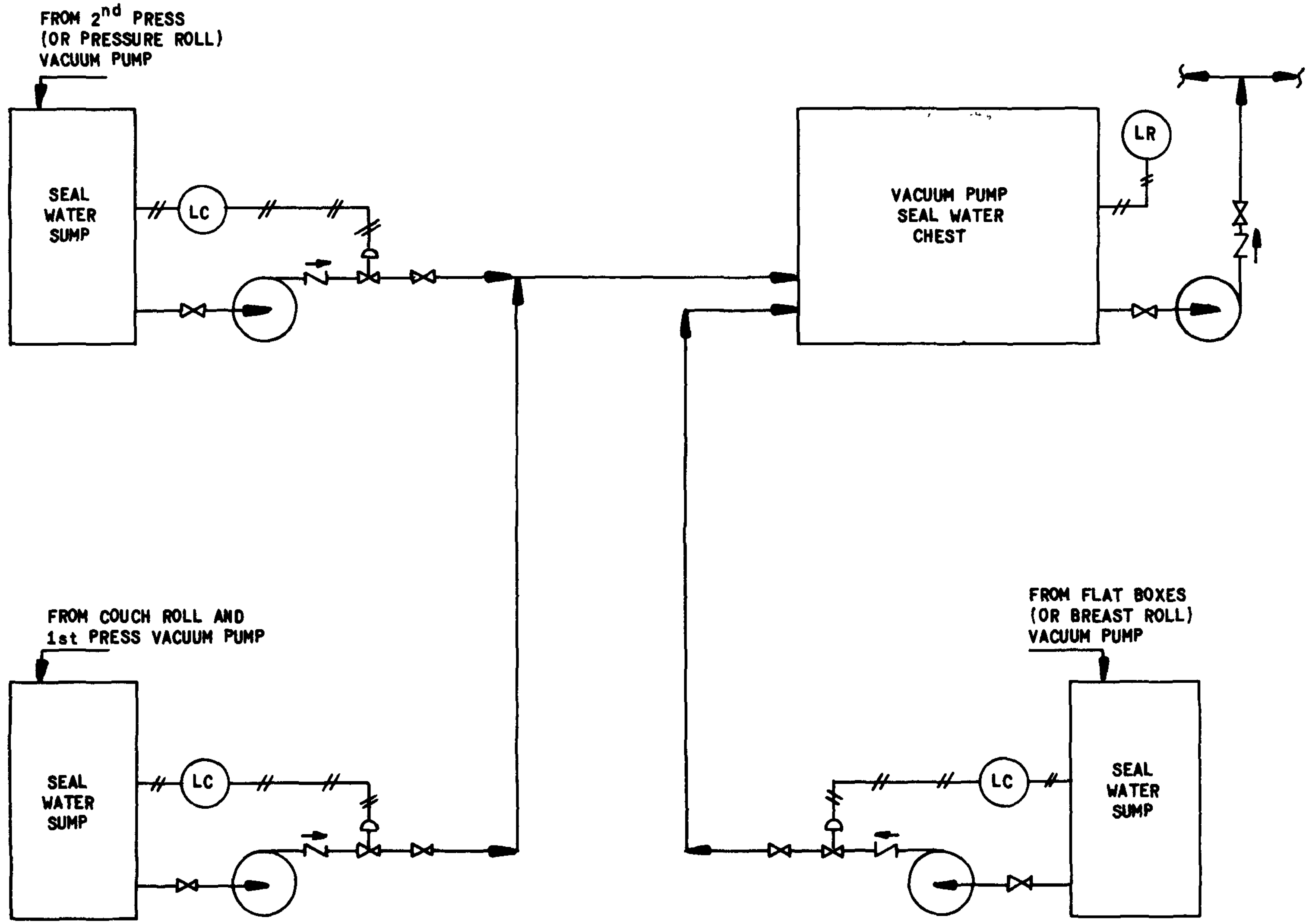
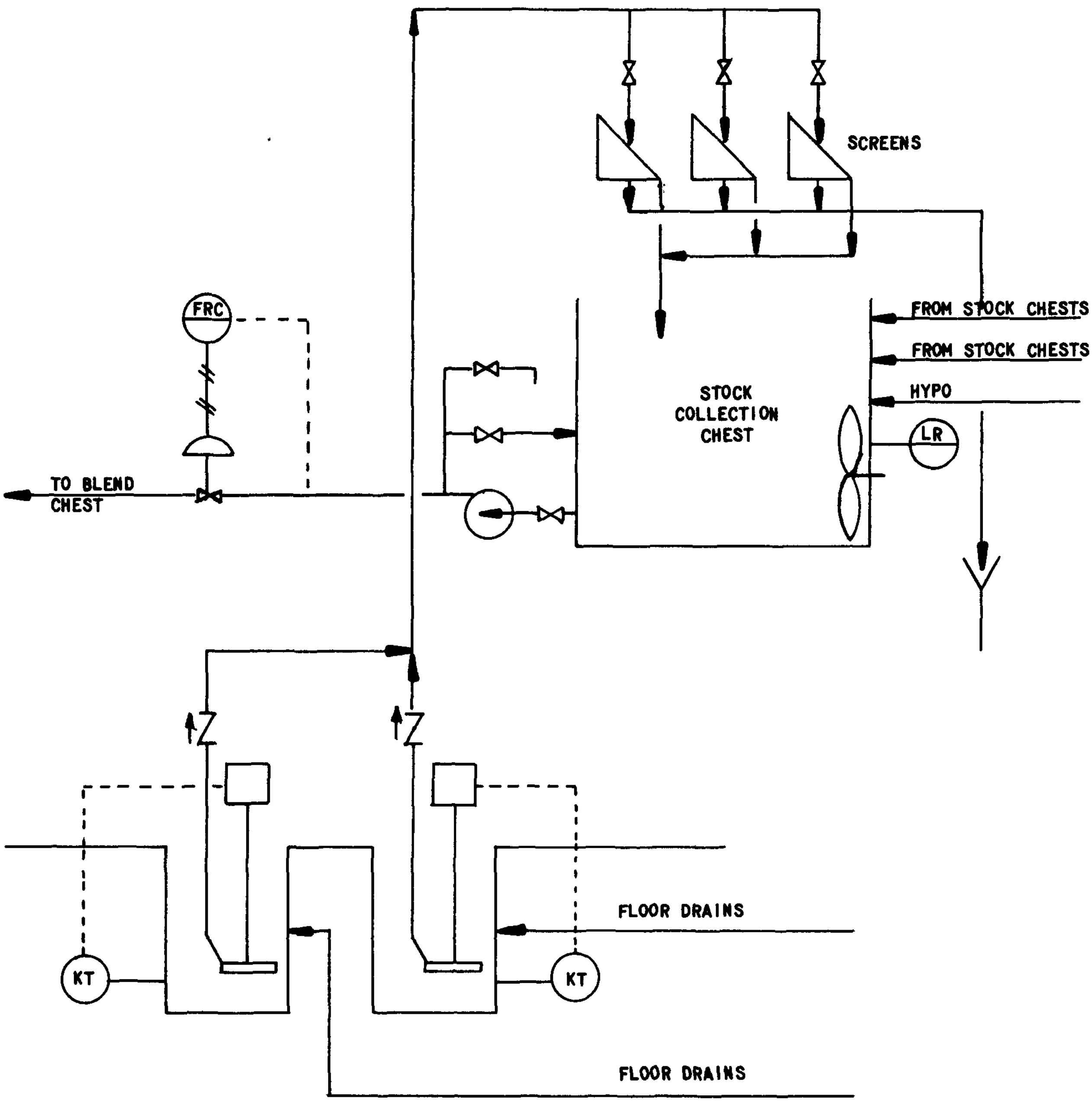


Figure 103

PAPER MILL STOCK SPILL COLLECTION SYSTEM



Cost curves have been developed for each treatment technology outlined in this report. The cost curves and resultant unit costs are based on "model" effluent treatment facilities sized for several flow capacities. These "model" effluent treatment facilities are based on assumed unit processes, yard piping layouts, methods and materials of construction, site and soils characteristics, unit construction costs, and operational practices. Detailed design for each unit, process and mechanical layout, is beyond the scope and time limitations of this report.

The construction costs presented are those defined as the capital expenditures required to implement the control 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. Items such as electrical, instrumentation, process piping, site preparation, and engineering are included as a percentage of the base capital costs, which varies for each applicable control technology. A 15 percent contingency is also included with each control technology to cover miscellaneous work items not included in the estimates.

The annual operating costs presented in this report for the external effluent treatment facilties are subdivided into three categories, as follows:

1. Total Operating Costs
2. Depreciation and Interest
3. Operation and Maintenance

Depreciation costs reflect the accounting charges for replacement of the capital assets over a period of years. Straight line depreciation has been assumed in all annual cost calculations. Interest is the financial charges on the capital expenditures for the pollution control facilities. For purposes of this report, depreciation plus interest are assumed to be 15 percent of the initial capital expenditure.

The operation and maintenance costs are those costs expended for annual operation of the external waste treatment facility. These costs are subdivided as follows:

1. Operator Labor
2. Maintenance Labor
3. Energy Requirements
4. Chemicals

Operator labor costs are based on the annual manhours required to perform the tasks for proper operation, administration, quality control, monitoring, etc., for the "model" treatment facility. The maintenance costs are the annual manhours required for preventative maintenance tasks such as lubrication, equipment inspection, minor parts replacement, painting, etc. It was assumed that major equipment repair and/or replacement and miscellaneous yard work would be done by the existing mill personnel.

Chemical usage is based on estimated quantities required to meet effluent limitations, or as required for proper operation of the particular treatment technology. The energy requirements are based on the additional horsepower and operating times attributable to the effluent control technology.

The total annual operating costs presented in this report are the sum of the annual costs for operator labor, maintenance labor, energy requirements, and chemicals.

Ambient temperatures can have a significant impact on the performance of biological treatment facilities. In cold climates an aerated stabilization basin with long detention times will tend to approach ambient temperatures which can create operational and treatment problems. These problems can include freezing of basin surfaces, ice formation on equipment and structures, and a reduction in treatment efficiencies. These problems can be alleviated through use of short term detention systems such as activated sludge.

An activated sludge system is not affected to the same degree during cold weather operations as an ASB system. It may be necessary, therefore, for certain northern mills to consider the use of an activated sludge system if they are to achieve the effluent limitations. Based on the above comments, this report presents costs for both activated sludge and aerated stabilization systems to allow cost comparisons of each system. In addition to increased efficiencies during cold weather, it is anticipated that many mills may desire installation of an activated sludge system because of limited land availability for construction of an aerated stabilization basin.

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 by most pulp and paper mills for preliminary treatment. The high solids mill sewers flow into this facility, with the low solids sewers bypassing it. The bar screen used for purposes of this report 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 facility to allow for screening during periods of maintenance on the mechanical bar screen. A "dumpster" unit is used for containment of the removed solids.

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 for this report assumed 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.

Primary Clarification

For purposes of this report, it has been assumed that internal fiber recovery is being accomplished to the degree of economic justification. 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, with total removal being accomplished by mechanical clarification. For purposes of determining the amount of sludge produced, reductions by primary clarification of 75 to 85 percent of total suspended solids were used. The clarifier selected for this report is a heavy-duty thickener type with rotary sludge scraper, and scum removal facilities. The size of these units are based on an average design overflow rate of 600 gpd/ft 2. The rotary sludge scraper mechanism is sized for a torque rating of 15(D)2. For flows in excess of five (5) mgd, two parallel units, each capable of 50 percent of the daily flow, were assumed to be used. Waste solids are withdrawn by pumping from the primary clarifier at an anticipated solids content of 3-4 percent to either a sludge lagoon or a mechanical dewatering device. Scum collected in the clarifier discharges into a storage tank where it is then pumped for dewatering. The capital costs prepared for primary clarification include excavation, backfill, concrete, mechanical, electrical, and instrumentation equipment, scum facilities, waste sludge pumps, and yard piping related to unit construction.

Sludge Lagoon

Waste solids pumped from the mechanical clarifier can be dewatered in a lagoon. In a sludge lagoon the waste solids are allowed to settle, the decanted water recycled back to the waste treatment system. In addition, a sludge lagoon may serve as an emergency solids disposal area when the mechanical dewatering facilities are down due to mechanical malfunction. The lagoon costed in this report provides sufficient capacity for five years' detention of 20 percent solids. The capital cost includes the required earthwork to construct such a facility.

Aeration

BOD_5 reduction in pulp and paper wastes is generally accomplished by biological treatment. Oxygen required for biological treatment may be supplied either by mechanical surface aerators or a diffused air system. The costs presented in this report are based on the use of mechanical surface aerators. The aeration equipment is sized to provide sufficient oxygen for BOD_5 reduction and to ensure proper mixing. Depending on the particular biological treatment process selected, oxygenation requirements will differ.

One of the most used biological treatment processes by the pulp and paper industry is the Aerated Stabiliztion Basin (ASB). Standard design criteria for aeration of an ASB system suggests providng approximately 1.25 lbs O_2/lbs BOD_5. For this report, it was assumed that the efficiency of the mechanical aerators under actual operating conditions is approximately 1.75 lbs O_2/hp-hr. This varies depending on type of equipment and the characteristics of the system (temperature, basin configuration, biological characteristics, alpha and beta).

The activated sludge system with its many process variations has had limited use by the pulp and paper industry. For cost analysis in this report, a high rate activated sludge system was considered. This system requires approximately one pound of oxygen per pound of BOD_5 removed. Mechanical aerator performance for this system is assumed to be the same as that listed above for an ASB.

Aerated Stablization Basin

Biological treatment by aerated stabilzation basins has received wide acceptance by the pulp and paper industry. Aerated Stabilization Basins provide a high degree of BOD_5 reduction with minimal decreases in efficiencies due to shock loadings. In general, however, pulp and paper wastes are deficient in the nutrients (nitrogen and phosphorus) required for optimum biological treatment. Consequently, it is necessary to add these nutrients, usually in the form of ammonia and phosphoric acid, to the biological treatment system. The 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.

The basins chosen for preparation of the cost curves is a single cell earthen-construction 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.

The sizing of the aerated stabilization basins were evaluated on both organic loading rate and detention time design criteria. The design detention time is 14 days, which assumed 13 days of aeration with one day of quiescent settling. The design organic loading is 50# BOD_5/Ac-Ft./ 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 capital costs prepared for the aerated stabilization basin include excavation, dike construction, impervious soil material, nutrient feed systems, yard piping, stone slope protection and the instrumentation and electrical costs associated with the basin size.

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). The short detention time and variations in loadings (hydraulically and organically) make this process susceptible to upsets due to shock loadings. It is recommended that an equalization basin be included with this system to even out hydraulic and organic loads to the system.

As stated previously, pulp and paper wastes are deficient in nutrients (nitrogen and phosphorus). The 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 in this report.

Final clarifiers are required with the activated sludge basin to allow separation of the biological mass and treated stream. A large portion of these solids are recycled back to the activated sludge basin to maintain the biological mass in the aeration basin. 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 0.5-1.0 percent. The methods for disposal of these excess solids are presented in a subsequent section of this report.

Since the activated sludge process has high horsepower requirements, an earthen basin would be susceptible to erosion. Consequently, 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 clarifiers associated with the activated sludge process are described in a subsequent process item.

As in the ASB system, sizing of the activated sludge system is based on both detention time and organic loading. The detention time is eight hours (excluding recycle) while the organic loading rate is 50 lbs BOD_5/1000 Cu.Ft. of aeration volume. The governing value was selected for cost analysis in this report.

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 associated with the basin size.

Equalization Basin

An equalization basin is required quite often to minimize upsets due to fluctuation in pH valuations, and hydraulic and organic variations. This is particularly true of the activated sludge process. The equalization basin utlized for cost analysis provides a 12-hour detention time for equalization of process upsets and hydraulic peaks. The basin utlized is a concrete tank with control facilities to equalize the flow. The capital costs include excavation, tanks construction, concrete, backfill, and yard piping.

Vacuum Filtration

Various unit process are used by the pulp and paper industry for sludge dewatering (both primary and secondary solids). The method which has gained the widest acceptance in the industry is vacuum filtration. A vacuum filter consists of a rotary drum covered with a wire mesh on coil springs which is partially submerged in the waste solids. The rotary drum is divided into a series of compartments which are placed under a vacuum when submerged in the waste solids. The drum rotates so that when a compartment reaches the top of the circle the vacuum is released. A filter cake is built up on the filter media, and as it descends in rotation, this filter cake is removed from the filter media prior to re-submergence in the waste solids.

The efficiency of vacuum filtration operation is greatly affected by the consistency and properties of the waste solids being dewatered. The dewatering operation is more efficient and economical when the waste sludge solids to the filter are in a range of 3 to 5 percent. Consequently, often times it is advantageous to pre-thicken the waste sludge solids prior to vacuum filtration. This is particularly true when dewatering waste solids from a biological system.

The waste sludge (primary, excess biological solids, and solids from an ASB clari-flocculator) obtained from each treatment process is unique. The sludge obtained from each process requires detailed analyzation prior to actual design of dewatering faciltìes.

Waste sludge obtained from primary clarification usually has a solids content of 3 to 5 percent. These sludges normally contain fibrous material and wood particles which enhance its filterability. A filter rate of 6# Dry Solids/Sq.Ft. Filter Area/Hour is normally used for dewatering of primary waste solids. This filter loading rate for primary solids can oftentimes be achieved without the addition of chemicals; however, oftentimes, chemicals are required to obtain a filter cake of 20 to 30 percent solids.

As described previously, the waste biological solids obtained from an activated sludge system can be extremely gelatinous. This type of sludge is quite difficult to dewater because of its consistency and requires thickening prior to vacuum filtration. Once thickened, the waste biological solids can be combined with primary waste solids for vacuum filtration. When thickened waste biological solids are combined with primary solids, filter rates of 4#/Sq.Ft./Hour are normally obtained with the addition of chemicals to aid the vacuum filtration process.

Solids removal by clarification following an ASB is not a common practice in the pulp and paper industry. However, as solids removal becomes more important, industry will require such facilities. The solids in the effluent of an ASB are difficult to settle and dewater. Consequently, it is anticipated that a flocculant (such as alum) must be added at dosage rates of 100 to 300 mg/l in order to obtain efficient solids removal. Once withdrawn from the clarifier, the combined biological and chemical solids must be thickened prior to vacuum filtration. The thickened solids should then be combined with primary sludge for efficient vacuum filtration. By combining these solids in the above manner a filter rate of 3 lbs/Sq.Ft./Hour was used for design. In addition, chemical conditioning will be required to efficiently dewater these solids by vacuum filtration.

In design of vacuum filtration facilities, there are numerous variables in design that must be considered, as outlined above. The hours per week which the vacuum filters are operating depend on the amount of solids dewatered each day and the filter loading rate.

The capital costs prepared for vacuum filtration of waste solids include: solids storage tank and pumping, building, mechanical equipment and appropriate ancillary equipment, process piping, electrical, instrumentation, and a standby vacuum filter unit. The operation and maintenance costs include disposal of the solids to a landfill site.

Sludge Press

Many times it is advantageous to provide additional solids dewatering after vacuum filtration prior to ultimate disposal, particularly if the solids are to be burned. This is normally achieved by use of a V-Press. A V-Press will normally raise the solids concentration to 35 to 40 percent solids. A screw conveyor feeds solids into a gap between two revolving press wheels. These wheels carry the solids around till a so-called "pinch point" is reached. At this point the maximum pressure is exerted on the solids. The pressed solids are then released as the wheels gradually diverge. A screw conveyor then discharges the solids into a receiving container. The filtrate from the pressing operation is then recycled back to the treatment system. The capital costs for pressing of waste solids following vacuum filtration include mechanical equipment and ancillary equipment, electrical and instrumentation, and building.

Flotation Thickening

As cited previously, 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 vacuum filtration, the capacity of the vacuum filter is greatly reduced. Air flotation was selected as the thickening process for this study. 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. In a total pressurization system, the entire waste solids stream is pressured in an air saturation tank. The partial pressurization system withdraws a portion of the influent waste solids flow to be pressurized and saturated with air. This pressurized flow is then discharged back to the influent line. In recycle pressurization, a portion of the effluent from the flotation unit is pressurized and saturated with air and recycled back to the influent.

The pressurized influent enters the flotation unit where the diffused air bubbles are allowed to surface. Diffusion of the air bubbles promotes coagulation and ultimate thickening of the waste solids. The coagulated solids (thickened sludge) are then removed for vacuum filtration. 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. As in vacuum filtration, there are numerous process variables that can be evaluated 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. The following hours of application were assumed:

Secondary Solids - #/Day	Hours/Week
0-5,000	42
5,000-20,000	24
20,000-60,000	126

An air flotation loading rate of 2# Dry Solids/Sq.Ft./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.

Secondary Clarification

Secondary clarification is required with an activiated sludge system to provide separation of the biological mass and treated stream. In addition, they are often required after an ASB system for supplemental solids removal. The clarifier most effective for secondary solids separation is the contact type. The effluent from the activated sludge basin or ASB system 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 five (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/sq.ft. The drive mechanism would be rated for a torque of 10(D)2.

In a waste 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 capital costs presented for secondary clarification include excavation, backfill, concrete, recycle pumps, mechanical equipment, electrical, instrumentation, yard piping, and ancillary equipment for proper operation.

Mixed Media Filtration

Mixed media filtration is presented in this report as a "polishing process" following secondary treatment for supplemental suspended solids removal. The units evaluated are single-stage, parallel pressure filters with provision for operation of two units in series for two stage filtration. A clear well for storage of the backwash water is provided for backwash of the captured solids. A surface wash is also provided for scouring the media and minimizing slime growth. The backwash water with its high solids concentration is pumped to a storage tank where the solids can settle, with the decanted water being conveyed back into the treatment system. The settled solids are transported to the solids dewatering equipment. The design rate for the filters is 5 gpm/sq.ft. A standby unit is provided for periods of breakdown or maintenance on one of the other filters.

The capital costs for mixed media filtration include building, process equipment, equalization basin, piping, electrical, instrumentation, and ancillary equipment.

Neutralization

Pulping processes significantly change the pH of a wastewater. Such variations in pH can affect the waste treatment process; therefore, it is necessary to add chemicals (acid and/or caustic) and flash mix the wastewater for neutralization.

The capital cost for pH adjustment includes excavation, backfill, concrete, mixer, chemical feed system, etc. The flash mix tank provides one minute detention time at peak flow with mixing capacity of 1 Hp/ 1000 gal. capacity of mix tank.

Flow Monitoring Structure

In order to monitor the unit processes and overall efficiency of the treatment process, it requires installation of flow monitoring structures throughout the process. The flow monitoring structure considered in this study includes a Parshall flume and automatic sampling equipment.

Foam Control

In many installations, foam control is very critical. Included in this study, as required, is a foam tank with adequate capacity for storage of foam. As the foam builds up in the facility, it eventually settles because of its inability to support its own weight. The foam tank provides for a five-minute hydraulic capacity.

Outfall Sewer

The outfall sewer is defined as the sewers required to connect the mill to the treatment facility and the treatment facility to the diffuser. Thus, for this cost analysis, one (1) mile 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-part 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 costs presented in this report assume that the diffuser is of standard design and that moderate underwater conditions will be encountered. Standard design recommends 10 to 15 feet of diffuser/mgd; therefore, 12 feet/mgd was used. This can vary substantially depending on the desired and required diffusion characteristics. The capital costs include excavation backfill, laying and jointing of the diffuser pipe.

Minimum Lime Treatment

Where color removal technology has been required, treatment by minimum lime has been used in this report. The first caustic extraction stage effluent, approximately 20 percent of a mill's effluent, is mixed with 1500 to 3000 ppm of lime. Approximately 75 percent of the lime is recovered in a clarifier. The lime removed in the clarifier is then pumped to a lime mud mixer where it is combined with the kraft mill lime from the recausticized filter. The combined lime is then further thickened by filtration. The additional lime kiln capacity required to handle lime from a minimum lime system is approximately 15 percent. The mud drying and calcining capacity is increased through the addition of a flash drying system before the kiln. The capital costs presented for minimum lime treatment for color removal includes additional filters, kiln capacity, flash drying system, and a clarifier for settling of the lime.

RETROFIT COSTS

Capital investment costs for mills that must upgrade their external wastewater treatment facilities in order to be in compliance with the effluent limitations were determined and are presented below. These costs were predicated on the following criteria.

1. "Retrofit costs" are determined using only mills with existing suspended solids removal and biological treatment facilities. This

Figure 104

EFFLUENT TREATMENT COST

BLEACHED KRAFT DISSOLVING SUBCATEGORY

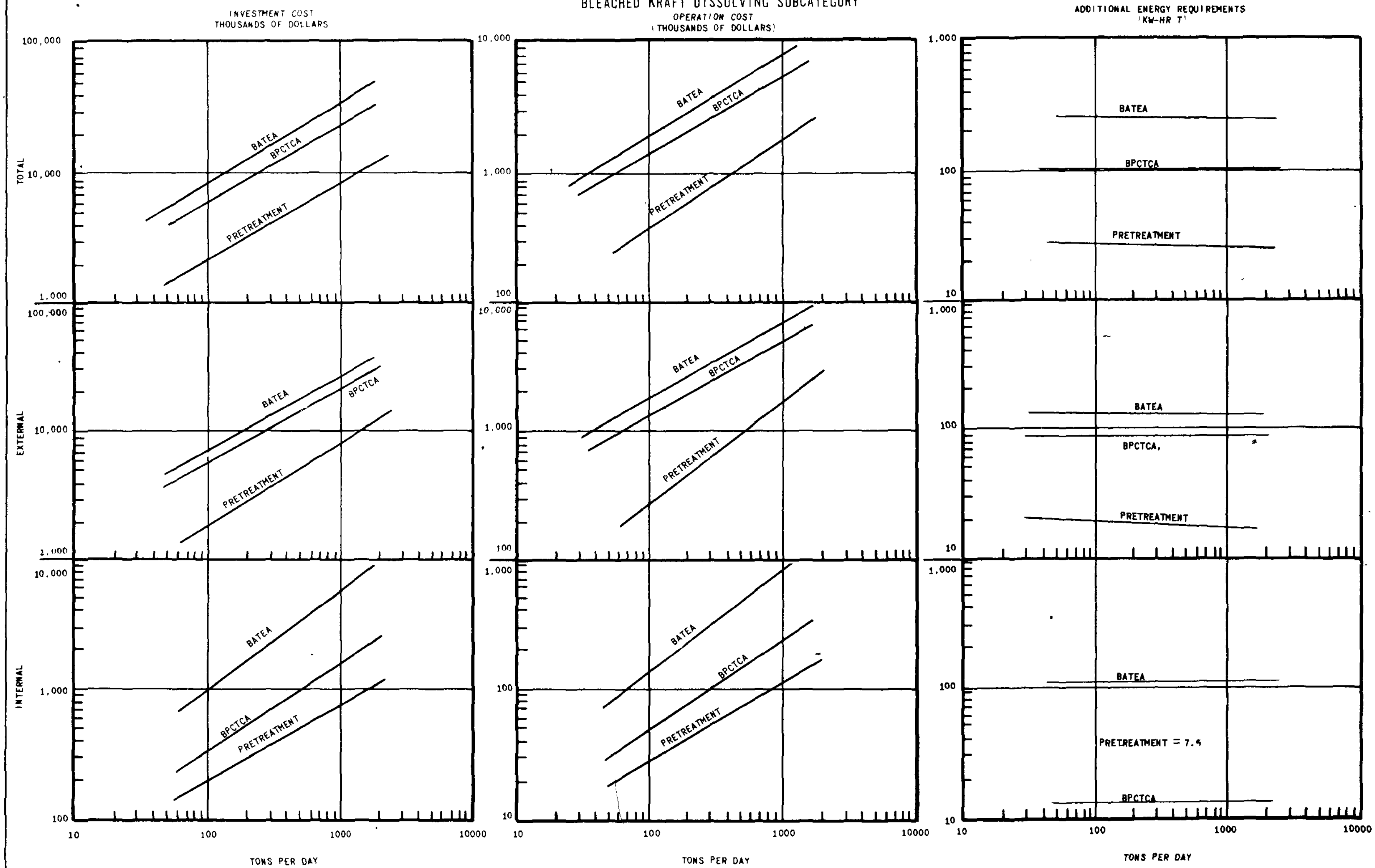


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Figure 105

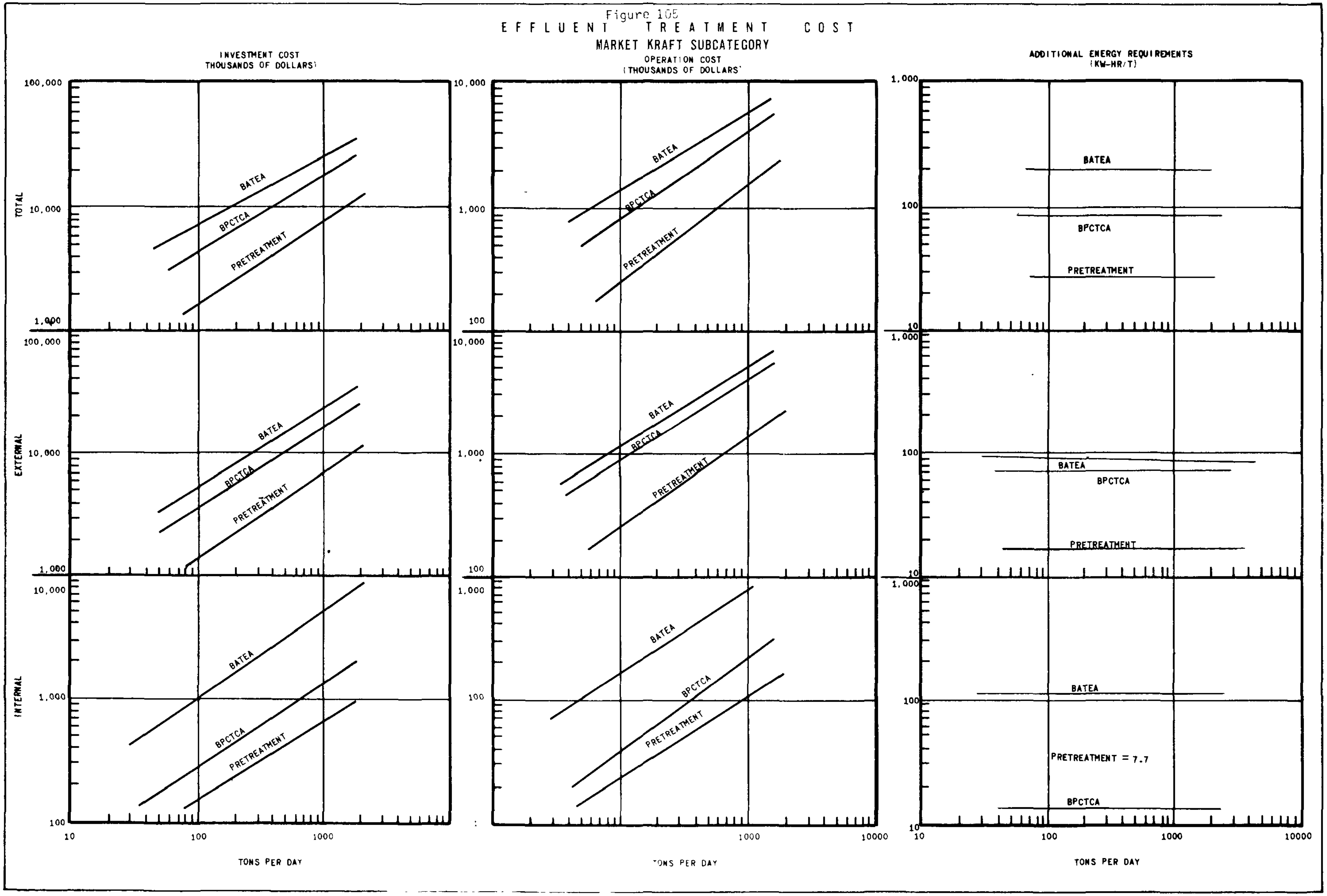


Figure 106

EFFLUENT TREATMENT COST

BCT KRAFT SUBCATEGORY

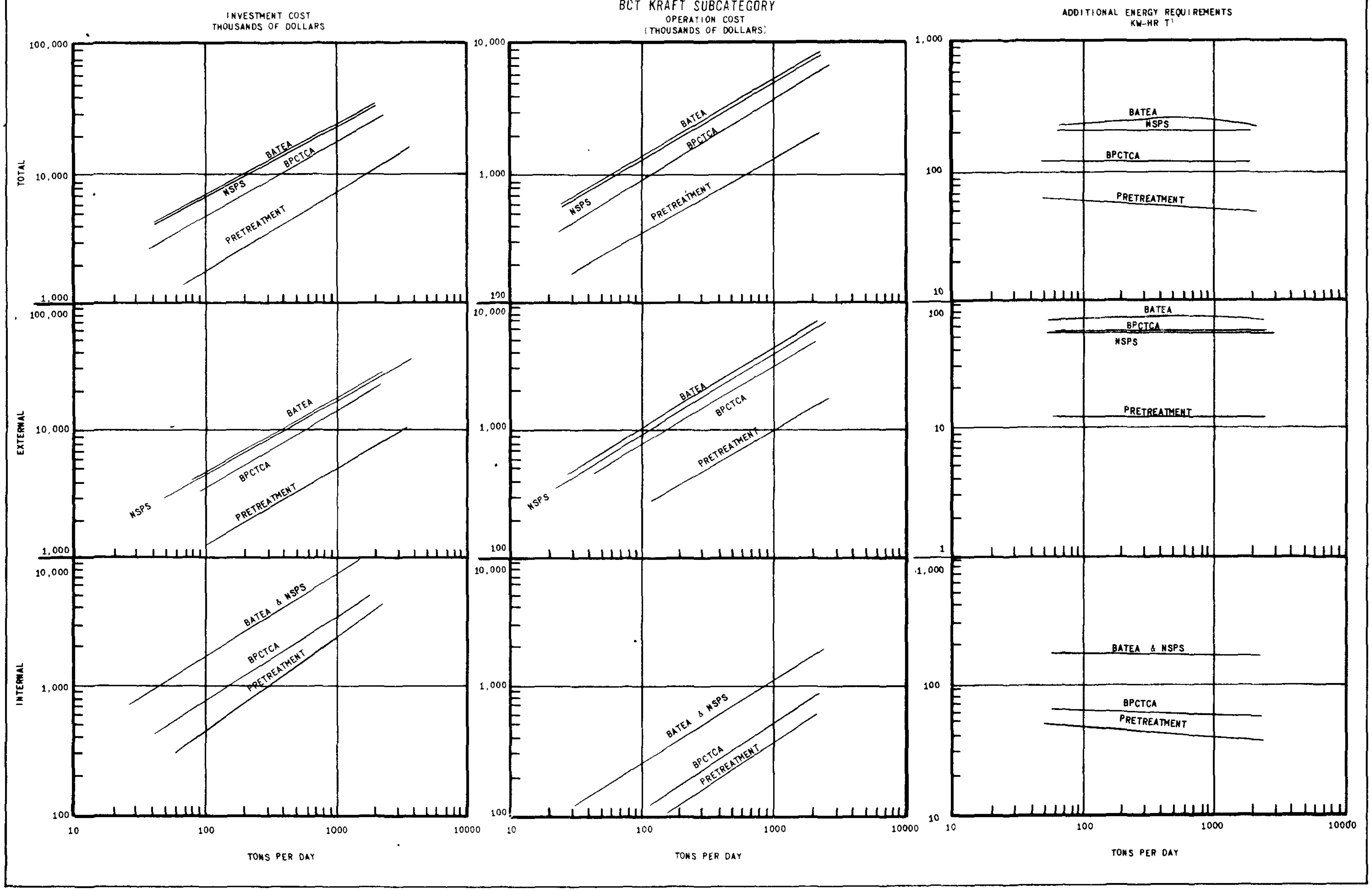


Figure 107
EFFLUENT TREATMENT COST
FINE KRAFT SUBCATEGORY

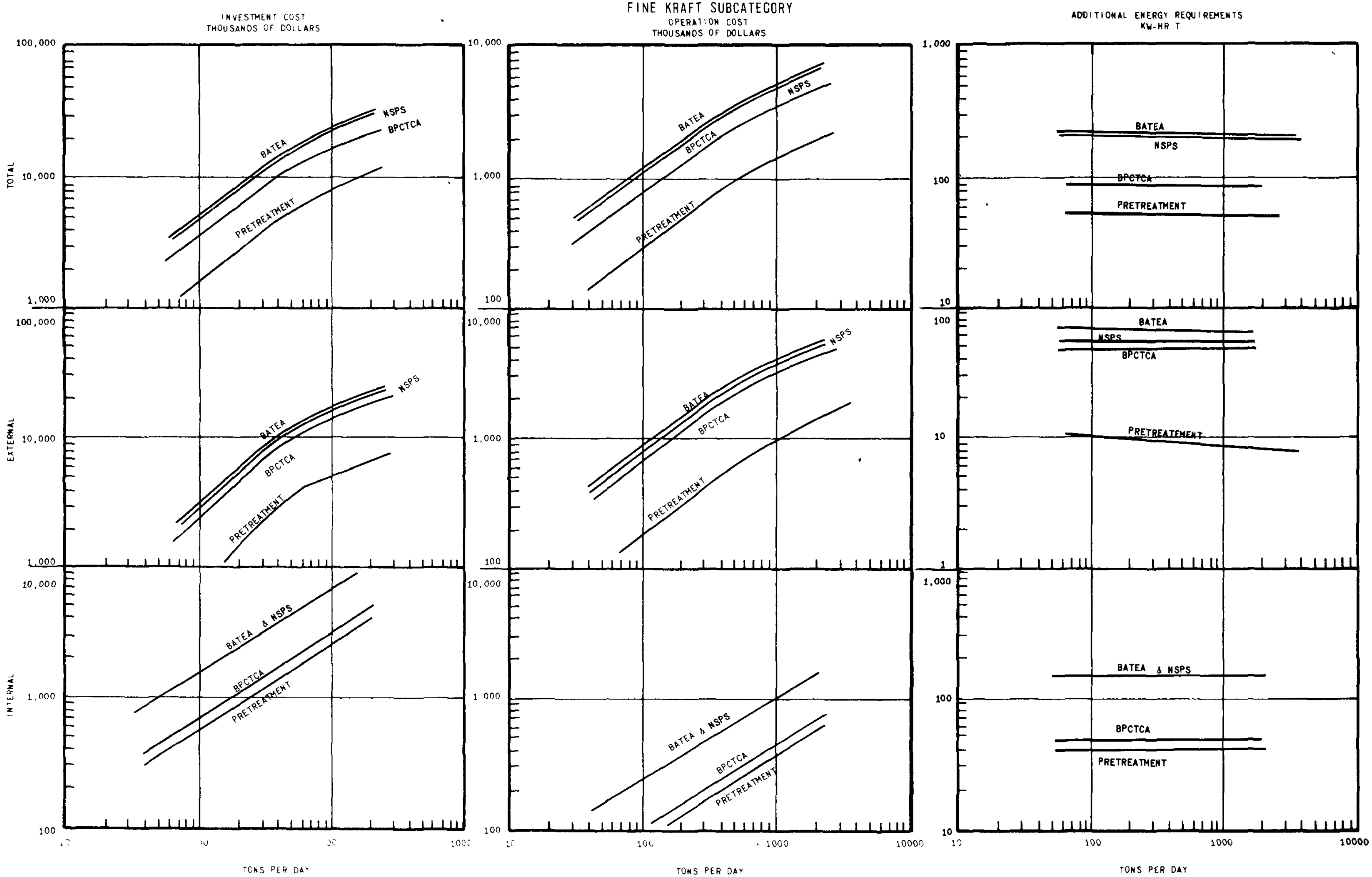


Figure 108
EFFLUENT TREATMENT COST
GROUNDWOOD CHEMI/MECH. SUBCATEGORY

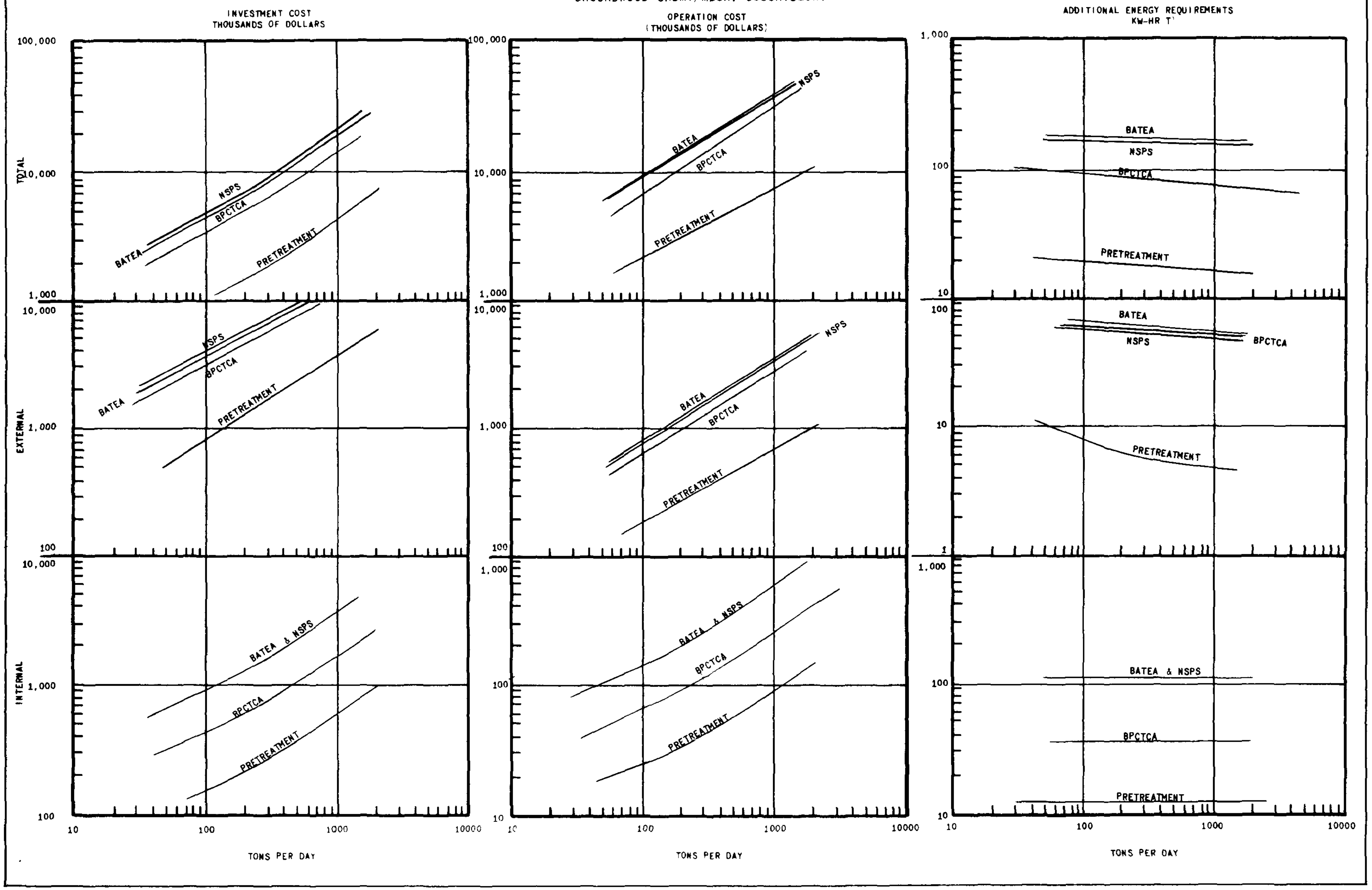


Figure 109

EFFLUENT TREATMENT COST

GROUNDWOOD THERMO. MECH SUBCATEGORY

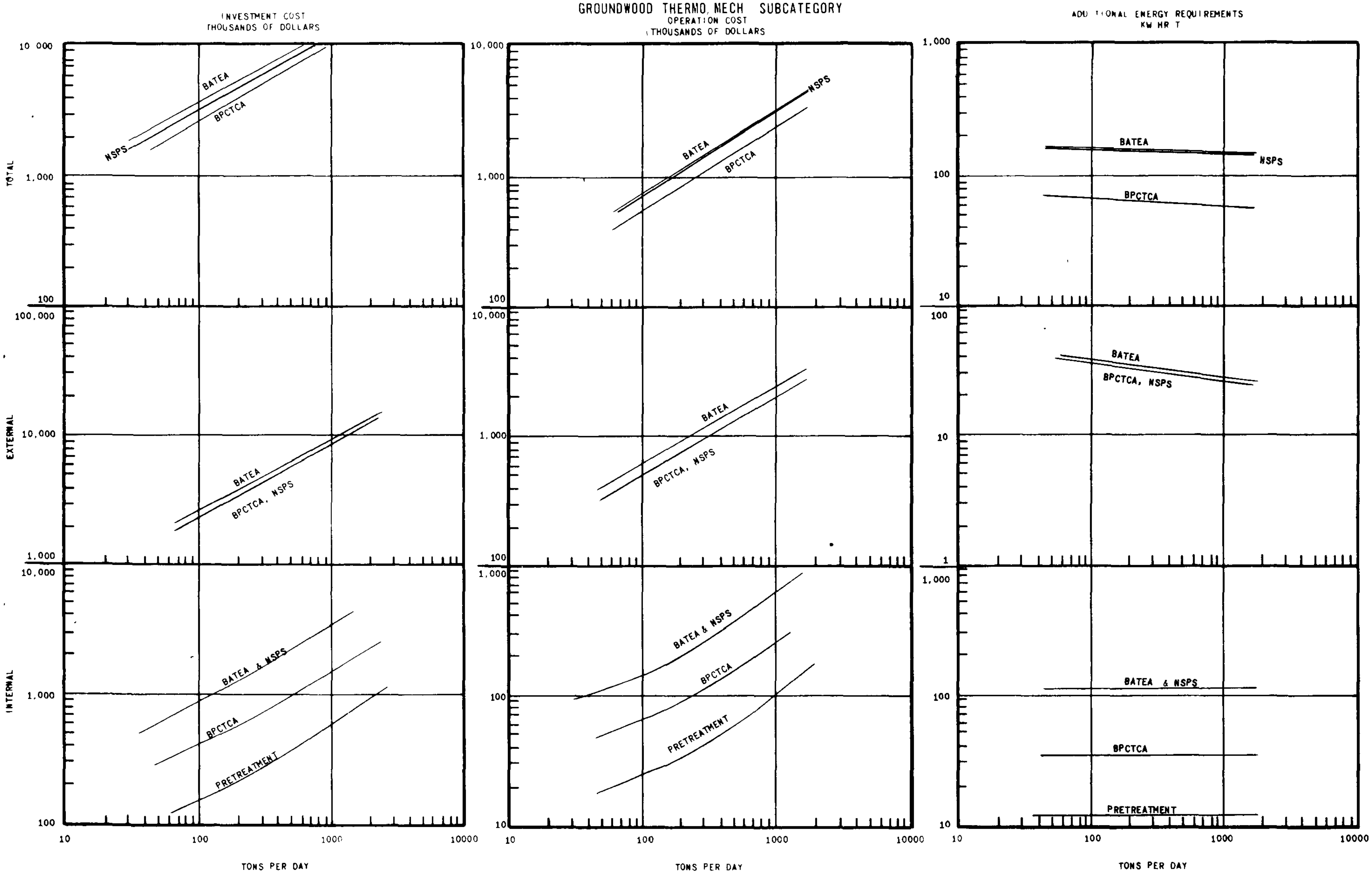


Figure 110

EFFLUENT TREATMENT COST

GROUNDWOOD C-M-N SUBCATEGORY

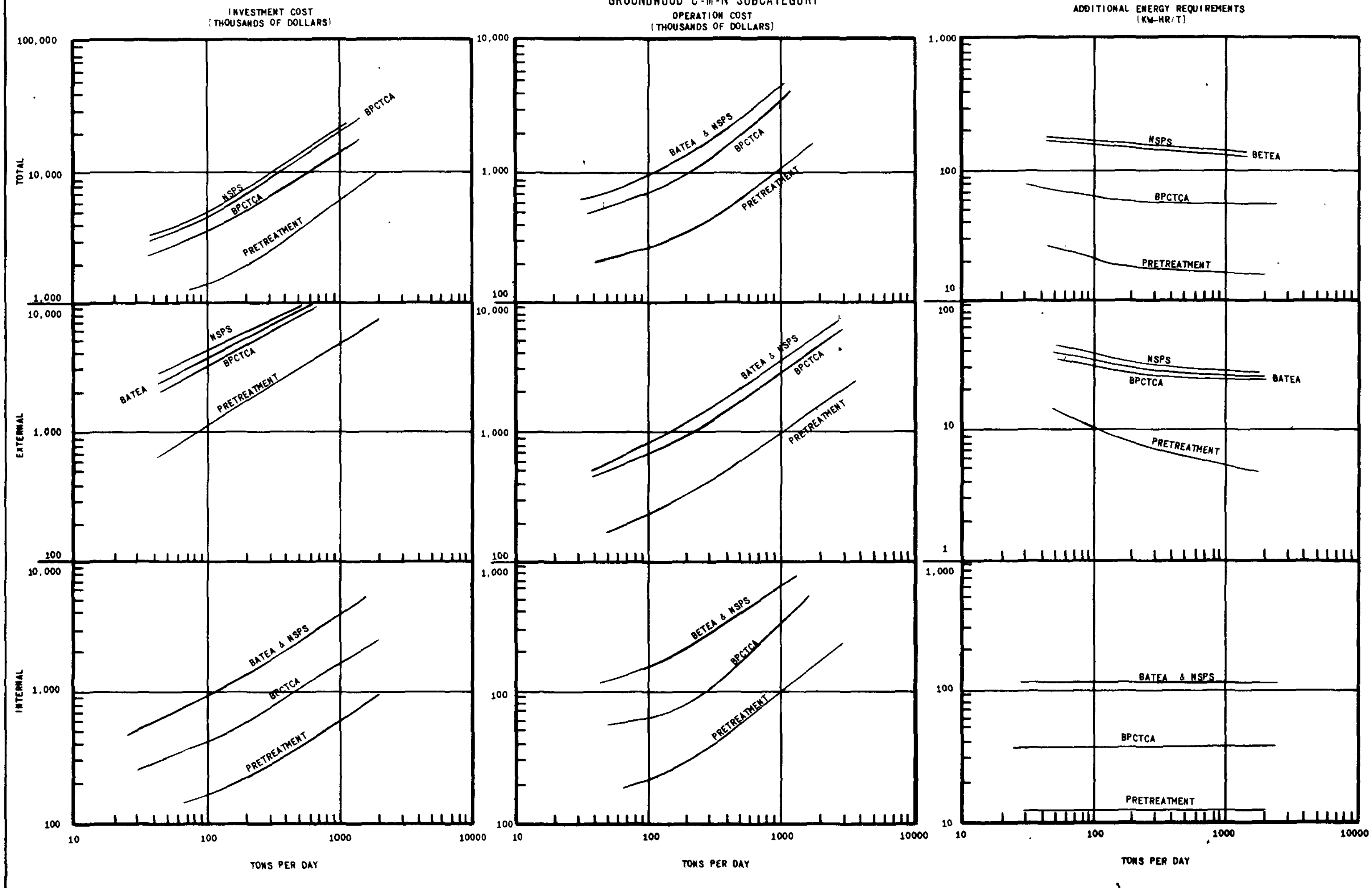


Figure 111

EFFLUENT TREATMENT COST

GROUNDWOOD FINE SUBCATEGORY

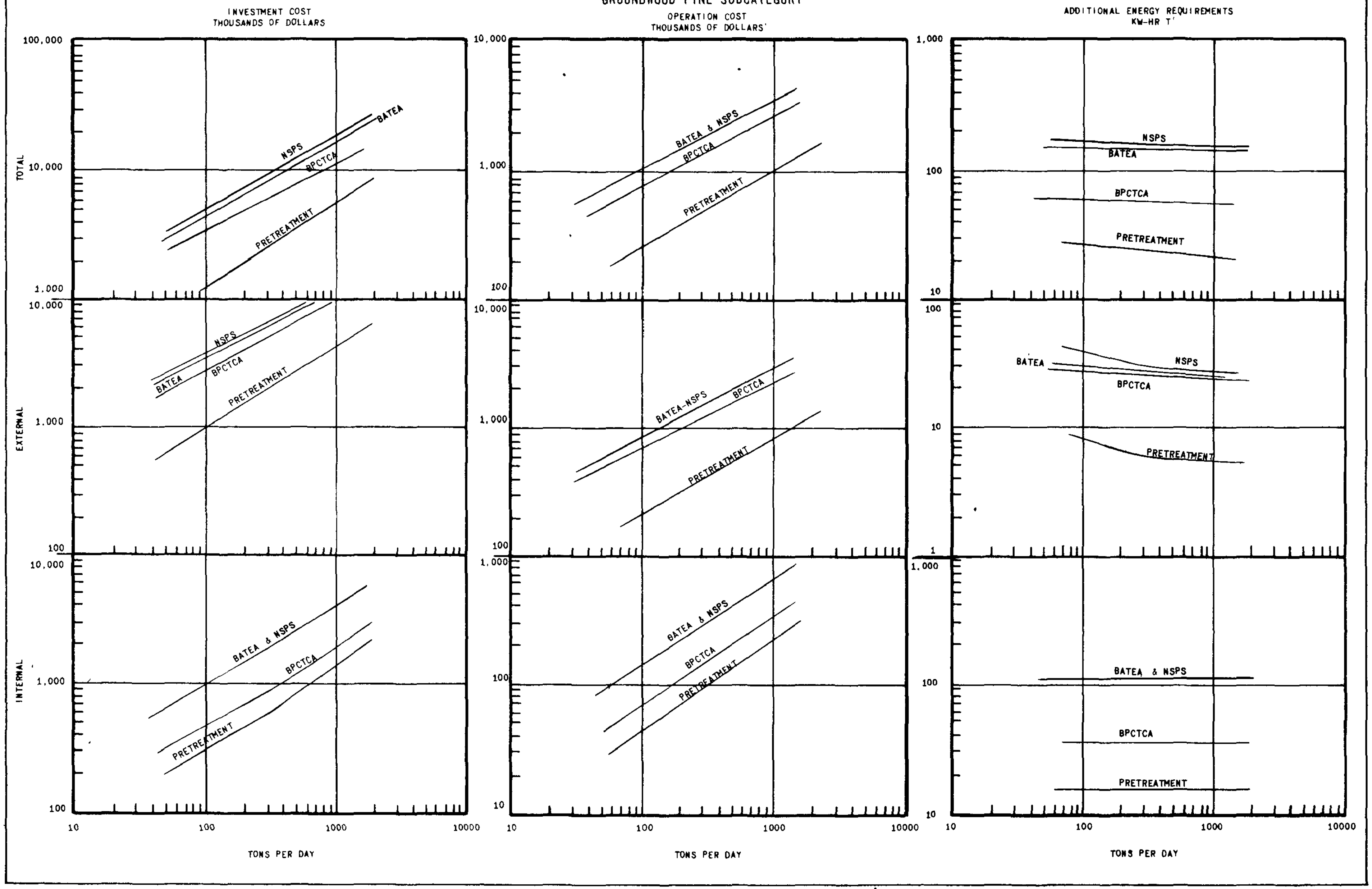


Figure 11.

EFFLUENT TREATMENT COST

SODA SUBCATEGORY

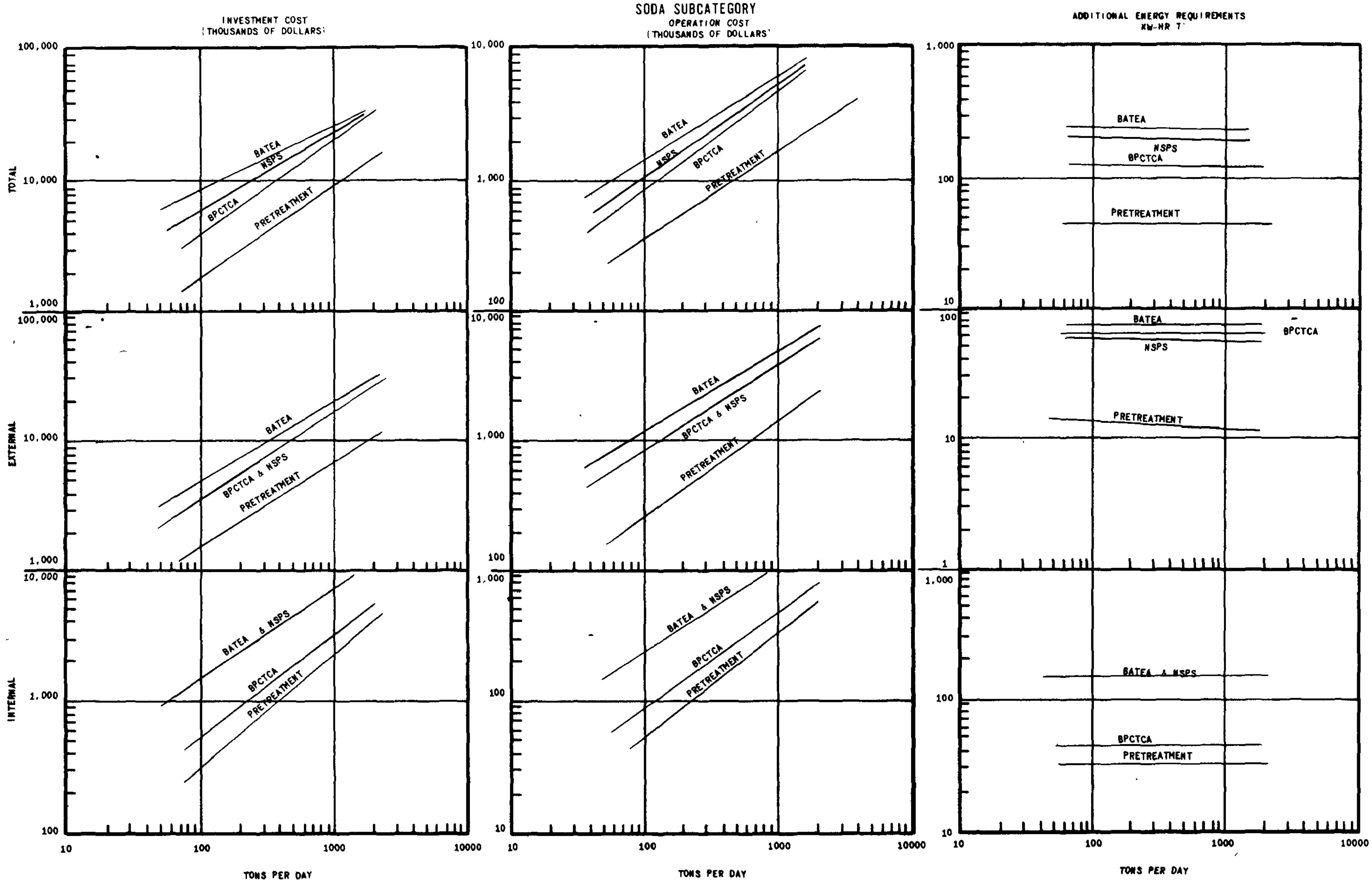


Figure 113
EFFLUENT TREATMENT COST
PAPERGRADE SULFITE SUBCATEGORY

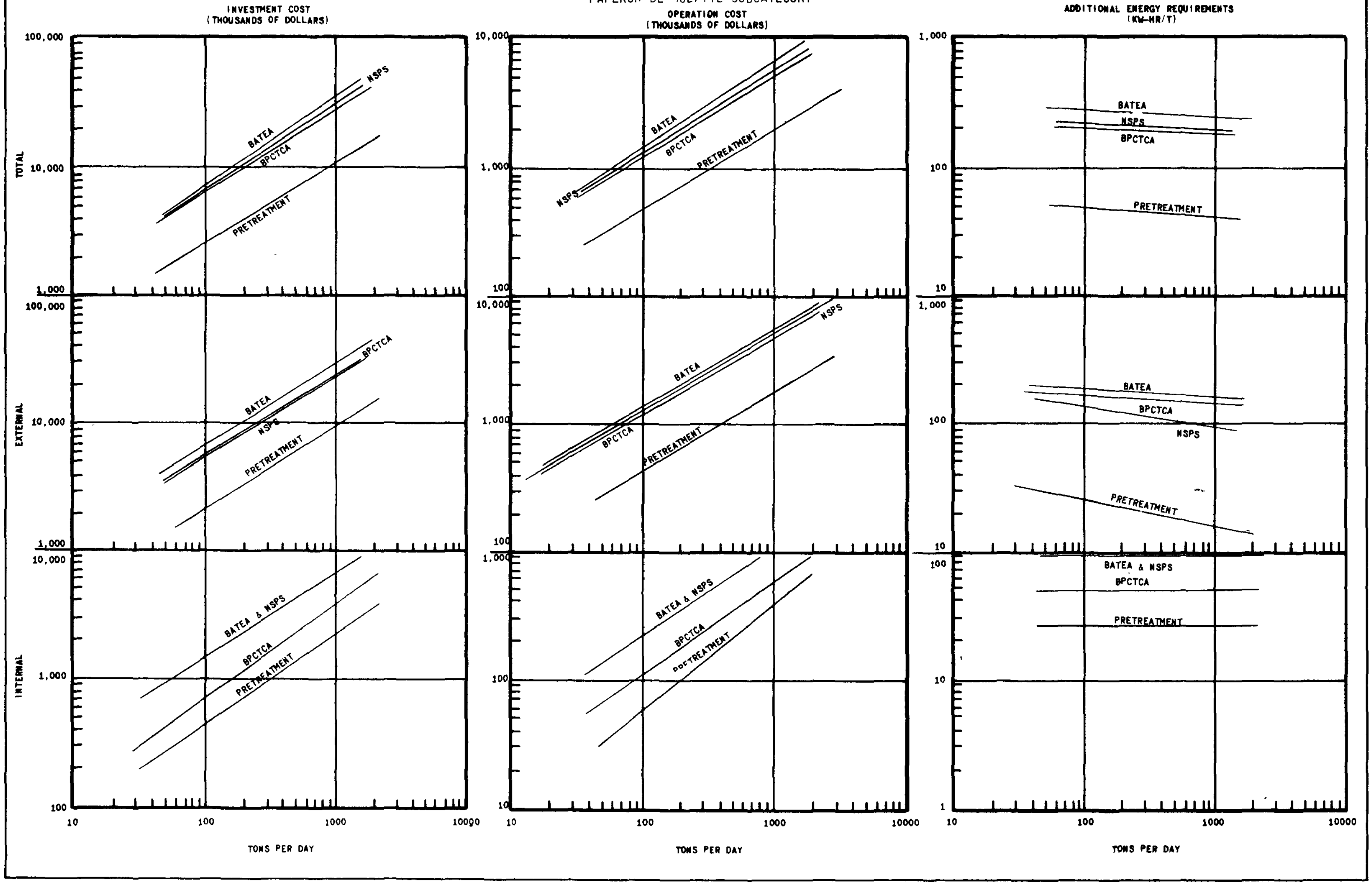


Figure 114

EFFLUENT TREATMENT COST

MARKET SULFITE SUBCATEGORY

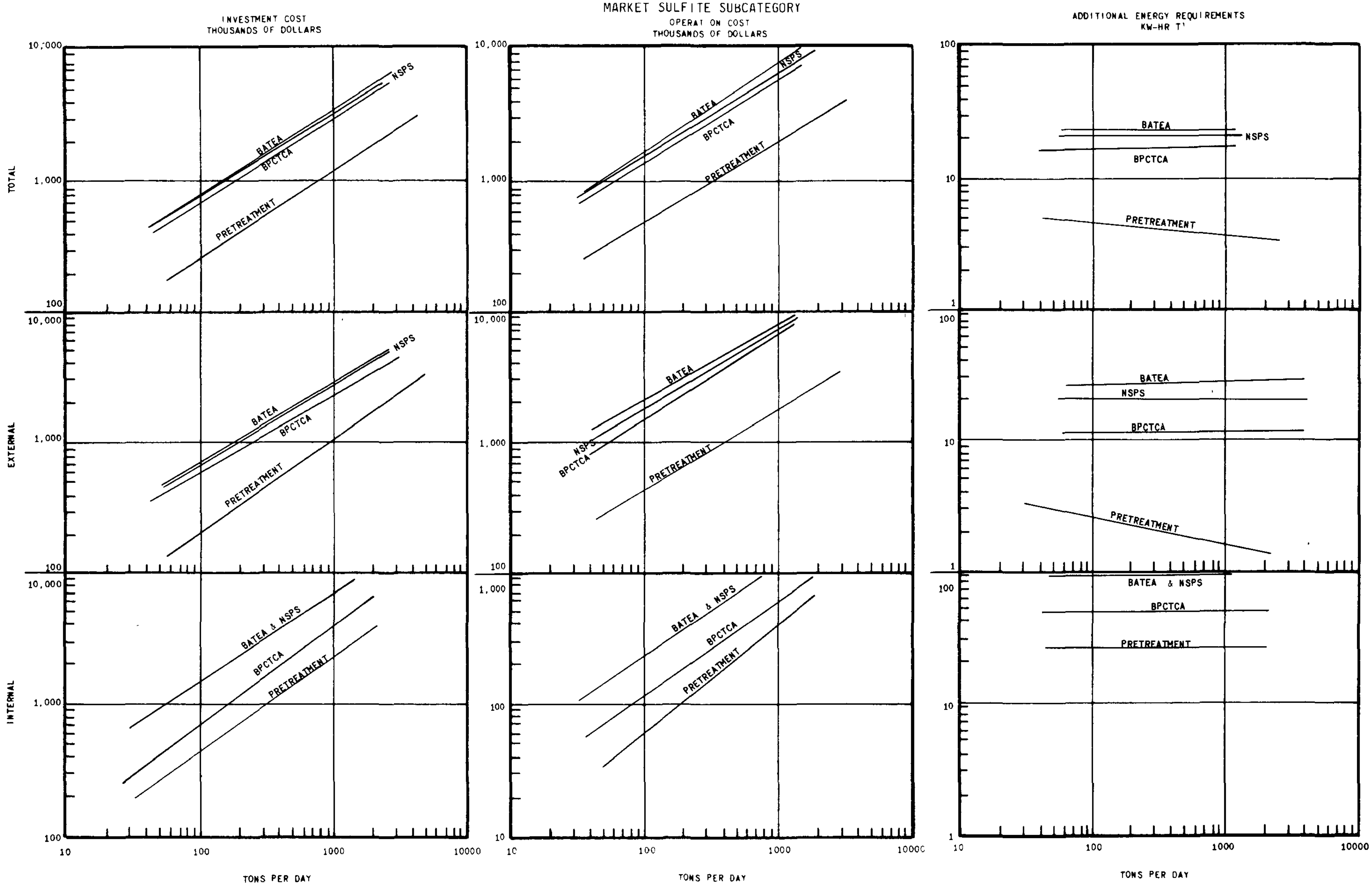


Figure 115

EFFLUENT TREATMENT COST

DEINK SUBCATEGORY

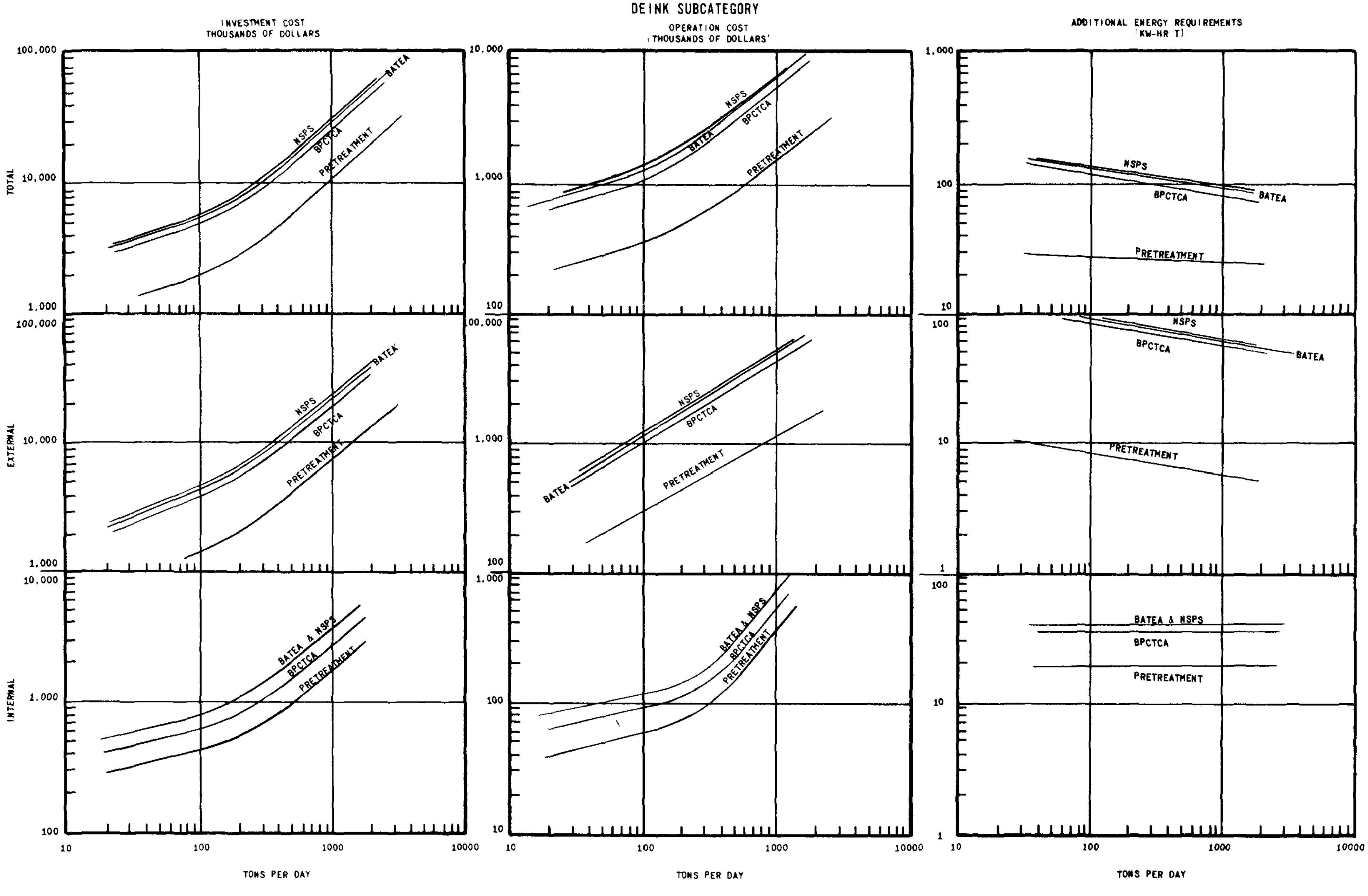


Figure 116

EFFLUENT TREATMENT COST

NON-INTEGRATED FINE SUBCATEGORY

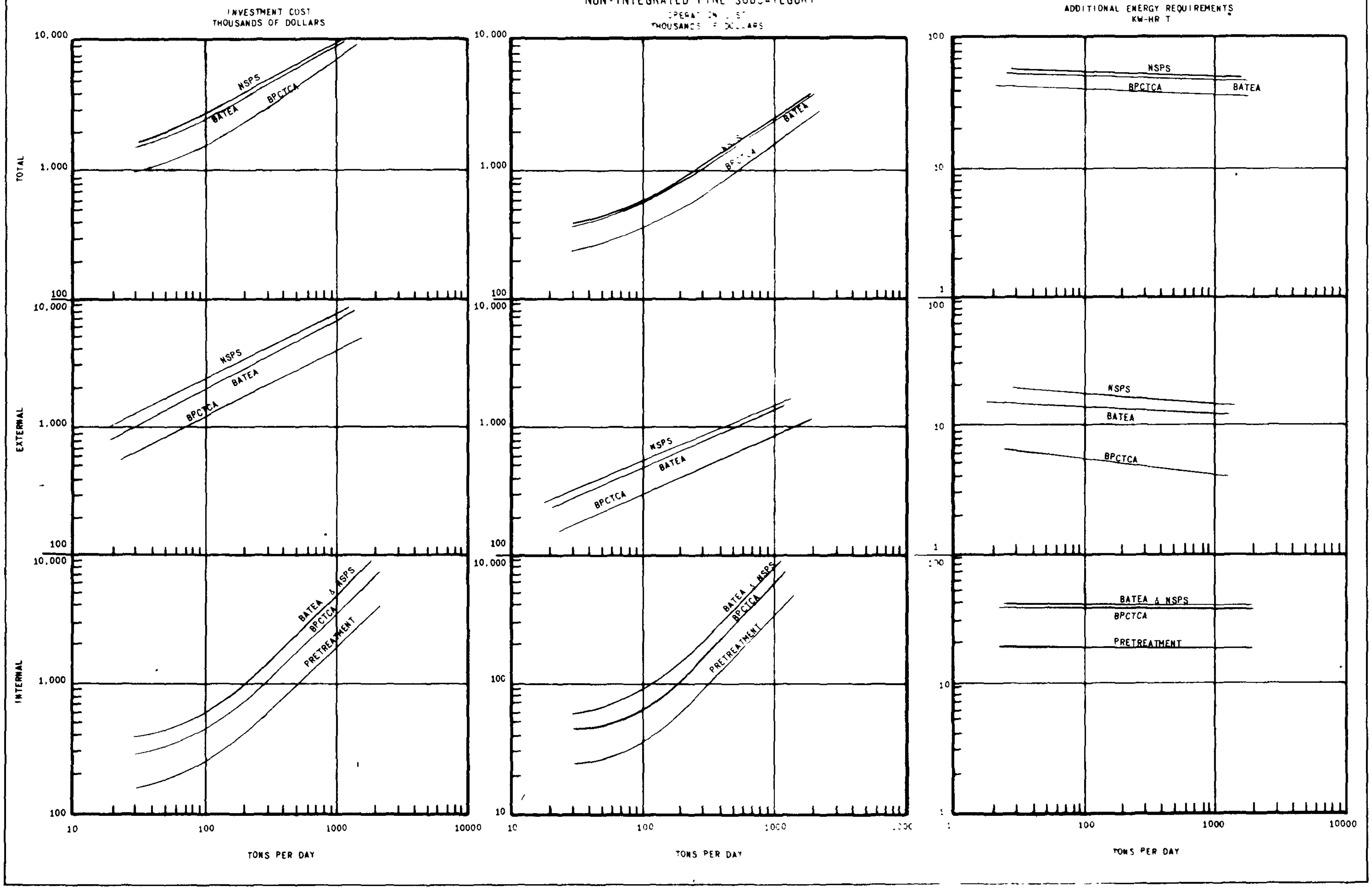


Figure 117

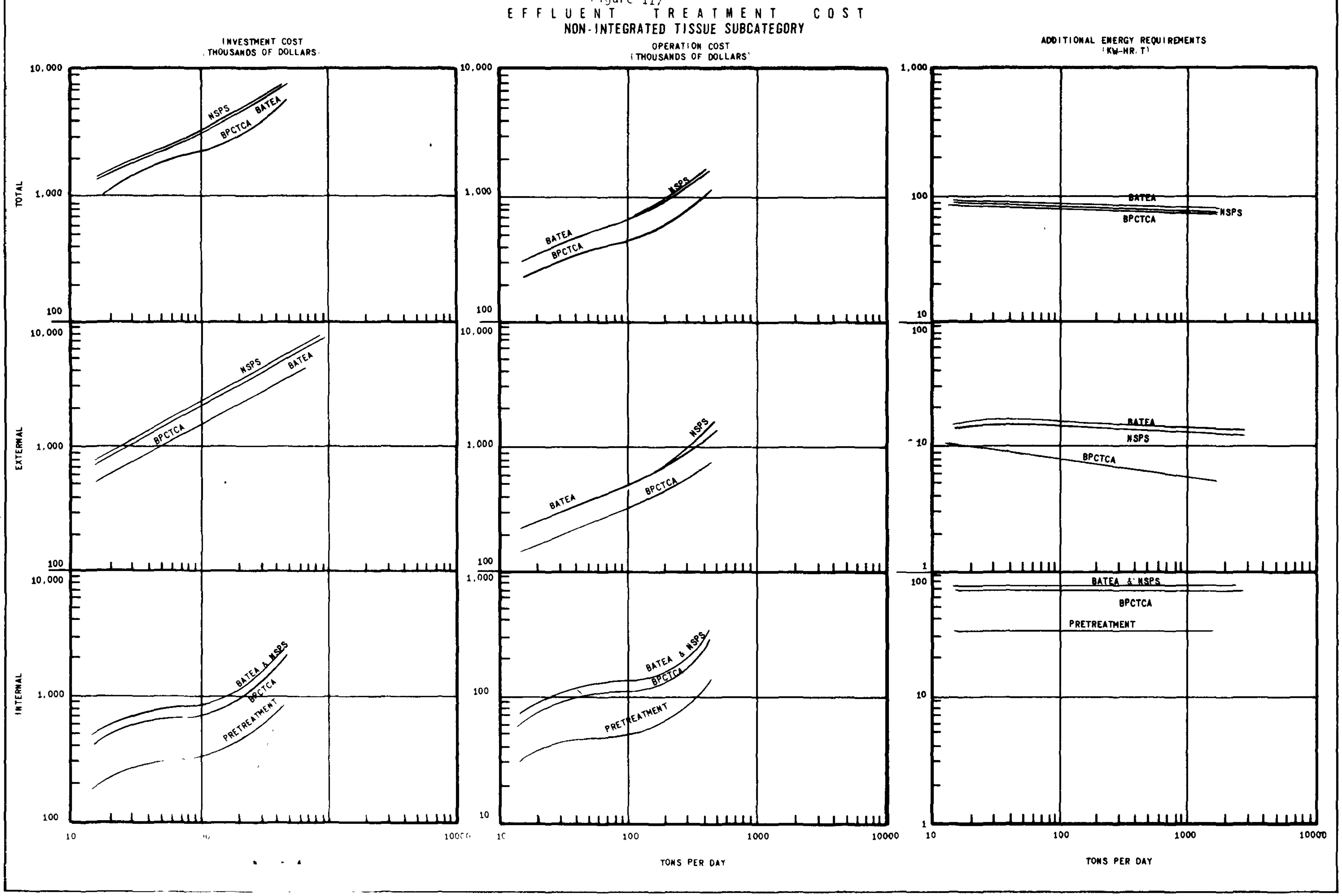
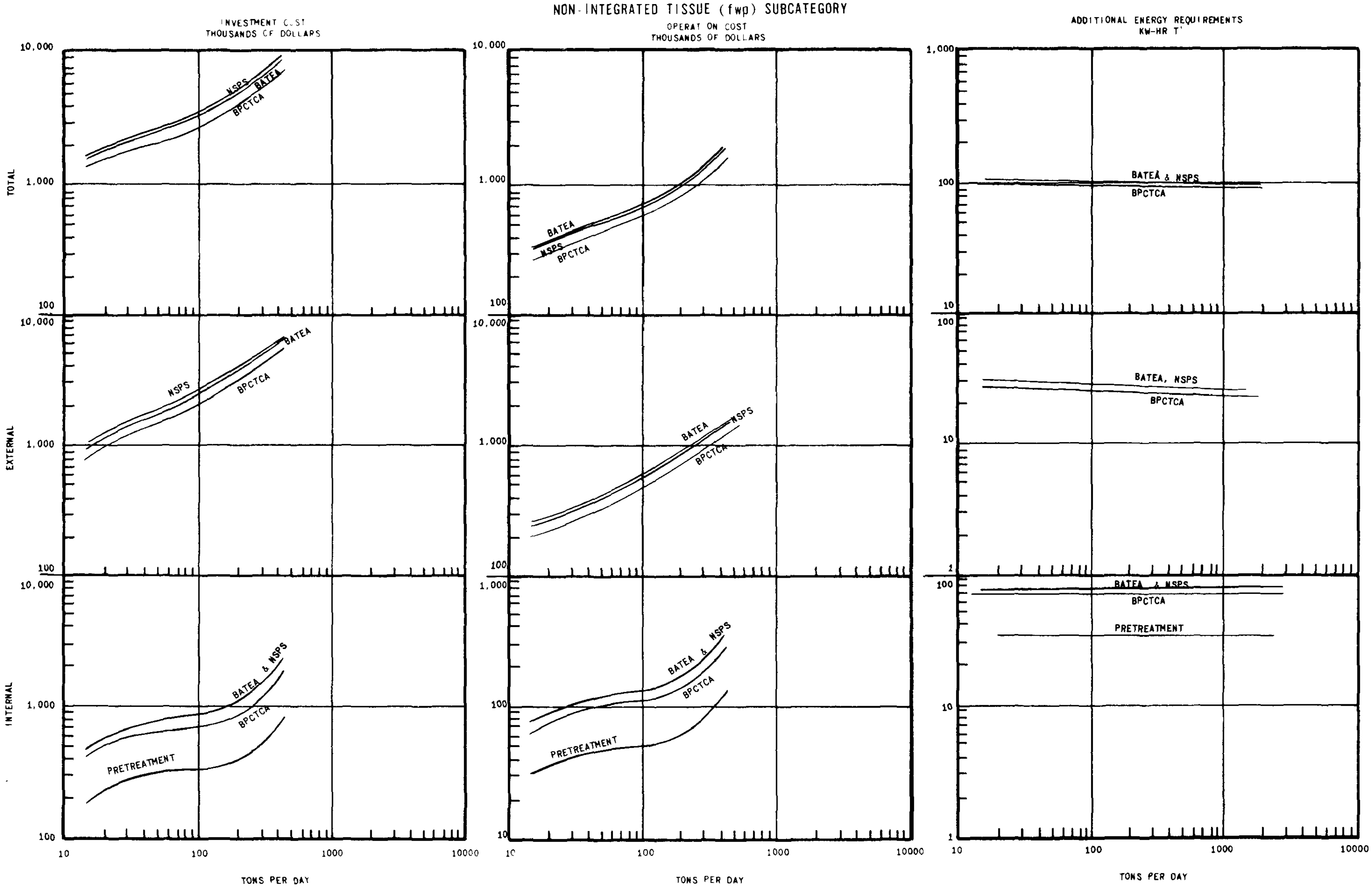

EFFLUENT TREATMENT COST
NON-INTEGRATED TISSUE SUBCATEGORY
INVESTMENT COST (THOUSANDS OF DOLLARS)
OPERATION COST (THOUSANDS OF DOLLARS)
ADDITIONAL ENERGY REQUIREMENTS (KW-HR/T)
TOTAL
EXTERNAL
INTERNAL
NSPS
BATEA
BPCTCA
BATEA & NSPS
PRETREATMENT
TONS PER DAY
10
100
1000
10000
1,000
10,000

Figure 118
EFFLUENT TREATMENT COST
NON-INTEGRATED TISSUE (fwp) SUBCATEGORY



selection criteria is based on evaluation of all the pertinent data generated by this study which established that BPCTCA for all mills in each subcategory is primary and biological treatment. Mills in the tissue FWP (predominantly a waste paper furnish) subcategory require primary and biological treatment but mills using predominantly virgin pulp are an exception in that these mills require only primary treatment for BPCTCA. Therefore the mills in this subcategory that were selected to determine "retrofit costs" include mills with only primary treatment facilities.

2. A table listing all mills for each subcategory was prepared describing the mill size, production and reported treatment trains. Using the criteria described above, selection of all the mills in each subcategory or segment to be used for the determination of retrofit costs were made.

3. Retrofit costs are based on the difference between the annual average BOD_5 and TSS actually achieved by each selected surveyed mill and the average of the annual averages achieved by the mills used to establish the effluent limitations for the subcategory. This difference represented the additional BOD_5 and TSS removal required for each mill. The annual average wastewater volume and the additional BOD_5 and TSS removal required for each mill was then developed. This information as well as mill size and treatment train is tabulated by the segment in Table 186.

Using the procedures and selection criteria described above the methodology for the determination of "retrofit costs" for each subcategory or segment was as follows:

Groundwood Mills

The groundwood segment includes the following subcategories: chemi-mechanical, thermo-mechanical, groundwood making fine paper and groundwood making coarse, news and molded paper products. There are a total of 19 mills that were surveyed and 20 mills that were not surveyed in this segment and only three mills qualified for determination of retrofit costs. The remaining mills either discharged to a municipal system, have no treatment facilities, have only primary treatment facilities or are in compliance with the effluent limitations. The design criteria on which "retrofit costs" are based are described in Table 187. "Retrofit costs" for the three mills selected are shown in Table 190.

Sulfite Mills

The sulfite segment includes the sulfite and dissolving sulfite subcategories. There are 11 mills in this segment that were subject to detailed survey and 17 mills that were not. There were only two mills in the entire segment that qualified for determination of retrofit costs. The remaining mills discharged to a municipal sewer, have no treatment, have only primary treatment or are in compliance with the effluent limitations. The design criteria on which these costs are based is described in Table 187. "Retrofit costs" for the

TABLE 186

SURVEYED MILLS USED TO DETERMINE RETROFIT COSTS

Mill Code	Tons/ Day	Treatment Train	Flow M.G.D.	#/Day To Be Removed	
				BOD	TSS
			Groundwood		
003	542	C-TF-C	13.8	6,179	3,848
002A	217	C-A	4.9	586	1,259
004A	71	SB-SB-SB	2.1	277	I.C.
			Sulfite		
051	296	C-ASB	16.6	240	503
052	101	C-ASB	4.1	537	I.C.
			Soda		
150	300	C-TF	12.0	19,000	24,000
152	638	C-ASB	17.0	I.C.	24,000
			Bleached Kraft		
140	320	SB-ASB	6.0	2,300	1,200
108	1000	C-ASB	55	6,800	4,000
120	1160	ASB	36.1	580	19,952
110A	1132	ASB	27.8	906	3,736
136	1650	ASB	47.4	3,300	83,655
134	945	ASB	21.0	8,978	37,044
104A	1342	A	70.2	13,554	27,511
116	1150	ASB	36.1	13,685	83,605
118	192	A	5.0	1,133	N.A.
132	417	*	8.1	3,294	I.C.
103	425	ASB	18.4	7,055	I.C.
107A	310	A	9.4	I.C.	3,689
112	640	ASB	16.9	I.C.	13,824
121A	1351	ASB	48.4	1,080	O.K.
138	986	ASB	33.0	1,578	4,733
113A	1177	ASB	39.8	2,589	N.A.
109A	1119	A	43.8	4,923	24,170
100	1027	ASB	37.1	21,362	I.C.
501	1385	ASB	66.1	21,745	26,315
122A	598	ASB	17.3	12,080	15,608
111A	772	ASB	25.0	I.C.	772
102A	1020	ASB	34.7	36,108	8,976

I.C. = In Compliance
N.A. = Not Applicable
* = Oxidation Lagoon

TABLE 186
(continued)

Mill Code	Tons/ Day	Treatment Train	Flow M.G.D.	#/Day To Be Removed	
				BOD	TSS
		Deink			
210	320	SB-PS	6.2	6,003	I.C.
205A	100	C-ASB	1.9	245	N.A.
		Fine			
284	375	C-ASB-C	2.3	262	I.C.
257A	187	C-A	1.9	430	N.A.
		Tissue			
252	49	C-PS	0.6	54	I.C.
303	45	FI	2.8	239	N.A.
308A	160	C	4.4	560	304
318	125	C	4.2	188	438
333	163	C	5.2	652	N.A.
337	36	C	4.5	508	72
259A	194	C-FI	3.4	446	I.C.
312	15	C-ASB-PS	0.7	N.A.	590
313	37	C-PS	0.2	644	N.A.
330	20	C	0.4	352	N.A.
208A	104	C	1.5	707	62
302	226	C-PS	2.8	226	N.A.
329	74	C	2.7	488	96

I.C. = In Compliance
N.A. = Not Applicable

two mills shown in Table 190 represents the total costs for the entire sulfite segment.

Soda Subcategory

The two mills listed in Table 186 for the soda subcategory are the mills that qualify for development of "retrofit costs" for this subcategory. The costs to upgrade the wastewater treatment facilities for these two mills, i.e., "retrofit costs" are shown in Table 190. The design criteria on which these costs are based is described in Table 187.

Deink Subcategory

Four mills listed in Table 186 in this subcategory qualified for selection to determine retrofit costs. The remaining mills in this subcategory discharged to a municipal system, have no treatment, have primary treatment only, or are in compliance with the effluent limitations. The "retrofit costs" developed for these four mills therefore represent the costs for the entire subcategory which are shown in Table 190. The design criteria on which these costs are based is described in Table 187.

(Non-Integrated) Fine Paper Subcategory

The two mills shown in Table 186 provide the basis for determining "retrofit costs" for this subcategory. The other mills in this subcategory discharged to a municipal system, have no treatment, have primary treatment only, or are in compliance with the effluent limitations. The retrofit costs for this subcategory are shown in Table 192 and the design criteria on which they are based are shown in Table 187.

Bleached Kraft Mills

The bleached kraft market pulp, dissolving pulp, fine paper and BCT subcategories are included in this segment. The twenty-two mills listed in Table 186 under the bleached kraft segment are those that require the determination of "retrofit costs." In addition to these mills there are ten more that were not surveyed, for which retrofit costs must be determined. There is insufficient data available for these unsurveyed mills to develop adequate design criteria on which to base "retrofit costs." Therefore those costs developed for the surveyed mills which are based on the design criteria shown in Table 188 approximate retrofit costs for the unsurveyed mills. The total retrofit costs for the entire bleached kraft segment were derived using the procedures described below.

Surveyed Mills

Two of the twenty-two bleached kraft mills listed in Table 186, required no additional capital costs to achieve compliance. Improved operation and additional chemical usage appeared to be the probable solution for these mills. The remaining twenty mills require various improvements in existing treatment facilities in order to achieve the

TABLE 187

BASIS FOR RETROFIT COST DETERMINATION

The following list represents the additional removal requirements to be achieved by existing primary and secondary treatment facilities.

Tons/ Day	MGD	BOD #/Day	Added Treatment Required	TSS #/Day	Added Treatment Required
			Groundwood Segment		
560	13.0	6200	Aerators + 3 days retention	4000	Chemical feed only
220	5.0	600	Aerators only	in compliance	None
75	2.0	300	Aerators only	"	None
			Sulfite Segment		
300	17.0	300	Aerators only	500	none
100	4.0	600	Aerators only	In compliance	None
			Soda Segment		
600	17.0	11000	Aerators + 6 days retention	24000	Chemical feed + sludge handling
300	12.0	10000	Aerators + 8 days retention	24000	Chemical feed + sludge handling
			Deink Segment		
850	18.0	300	Aerators only	3000	Chemical feed only
400	7.0	8200	Aerators + 4 days retention	2700	Chemical feed only
320	6.0	6000	Aerators + 3 days retention	In compliance	None
200	3.0	1000	Aerators only	3000	Chemical feed
100	2.0	300	Aerators only	3000	Chemical feed
			Fine Segment		
375	2.5	270	Aerators only	In compliance	None
200	2.0	450	Aerators only	2000	Chemical feed

additional BOD_5 and TSS removals shown. The design criteria shown in Table 188 applies for from one to as many as four mills, all of which are included in the twenty surveyed mills. The costs to provide the additional treatment indicated are shown in Table 194 under the surveyed mills section. The retrofit costs used for the various treatment levels required are shown in Table 191.

Unsurveyed Mills

The ten mills that require additional treatment facilities are listed in Table 193, showing mill size and wastewater volume for each mill. The average mill size is 1092 kkg/day (1200 T/D) and volume is 113.4 MLD (30 MGD); therefore, the retrofit costs developed for the surveyed mills that averaged 910 kkg/day (1000 T/D) and 121 MLD (32 MGD) were used to determine retrofit costs for these unsurveyed mills. Using Table 188, it can be seen that there are ten surveyed mills requiring from two to ten days additional retention time in their aeration basin. The ten unsurveyed mills all use aeration basins and it was assumed that the amount of additional treatment known to be required by the surveyed mills could reasonably be expected to be required by the unsurveyed mills. Therefore the retrofit costs developed for the surveyed mills, increased by a factor of 1.2 to reflect the larger size of the unsurveyed mills was used to determine the retrofit cost for these mills. It was also assumed that the number of mills requiring the differing levels of treatment would be the same for the ten unsurveyed mills as was experienced by the ten surveyed mills. The results of these calculations are shown in Table 194. The total retrofit costs for the entire segment is also shown in this table.

Tissue Segment

The tissue segment includes the tissue made from virgin pulp and tissue (made from waste paper) subcategories. BPCTCA for the former subcategory is primary treatment and for the latter, primary treatment plus biological treatment. The thirteen mills listed in Table 186 are those surveyed mills that require the determination of retrofit costs. In addition, there are eleven mills that were not surveyed for which retrofit costs must be determined. There is insufficient data available for these unsurveyed mills to develop adequate design criteria on which to base retrofit costs. Therefore, those costs developed for the surveyed mills which are based on the design criteria shown in Table 189 were used to determine approximate retrofit costs for the unsurveyed mills. The total retrofit costs for the entire tissue segment were derived using the procedures described below.

Surveyed Mills

The surveyed mills listed under the tissue segment in Table 186, require various improvements in existing treatment facilities in order to achieve the additional BOD_5 and TSS removals shown. The design criteria shown in Table 189 were derived by grouping the mills by size and whether they used predominantly virgin pulp or waste paper. The first three treatment levels shown in Table 189 are for ten mills that

TABLE 188

BASIS FOR RETROFIT COST DETERMINATION

The following list represents the additional removal requirements to be achieved by existing primary and secondary treatment facilities in the bleached kraft segment.

ALL ASB TREATMENT FACILITIES

OF ills	Tons/ Day	MGD	BOD #/Day	Added Treatment Required	TSS #/Day	Added Treatment Required
	320	6.0	2400	Aerators only	1200	None
	1000	55.0	6800	Aerators + 3 days retention	4000	Chemical feed only
	1000	32.0	1000	Aerators only	7000	Chemical feed only
	1000	32.0	3000	Aerators + 2 days retention	28000	Chemical feed + sludge han
	1000	32.0	8000	Aerators + 4 days retention	19000	Chemical feed + sludge han
	1000	32.0	13000	Aerators + 6 days retention	50000	Chemical feed + sludge han + Clarifier for 16 MGD
	1000	32.0	22000	Aerators + 8 days retention	13000	Chemical feed + sludge han
	1000	32.0	36000	Aerators +10 days retention	9000	Chemical feed + sludge han

ALL ACTIVATED SLUDGE TREATMENT FACILITIES

250	7.0	1000	Aeration	3000	Chemical feed
1230	57.0	10000	Provide Activated Sludge plant for 20 MGD	26000	Chemical feed for 57 MGD

NOTE: Added aerators, chemical feed, & sludge handling facilities are to be sized for pounds per day of additional removal required. Additional days retention are to be made for the MGD's shown.

TABLE 189

BASIS FOR RETROFIT COST DETERMINATION

The following list represents the additional removal requirements to be achieved by existing primary and secondary treatment facilities in the tissue segment.

TISSUE FROM 60% PURCHASED PULP OR MORE

AVG. T/D	# OF MILLS	AVG. MGD	BOD #/DAY	TSS #/DAY	ADDED TREATMENT REQUIRED
43	3	2.6	270	270	Chemical feed + full primary system for 1.3 MGD. Use clarifiers
160	4	4.3	460	500	Chemical feed + full primary system for 1.0 MGD. Use clarifiers
135	3	2.3	475	80	Chemical feed + full primary system for 0.6 MGD. Use clarifiers
TISSUE (fwp-90% WASTE PAPER OR MORE)					
25	3	0.4	500	330	Aerators + 4 days retention for 0.4 MGD + sludge handling facilities.

NOTE: Added aerators, chemical feed, & sludge handling facilities are to be sized for pounds per day of additional removal required. Additional days retention are to be made for the MGD's shown. Full primary system includes pumping and sludge handling facilities for flow and pounds per day removal requirements shown.

Table 190

RETROFIT

EFFLUENT TREATMENT COSTS

(All Costs In Thousands Of Dollars)

Mill Size				Retrofit Costs			
Tons/Day	MGD	BOD_r #/Day	TSS_r #/Day	Additional Investment Cost	Additional Operating Cost	Depreciation & Interest	Operating & Maintenance
				Groundwood Segment			
560	13.0	6200	4000	1540	450	230	220
220	5.0	600	None	50	15	10	5
75	2.0	300	None	30	10	5	5
				Sulfite Segment			
300	17.0	300	500	25	10	5	5
100	4.0	600	None	45	10	5	5
				Soda Segment			
600	17.0	11,000	24,000	3870	1040	580	460
300	12.0	19,000	24,000	4430	1130	665	465
				Deink Segment			
400	7.0	8200	2700	1820	435	275	160
320	6.0	6000	None	1430	285	215	70
200	3.0	1000	3000	125	55	20	35

Table 191
RETROFIT
EFFLUENT TREATMENT COSTS

(All Costs In Thousands Of Dollars)

Mill Size				Retrofit Costs			
Tons/Day	MGD	BOD_r #/Day	TSS_r #/Day	Additional Investment Cost	Additional Operating Cost	Depreciation & Interest	Operating & Maintenance
				Bleached Kraft Segment			
320	6	2400	1200	150	40	25	15
1000	55	6800	4000	2980	1130	445	685
1000	32	1000	7000	125	345	20	325
1000	32	3000	2800	3115	1050	470	580
1000	32	8000	1900	3930	1170	590	580
1000	32	13,000	50,000	6570	1730	985	745
1000	32	22,000	13,000	5410	1470	810	660
1000	32	36,000	9000	6250	1630	940	740
				Bleached Kraft Segment Waste Activated Sludge			
250	7	1000	3000	110	95	20	75
1230	57	10,000	26,000	6885	2270	1035	1235

Table 192
RETROFIT
EFFLUENT TREATMENT COSTS

(All Costs In Thousands Of Dollars)

Mill Size Tons/Day	MGD	BOD_r #/Day	TSS_r #/Day	Retrofit Costs Additional Investment Cost	Additional Operating Cost	Depreciation & Interest	Operating & Maintenance
				Fine Segment			
375	2.5	270	None	25	10	5	5
200	2.0	450	2000	85	40	15	25
				Tissue Segments			
43	2.6	270	270	630	175	95	80
160	4.3	460	500	600	165	90	75
135	2.3	475	80	405	125	60	65
				Tissue (fwp)			
25	0.4	520	330	520	105	80	25

Table 193

UNSURVEYED MILLS -- REQUIRING RETROFIT
BLEACHED KRAFT SEGMENT

Code	T/D	MGD
179	1700	NA
173	1500	24.0
149	1500	42.0
177	1500	35.0
167	1600	38.0
180	1300	20.0
171	920	30.0
161	725	36.0
174	720	29.0
187	640	20.0
Average	1200	30.0

Table 194

RETROFIT COSTS FOR THE BLEACHED KRAFT SEGMENT

Surveyed Mills

Number of Mills	Cost Per Mill $,1000	Total Cost $1,000
1	150	150
1	2,980	2,980
4	125	500
3	3,115	9,345
2	3,930	7,860
2	6,570	13,140
2	5,410	10,820
2	6,250	6,250
1	110	220
2	6,885	13,770

Unsurveyed Mills

Number of Mills	Cost Per Mill $1,000	Size Factor	Total Cost $1,000
3	3,115	1.2	11,214
2	3,930	1.2	9,432
2	6,570	1.2	15,768
2	5,410	1.2	12,984
1	6,250	1.2	7,500
		TOTAL COST PER SEGMENT	121,933

Table 195

RETROFIT COSTS FOR THE TISSUE SEGMENT

Surveyed Mills

Number of Mills	Average T/D	Cost Per Mill $1,000	Factor	Total Cost $1,000
3	43	630	1	1,890
4	160	600	1	2,400
3	135	405	1	1,215
3	25	520	1	1,560

Unsurveyed Mills

Mill Code	Average T/D	Cost Per Mill $1,000	Factor	Total Cost $1,000
607	10	630	10/43	147
609	20	630	20/43	293
335	30	630	30/43	440
344	30	630	30/43	440
339	30	630	30/43	440
338	35	630	35/43	513
336	36	630	36/43	527
348	40	630	40/43	586
329	50	630	50/43	735
327	75	630	75/43	1,099
612	210	600	210/160	788
			TOTAL COST PER SEGMENT	13,073

require primary treatment only, i.e., tissue subcategory. The last treatment level is for three mills that require biological treatment, i.e., tissue (FWP) subcategory. The costs to achieve these various treatment levels are shown in Table 192. These costs are multiplied by the number of mills to which they apply and a total for each level of treatment is obtained for each of the four levels of treatment required. These final retrofit costs are shown in Table 195 under the surveyed mills section.

Unsurveyed Mills

The eleven unsurveyed mills that require additional treatment facilities are listed in Table 195. For purposes of developing retrofit costs for these mills, the cost developed for the surveyed mills for the group of mills that averaged 39.1 kkg/day (43 T/D) in size, see Table 192, was used for the first ten mills. To determine the cost for the eleventh unsurveyed mill, 191 kkg/day (210 T/D), the retrofit cost developed for the mills that averaged 146 kkg/day (160 T/D) was used, see Table 192. A correction factor was employed in each calculation to reflect the difference in size between the unsurveyed mill and the surveyed mill. The list of unsurveyed mills and the results of these calculations is shown in Table 195 under the unsurveyed mills section. The total retrofit costs for the entire tissue segment is also shown in this table.

Development of Costs

A sample calculation showing how the costs presented in Tables 151-184 for the BK:BCT subcategory were developed is shown in the following pages.

SAMPLE CALCULATION

FOR: BCT Kraft Subcategory
MILL SIZE: 670 Tons per day

A. Internal Costs (All Costs in $1,000)		Capital Cost Subtotal	Capital Cost Total
1. To Achieve Pretreatment:			
90% of Item 3.	0.9 x 62		55.8
33% of Item 5.	0.33 x 103		34.3
75% of Item 9.	0.75 x 135		101.0
50% of Item 10.	0.5 x 530		265.0
33% of Item 12.	0.33 x 23.5		7.8
33% of Item 13.	0.33 x 11.7		3.9
33% of Item 14.	0.33 x 93		31.0
33% of Item 18.			
Pulp Mill		13.3	
Paper Mill (Three alarms per machine)		6.5	
	0.33 x 19.8		6.6
90% of Item 21. (All disc savealls)			
Two Board Machines, 220 TPD ea.		574.0	
Three tissue machines, 75 TPD ea.		780.0	
	0.9 x 1354		1219.0
20% of Item 23. (For Board Machines)			
	0.2 x 124		24.8
30% of Item 24. (For Tissue Machines)			
	0.2 x 108		21.6
33% of Item 28.	0.33 x 83		27.7
	TOTAL CAPITAL COST		$1,798,500
	INT. & DEP. AT 15%		$ 269,790

2. To achieve BPCTCA

Item	Cost	Item	Cost
3	62.0	14	93.0
5	103.0	18	19.8
9	135.0	21	1354.0
10	530.0	23	124.0
12	23.5	24	108.0
13	11.7	28	83.0

TOTAL CAPITAL COST	$2,647,000
INT. & DEP. AT 15%	$ 397,060

3. To achieve BATEA

Item	Cost	Item	Cost
2	145.0	15	147.0
4	560.0	16	95.0
6	730.0	17	237.0
7	288.0	26	430.0
8	245.0	29	193.0

SUBTOTAL	$3,070,000
PLUS BPCTCA	$2,647,000
TOTAL CAPITAL COST	$5,717,000
INT. & DEP. AT 15%	$ 857,560

4. For NSPS

Cost same as BATEA

TOTAL CAPITAL COST	$5,717,000
INT. & DEP. AT 15%	$ 857,560

B. Internal Power Requirements

1. Power Required To Achieve Pretreatment

			KW-HR/T
90% of Item 3.			0.27
33% of Item 5.			0.50
75% of Item 9.			5.54
50% of Item 10.			0.06
33% of Item 12.			0.01
33% of Item 13.			0.00
33% of Item 14.			0.07
33% of Item 18.			0.00
90% of Item 21.			
$\frac{440}{665} \times 21.$ (Board)		13.89	
$\frac{225}{665} \times 56.2$ (Tissue)		19.01	
	0.9×32.9		29.61
20% of Item 23. (For Board Machines)			
$\frac{440}{665} \times 15.2 = 10.1$			
	0.2×10.1		2.02
20% of Item 24 (For Tissue Machines)			
$\frac{225}{665} \times 11.5 = 3.9$			
	0.2×3.9		0.78
33% of Item 28			0.76
	TOTAL		39.62 KW-HR/TON

2. Power required to achieve BPCTCA

Item	KW-HR/T	Item	KW-HR/T
3	0.30	14	0.22
5	1.51	18	0.00
9	7.38	21	32.90
10	0.11	23	10.10
12	0.03	24	3.90
13	0.00	28	2.27
	TOTAL		58.72 KW-HR/T

3. Power required to achieve BATEA

Item	KW-HR/T	Item	KW-HR/T
2	- 1.30	15	1.73
4	10.80	16	0.57
6	56.50	17	3.70
7	2.43	26	17.16
8	2.34	29	2.20
	SUBTOTAL		96.13
	PLUS BPCTCA		58.72
	TOTAL		154.85 KW-HR/T

4. Power Required for NSPS

Requirements same as BATEA

TOTAL CONNECTED 154.85 KW-HR/T

C. External Cost

1. To Achieve the Pretreatment Level

Design Flow 50 K gal/T x 670 TPD x 1.5/1.3 = 38.7 MGD

Clarifier Flow 38.7 MGD x 47% = 18.2 MGD

Solids 48,819 #/D Dry Solids

53 Million Gal. @ 5 Years 20%

Black Liquor Spill Lagoon 2500 Gal. - D/T x 670 TPD = 1.67 MG

25% of the Cost

Unit Process:	Capital Cost ($1000)	Depreciation and Interest ($1000)	Operation and Maintenance ($1000)
Preliminary Treatment	170	25	12
Mill Effluent Pumping	850	127	70
Primary Clarification	1500	225	24
Sludge Lagoon	540	81	
Flow Monitoring	36	5	39
Outfall	504	76	
Diffuser	240	36	
Foam Control	85	13	
Black Liquor Spill Lagoon	25	4	—
TOTAL COST:	$3,950,000	$592,000	$145,000

2. To Achieve BPCTA Treatment Level

Design Flow 36.5 K gal/T x 670 TPD x 1.5/1.3 = 28.2 MGD

Solids 72% Removed x 103 #/T x 670 TPD x 92% of TSS to Clarifier = 45,712 # Dry Solid/D

BOD 8.4% Removed Through Primary Clarifier

BOD Influent to ASB 91.6% x 67 #/T x 670 TPD = 41,119 #/D

BOD Effluent 7.6 #/T x 670 TPD = 5902 #/D

BOD_r = 35,217 #/D

ASB - Biological = $\frac{35,217 \text{ \#/D}}{50 \text{ \#/Ac-ft./D}}$ = 704 Ac-Ft. = 230 MG

ASB - Detention 28.2 MGD x 14 Days = 395 MG

Detention Controls

Aerators 1.25 $\#O_2/BOD_r$ x 35,217 $\#BOD_r/D$ x 1.6 = 70,434 $\#O_2/D$

= 2934 $\#O_2$/Hr.

H.P. Required = $\frac{2934 \ \#O_2/\text{Hr.}}{1.75 \ \#O_2/\text{HP-Hr.}}$ = 1676 H.P.

Black Liquor Spill Lagoon 75% of the Cost

Unit Process:	Capital Cost ($1000)	Depreciation and Interest ($1000)	Operation And Maintenance ($1000)
Aerators	1700	225	200
ASB	4000	600	151
Vacuum Filter	900	135	205
Press	200	30	28
Flow Monitoring	32	5	
Black Liquor Spill Lagoon	75	11	
TOTAL COST:	$6,907,000	$1,036,000	$584,000

3. To Achieve BATEA Treatment Level

Design Flow 27 K gal/T x 670 TPD x 1.5/1.3 = 20.9 MGD

Caustic Flow 20.9 MGD (0.2) = 4.2 MGD

Unit Process:	Capital Cost ($1000)	Depreciation and Interest ($1000)	Operation And Maintenance ($1000)
Mixed Media Filtration	1700	255	300
Flow Monitoring	28	4	
Mini Lime	840	126	154
Mill Effluent Pumping	580	87	45
TOTAL COST:	$3,148,000	$472,000	$499,000

4. To Achieve NSPS Treatment Level:

The calculations for NSPS are the same as those for the previous treatment levels.

Unit Process:	Capital Cost ($1000)	Depreciation and Interest ($1000)	Operation And Maintenance ($1000)
Preliminary Treatment	130	20	8
Mill Effluent Pumping	580	87	45
Primary Clarification	1000	150	20
Sludge Lagoon	480	72	
Aerators	1400	210	155
ASB	3500	525	133
Vacuum Filtration	1500	225	244
Press	200	30	31
Flow Monitoring	28	4	35
Outfall	371	56	
Diffuser	100	15	
Foam Control	65	10	
Air Flotation	440	66	42
Secondary Clarification (With Recycle)	2700	405	290
Black Liquor Spill Lagoon	95	14	___
TOTAL COST:	$12,589,000	$1,889,000	$1,003,000

D. External Power Requirements

1. Power Required for Systems Added to Achieve the Pretreatment Level.

Unit Process:	KW-Hr/Ton
Preliminary Treatment	0.20
Mill Effluent Pumping	10.42
Primary Clarification	0.61
TOTAL:	11.21 KW-Hr/Ton

2. Power Required for Systems Added to Achieve the BPCTCA Treatment Level.

Unit Process:	KW-Hr/Ton
Aerators	40.89
Vacuum Filtration	1.23
Press	0.41
SUBTOTAL:	42.53
Pretreatment	11.21
TOTAL:	53.74 KW-Hr/Ton

3. Power Required for Systems Added to Achieve the BATEA Treatment Level.

Unit Process:	KW-Hr/Ton:
Mill Effluent Pumping	5.72
Minimum Lime	10.22
SUBTOTAL:	15.94
To Achieve BPCTCA:	53.74
TOTAL:	69.68

4. Power Required for System to Achieve the NSPS Treatment Level.

Unit Process	KW-Hr/Ton
Preliminary Treatment	0.20
Mill Effluent Pumping	5.52

Primary Clarification	0.41
Aeration	31.69
Vacuum Filtration	1.23
Press	0.20
Air Flotation	0.41
Secondary Clarification	3.27
TOTAL:	42.93 KW-Hr/Ton

Cost of SSL Recovery

A study of the economics of an MgO recovery system for a 453.5 kkg (500 ton) per day magnesium bisulfite pulp mill was conducted and the results are discussed below and presented in Table 196. Costs were computed at Fall 1974 prices. The Engineering News Record was used to adjust costs that were not directly available at 1974 prices.

It was found that for a new sulfite mill producing 453.5 kkg (500 ton) per day of unbleached pulp it would cost $774,000 per year or $4.63 per kkg ($4.20 per ton) of pulp to cover the fixed plus operating costs of the MgO recovery system. The firing of spent liquor in the recovery furnace produces a net flow of 73,550 kkg (162,000 pounds) of steam per hour from the boiler. Therefore, the capacity of the power boiler required for a new mill can be reduced from 109,415 kg (241,000 pounds) to 35,865 kg (79,000 pounds) of steam per hour. The lower cost of the smaller boiler results in a $1,040,000 savings in capital expense which could be credited to offset a fraction of the capital expenditure of $31,250,000 required for the MgO recovery installation. Since the total capital cost for the MgO recovery system includes the equipment required for the regeneration of magnesium bisulfite cooking liquor, the cost for a new mill would also reflect the savings incurred by the elimination of the liquor preparation system that would have been installed in a calcium base sulfite mill. This capital savings amounts to $621,000.

For an existing sulfite mill, the capital savings on equipment mentioned above were not included in the cost calculations. The total fixed plus operating cost for the addition of an MgO recovery system in an existing mill was determined to be $1,059,000 per year or $6.28 per kkg ($5.70 per ton) of pulp produced.

The operating costs include additional costs and savings realized due to the operation of the MgO recovery system compared with the operating costs of a calcium base sulfite mill without recovery. Costs under consideration included the difference in costs of chemicals, electricity, manpower, maintenance, and fuel.

The cost of chemicals was determined by comparing the cost of chemicals for calcium base liquor to the cost of makeup chemicals for magnesium base liquor with a chemical recovery system. The chemical savings amounts to $1,015,000 per year for the magnesium base liquor.

The additional electrical requirement for the operation of the liquor recovery system is 181 KWH per kkg (164 KWH per ton) of pulp. At an average cost of $12 per 1000 KWH, this results in an electrical cost of $360,000 per year. Operation of the recovery system requires four men at an estimated annual cost of $16,000 per man, which covers the costs of salary, overtime and overhead. The manpower requirements of the MgO recovery system amount to $256,000 annually.

Maintenance cost information was supplied by an equipment manufacturer (326). The total maintenance cost for the recovery system amounted to $500,000 per year. This figure is a typical maintenance expenditure for an existing MgO recovery system of similar size. However, it was noted that this figure could probably be reduced in the future due to familiarization with the recovery process and design revisions in the trouble areas. The equipment manufacturer also supplied order of magnitude capital cost estimates for power boilers and the MgO recovery system.

Fixed costs of the recovery system include interest and depreciation and were calculated as 15% of the total investment. The fixed costs amount to $4,688,000 per year.

The greatest savings incurred by the installation of an MgO recovery system is the savings in fuel due to the burning of spent sulfite liquor. The net heat available from the recovery boiler was calculated by first determining the gross heat produced in the boiler and then subtracting the heat required to operate the recovery system. Heat required for the system includes the heat needed to evaporate the liquor from 13% solids to 56% solids in a qunituple effect evaporator plus heat needed to evaporate the remaining water in the liquor fired to the boiler plus steam required to operate soot blowers. Converting the net heat available to its equivalent amount of No. 6 fuel oil, at $10 per barrel, a saving of $3,730,000 per year results.

With the relative cost of fuel rising, MgO recovery becomes more attractive. For the 453.5 kkg (500 ton) per day mill used in the calculations, the break even point for the magnesium base liquor recovery system installed in a new mill would be at a price of No. 6 fuel oil of $12.10 per barrel. For an existing mill the system would break even at a fuel oil cost of $12.85 per barrel. These break even figures are calculated using Fall 1974 prices and are contingent on the stability of other prices used in the computations.

It should also be noted that a mill would not consider a capital expenditure solely on economic considerations unless that expenditure would be paid for in a minimum of 5 years through profits generated through the operation of the system. Therefore, the evaluation indicates that a mill would not make the decision to install an MgO recovery system purely for economic gain but other factors may justify the installation of recovery systems, such as physical location of the mill, shortage of chemicals, or pollution control, since the annual cost of the MgO system is generally less than two percent of the selling price of the paper products.

In addition, this general analysis does not eliminate the possibility of a specific mill making an MgO recovery system profitable. The variation in capital cost of the recovery system is the determinant in the profitability of the specific installation. One mill has reported that the MgO recovery installation in their 544 kkg (600 ton) per day mill showed an appreciable return one year after it was put on line in September 1969 (327). The profitability of the system can be attributed to the modification of existing equipment, availability of space and short piping runs.

Table 196

ECONOMICS OF MgO RECOVERY - NEW MILL 500 T/D

VARIABLE OPERATING COSTS

		$1000/yr.
Base Costs	Chemical Savings of MgO System as compared to Ca.	+ 160
Sulfur Costs	Chemical Savings of MgO System as compared to Ca.	+ 855
Electrical Costs	$12/1000 KWH	- 360
Manpower Costs	4 men, 4 shifts, $16,000/man	- 256
Maintenance Costs	Total MgO Recovery System	- 500
	Savings due to smaller power boiler required	+ 25
	Savings due to elimination of Ca Base Liquor Preparation	+ 11
Net Heat Available Expressed as #6 Oil	71.3 lb. #6 Oil/10^6 BTU #6 Oil @ $10./bbl.	+3730
	NET OPERATING COST	+3665

FIXED COSTS

Fixed Costs - Recovery System	15% of Investment	-4688
Fixed Costs - Power Boiler	Fixed cost savings incurred by reduction in Power Boiler size	+ 156
Fixed Costs - Liquor Prep.	Savings incurred by eliminna-tion of Ca Base Liquor preparation	+ 93
	TOTAL FIXED COST	-4439

TOTAL YEARLY COSTS

Total Cost	Total Fixed Cost + Net Operating Cost	- 774

+ Denotes Credit
- Denotes Cost

Table 196 (Cont'd)

ECONOMICS OF MgO RECOVERY - NEW MILL 500 T/D

INVESTMENT COSTS

		Million Dollars
Investment Cost	Cost of Total recovery system, Estimate by Babcock & Wilcox	31.25
Investment Savings	Due to Reduction in power boiler size	1.04
Investment Savings	Due to elimination of Ca base liquor making system	.62
	NET INVESTMENT COST	29.59

ECONOMICS OF MgO RECOVERY - EXISTING MILL 500 T/D

VARIABLE OPERATING COSTS

		$1000/yr.
Base Costs	MgO w/recovery compared to Ca w/o recovery	+ 160
Sulfur Costs	Mg/O w/recovery compared to Ca w/o recovery	+ 855
Electrical Costs	$12/1000 KWH	- 360
Manpower Costs	4 men, 4 shifts, $16,000/man	- 256
Maintenance Costs		- 500
Neat Heat Available	Expressed as No. 6 Fuel Oil @ $10/bbl	+3730
	NET OPERATING COST	+3629
	FIXED COST 15% of Investment	-4688
TOTAL YEARLY COST		
Operating and Fixed Cost		-1059
TOTAL INVESTMENT COST		+31,250

Relative Costs of Short Detention Time Biological Treatment Systems

In order for the mills located in the northern climates to meet the effluent limitations, it is necessary that they use an aerobic biological system which minimizes the effects of cold climate. Since decreases in treatment effectiveness across biological systems for mills operating in Northern climates can be related to the temperature drop across the system, systems utilizing short detention times which minimize the heat transfer through the system should be used in order to minimize the impacts of temperature upon treatment effectiveness.

Cost curves have been developed for each biological treatment technology normally used by the pulp and paper industry. These curves and the resultant costs for "model" facilities are general and are subject to variations when applied on a mill by mill basis. The model mill is representive of a 608 kkg (670 tons)/day bleached kraft fine papers mill and the raw waste loads and final effluent qualities shown in Table 150 were used as the basis of the cost curves.

Several unit processes are common to all of the aerobic biological treatment system considered. The additional processes included in the systems are (1) preliminary treatment, (2) mill effluent pumping, (3) primary clarification, (4) neutralization, (5) secondary clarification, (6) foam control, (7) outfall with multi-port diffuser, (8) air flotation, (9) vacuum filtration, (10) V-press, and (11) emergency sludge lagoon.

The four alternative treatment systems considered were:

1. Conventional Activated Sludge - Conventional activated sludge systems are normally designed with a detention time of 6-8 hours. Because of the short detention times, this process is subject to upsets because of variations in wastewater flows and shock loadings. An equalization basin (12-hour detention) was included in this system to minimize process shock loadings and upsets of the treatment systems. The process design criteria were:

Detention Time	6-8 Hours
F/M Ratio	0.3-0.5
Organic Loading	50# BOD/1000 FT^3
02 Transfer	1.75# 02/HP-Hr.
02 Requirement	1.0# 02/BODR

2. Extended Aeration - Because of the larger detention times in the aeration basin, process upsets will not be as pronounced as with a short-term activated sludge system. Therefore, an equalization basin has not been included. The process design criteria were:

Detention Time	30 Hours
F/M Ratio	0.1
Organic Loading	20-40# BOD/1000 FT^3
02 Transfer	1.75# 02/HP-Hr.
02 Requirement	1.25# 02/#BODR

3. High-Purity Oxygen - A manufacturer of high-purity oxygen equipment was contacted to obtain suggested design criteria and budgetary cost estimates for a high-purity oxygen system. An equalization basin was included in the system for minimization of process upsets. From the manufacturer's data and other data, the following design criteria were determined:

Detention Time	1.8 Hours
F/M Ratio	0.65
Organic Loading	138# BOD/1000 FT^3

4. Rotating Biological Surfaces - Rotating Biological Surfaces have received limited use up to the present by the pulp and paper industry in northern climates. An enclosure was provided to house the process equipment and an equalization basin was provided. The design criteria were:

Detention Time	2.0 Hours
F/M Ratio	1.5
Organic Loading	2.2 Gal/Day/FT^2

As mentioned previously, minimization of temperature reduction through an aerobic biological treatment system is essential. Each of the above described systems will result in minimizing temperature reduction through the system because of their relatively short detention times. The equalization basin suggested for use in several of the systems is a tank which would be constructed at the maximum economical depth to minimize surface area. Temperature reductions through these equalization basins would be less than those for a comparable aerated facility where mixing exposes substantially additional water to the ambient temperature.

The extended aeration system considered uses an aeration period of approximately 30 hours. This system would be more susceptible to a temperature drop, with a corresponding increases in BOD5 and suspended solids in the effluent. This is primarily due to the detention time and the exposed surface area.

Figures 119 through 122 are presented to show the relative costs of achieving the effluent limitations for a model mill using either conventional activated sludge, extended aeration, oxygen activated sludge, or rotating biological surfaces treatment systems, respectively. The costs were prepared by the same methods as those presented in Tables 151 through 184. The total annual operating costs, also shown on Figures 119 through 122, are comprised of labor costs for operation and maintenance associated with the facility, power, chemicals and depreciation. Interest was assumed to be 15 percent of the capital expenditure.

ENERGY REQUIREMENTS

FIGURE 119
ACTIVATED SLUDGE

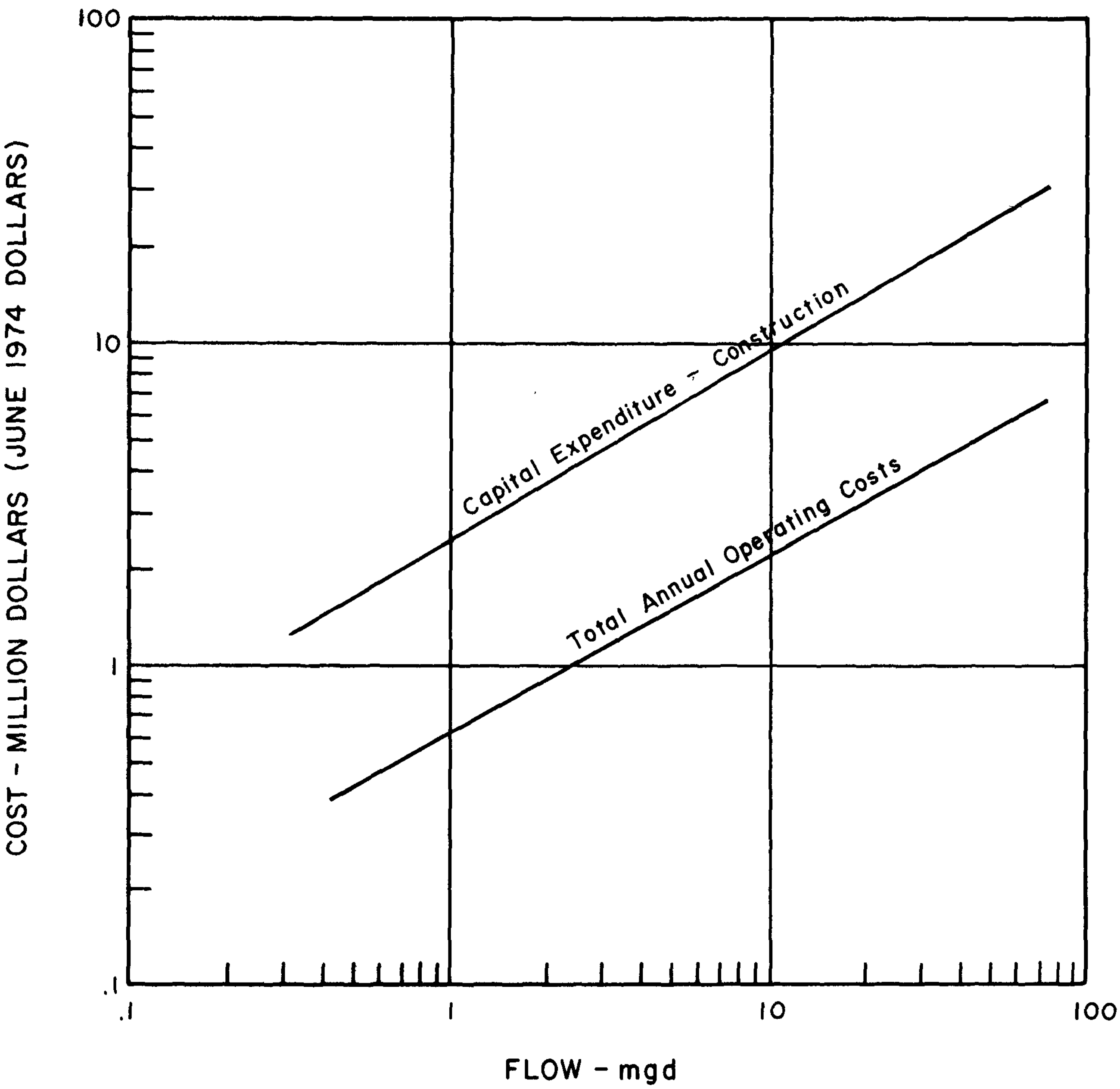


FIGURE 120
EXTENDED AERATION

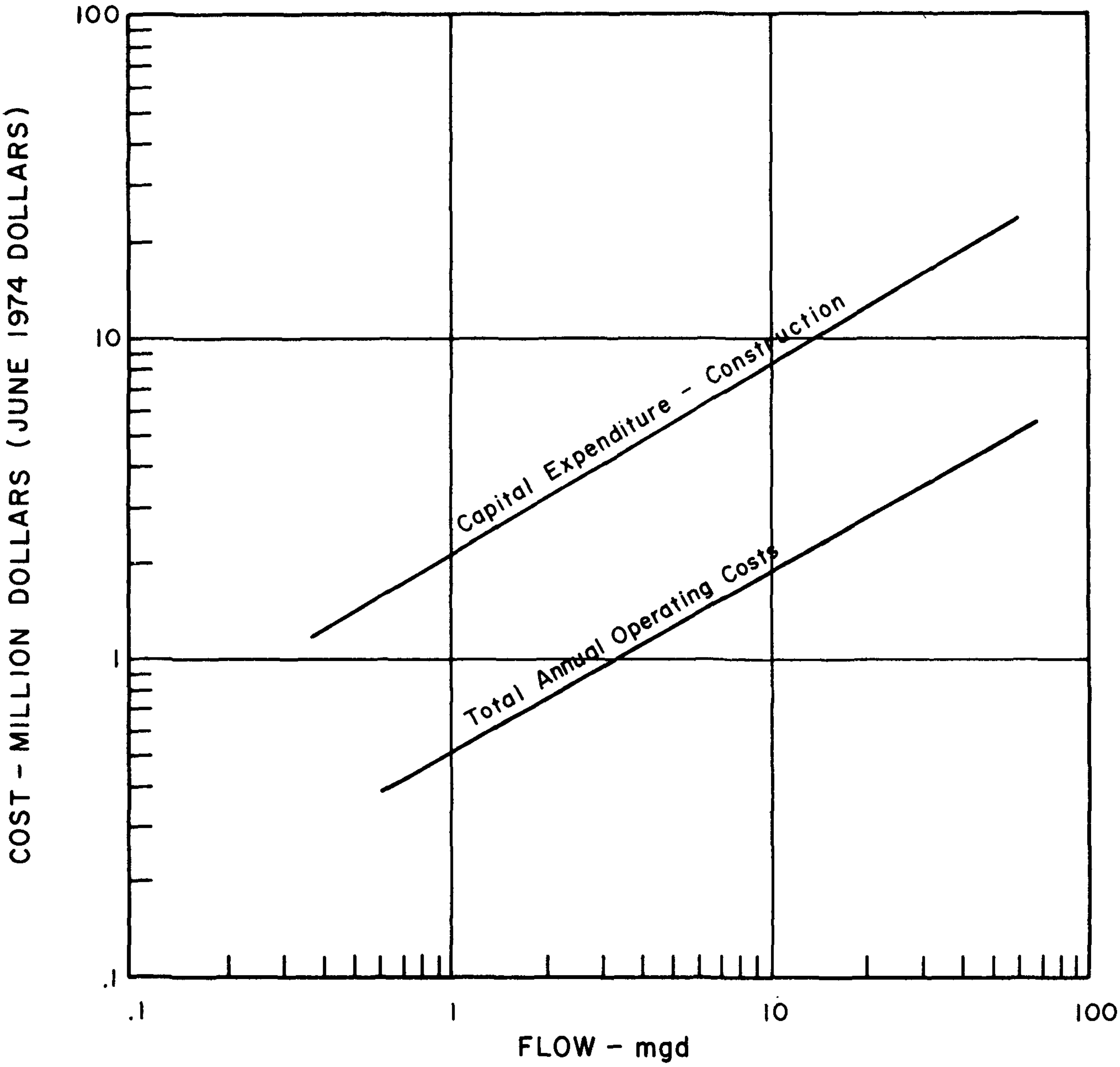


FIGURE 121
HIGH PURITY OXYGEN

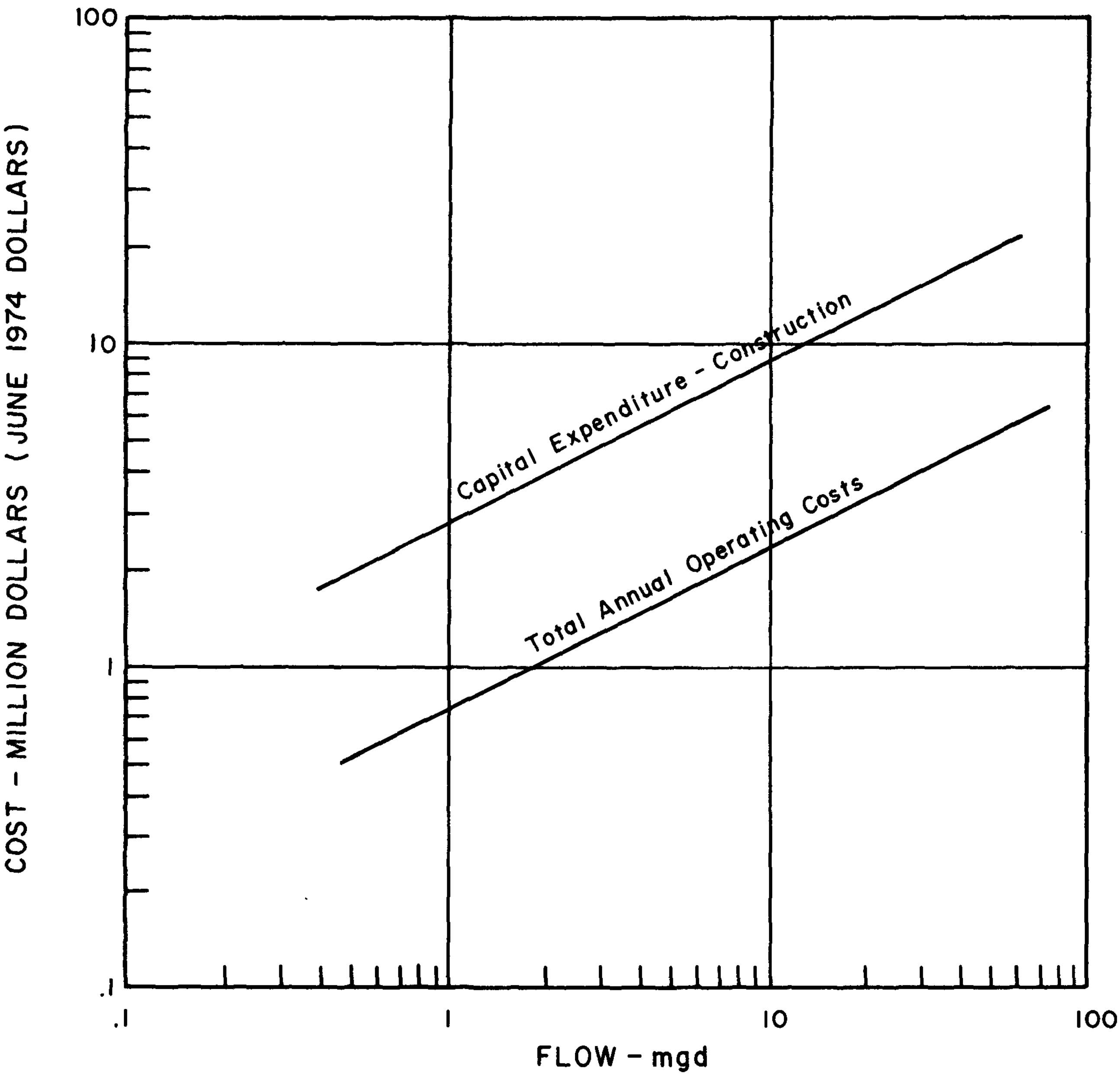
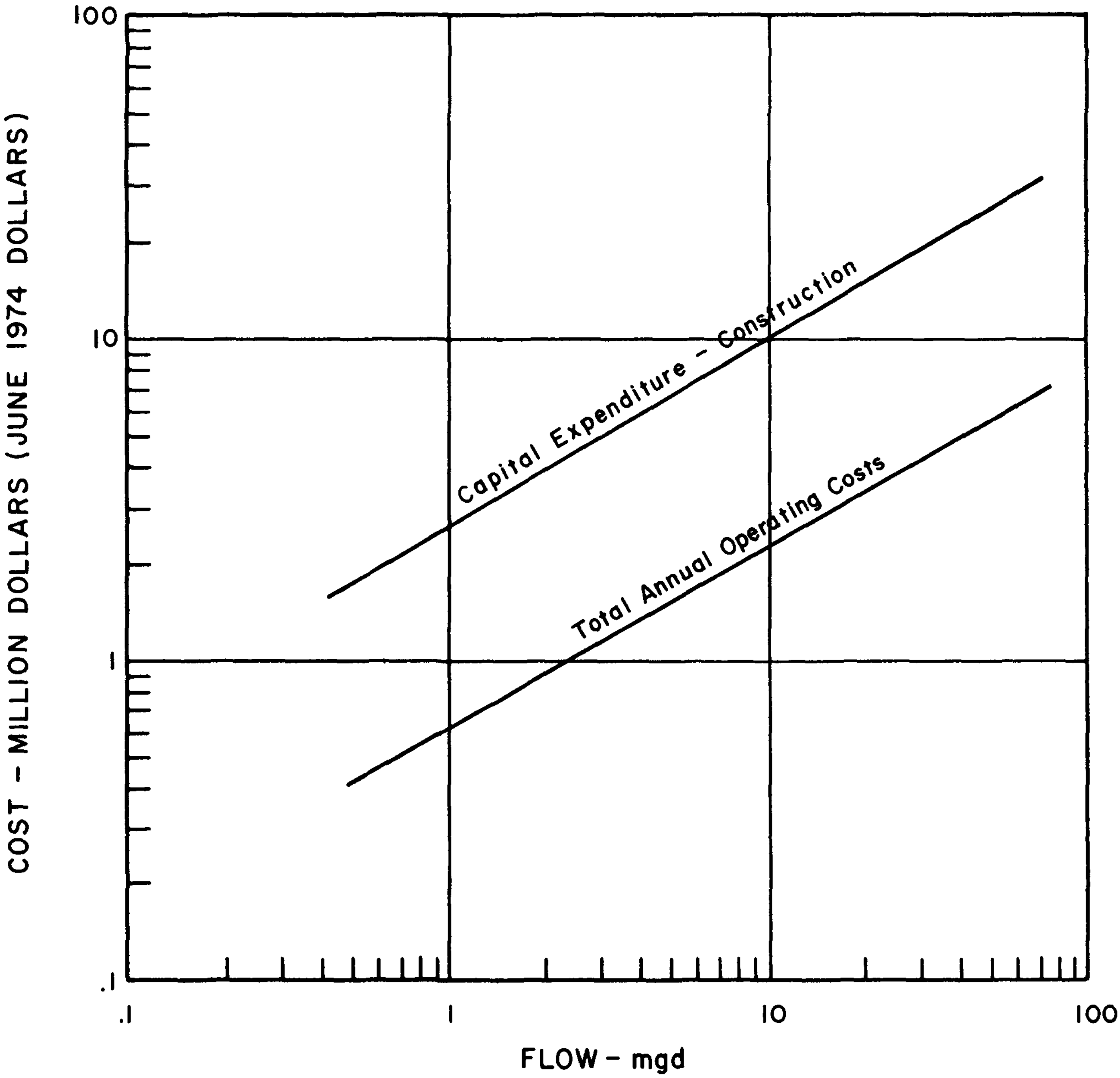


FIGURE 122
ROTATING BIOLOGICAL SURFACES



The costs presented in Tables 151 through 184 include energy costs. Costs for electrical energy are shown in Table 197 for secondary treatment with aerated stabilization basins and Table 198 for activated sludge in place of ASB. Such costs vary only slightly on a per-unit-of-production basis among mills of the same subcategory. Plant operation for 360 operating days per year have been assumed, and a unit cost of 2.0 cents per kwh was used. In cases where incineration of sludge is practiced, there may be a heat requirement or heat recapture, depending upon equipment employed, but no overall heat gain or loss from this cause is assumed on an industry-wide basis.

MgO liquor recovery is included with the base mill for the sulfite and dissolving sulfite subcategories.

Electrical energy projections at various levels of treatment are shown in Table 199, on a per kkg (ton)-of-production basis, using aerated stabilization basins, and Table 200 is for activated sludge in a place of ASB.

For approximate comparison purposes, total mill energy requirements per kkg (ton) (excluding internal and external treatment) are shown in Table 201.

NON-WATER QUALITY ASPECTS OF CONTROL AND TREATMENT TECHNOLOGIES

Air Pollution Potential

There are several potential air pollution problems associated with the external treatment of effluents from mills in each of the subcategories.

When properly designed and operated, primary and biological treatment do not produce odors associated with anaerobic decomposition. However, biological treatment of the waste waters of these subcategories does result in very localized odors, especially when mechanical aeration is employed. The odor is characteristic of wood extractives.

Odors can also arise from improper land disposal of liquid sludges as a result of their anaerobic decomposition. These derive primarily from organic acids and hydrogen sulfide produced on reduction of sulfates dissolved in the water content of the sludges. Dewatering prior to disposal on the land inhibits such decomposition, thus reducing odors. The use of sanitary landfill practices will also mitigate odor problems.

Sludge lagooning usually takes place on large sites. The low level of odor produced is generally confined to company property. The practice of decanting free water from lagoons and returning it to the treatment system has noticeably reduced the odor level in their immediate environs.

Table 197
AERATED STABILIZATION BASIN
ELECTRIC POWER COST
$1000 Per Year

Subcategory	Mill Size Ton/Day	Pretreatment	BPCTCA	BATEA	NSPS
Papergrade Sulfite	530	164	712	918	742
Market Sulfite	530	164	660	860	765
Low Alpha Sulfite	550	115	585	985	983
High Alpha Sulfite	550	115	913	1289	1088
Deink	230	44	167	178	178
Dissolving Kraft	600	113	443	981	853
Market Kraft	700	129	424	1000	803
BCT Kraft	670	248	550	1098	1017
Fine Kraft	670	245	451	990	946
Groundwood Chemi/Mech	300	35	188	353	346
Groundwood Thermo/Mech	300	23	140	302	298
Groundwood C-M-N	150	21	66	149	153
Groundwood Fine	300	49	128	293	293
Soda	300	95	237	477	441
Non-Integrated Fine	100	13	29	37	39
Non-Integrated Tissue	110	26	62	70	71
Non-Integrated Tissue (fwp)	110	25	75	80	80

Table 198
ACTIVATED SLUDGE
ELECTRIC POWER COST
$1000 Per Year

Subcategory	Mill Size Ton/Day	Pretreatment	BPCTCA	BATEA	NSPS
Papergrade Sulfite	530	164	641	846	665
Market Sulfite	530	164	665	865	723
Low Alpha Sulfite	550	115	520	919	808
High Alpha Sulfite	550	115	879	1255	1145
Deink	230	44	174	185	173
Dissolving Kraft	600	113	448	986	806
Market Kraft	700	129	406	982	743
BCT Kraft	670	248	540	1088	992
Fine Kraft	670	245	458	996	907
Groundwood Chemi/Mech	300	35	184	350	329
Groundwood Thermo/Mech	300	23	139	301	297
Groundwood C-M-N	150	21	72	155	145
Groundwood Fine	300	49	129	294	281
Soda	300	95	235	475	419
Non-Integrated Fine	100	13	29	38	37
Non-Integrated Tissue	110	26	62	74	69
Non-Integrated Tissue (fwp)	110	25	78	83	76

Table 199

AERATED STABILIZATION BASIN
ELECTRICAL ENERGY REQUIREMENTS FOR TREATMENT
kwh/ton

Subcategory	Mill Size Ton/Day	Pretreatment	BPCTCA	BATEA	NSPS
Papergrade Sulfite	160	47.1	196.4	249.4	205.2
	530	42.4	184.0	237.2	191.7
Market Sulfite	160	47.1	166.3	218.1	204.0
	530	42.4	170.7	222.4	197.7
Low Alpha Sulfite	550	28.6	145.8	245.4	244.9
High Alpha Sulfite	550	28.6	227.3	321.1	270.9
Deink	80	27.7	115.6	120.1	--
	230	26.2	99.4	105.8	105.9
	500	25.7	96.2	102.3	105.2
Dissolving Kraft	600	25.8	101.1	224.0	--
	1000	25.2	101.6	222.9	194.7
Market Kraft	350	25.6	83.4	198.0	--
	700	25.2	83.0	195.6	157.2
BCT Kraft	250	53.0	115.4	223.6	--
	670	50.8	112.4	224.5	208.0
	1300	49.7	112.4	221.6	204.6
Fine Kraft	250	50.6	92.5	204.0	--
	670	50.1	92.2	202.3	193.5
	1300	49.6	91.8	200.6	193.3
Groundwood Chemi/Mech	100	18.9	90.9	165.9	159.1
	300	16.2	85.9	161.4	157.8
	600	15.7	85.0	160.5	155.9
Groundwood Thermo/Mech	100	10.7	69.0	142.7	141.3
	300	10.7	64.0	138.1	136.3
	600	10.7	62.8	136.9	135.1
Groundwood C-M-N	75	21.6	64.4	140.4	145.9
	150	18.9	59.9	135.8	139.5
	500	17.0	58.1	133.7	134.4
Groundwood Fine	150	23.6	58.9	134.8	139.5
	300	22.2	58.5	134.0	134.0
	550	22.0	56.3	131.8	133.1
Soda	300	43.3	108.2	217.6	201.3
	700	42.2	107.7	215.8	197.5
Non-Integrated Fine	30	18.0	41.4	51.0	--
	100	18.0	40.2	50.6	52.8
	280	18.0	39.8	49.9	50.2
Non-Integrated Tissue	15	31.8	80.4	90.1	--
	35	31.8	78.5	87.9	--
	110	31.8	77.4	86.7	88.1
	450	31.8	76.7	85.9	85.1
Non-Integrated Tissue (fwp)	15	31.7	97.0	103.1	--
	35	31.7	94.3	100.3	--
	110	31.7	93.9	99.9	99.8
	450	31.7	92.8	98.6	97.9

Table 200
ACTIVATED SLUDGE
ELECTRICAL ENERGY REQUIREMENTS FOR TREATMENT
kwh/ton

Subcategory	Mill Size Ton/Day	Pretreatment	BPCTCA	BATEA	NSPS
Papergrade Sulfite	160	47.1	175.0	228.1	179.1
	530	42.4	165.7	218.6	172.0
Market Sulfite	160	47.1	237.8	289.6	194.1
	530	42.4	171.8	223.5	186.9
Low Alpha Sulfite	550	28.6	129.4	228.9	201.3
High Alpha Sulfite	550	28.6	218.9	312.7	285.3
Deink	80	27.7	107.1	111.6	--
	230	26.3	103.7	110.1	102.9
	500	25.7	101.4	107.5	100.3
Dissolving Kraft	600	25.8	102.2	225.1	--
	1000	25.1	97.0	218.3	184.0
Market Kraft	350	25.7	82.4	196.9	--
	700	25.3	79.5	192.1	145.4
BCT Kraft	250	53.0	115.4	223.7	--
	670	50.8	110.4	222.5	202.9
	1300	49.7	109.3	218.6	199.5
Fine Kraft	250	50.6	97.4	208.9	--
	670	50.1	93.6	203.7	185.5
	1300	49.6	93.2	202.0	182.8
Groundwood Chemi/Mech	100	18.9	92.3	167.3	153.6
	300	16.2	84.1	159.6	150.4
	600	15.7	82.2	157.7	148.8
Groundwood Thermo/Mech	100	10.7	71.8	145.5	144.1
	300	10.7	63.5	137.6	135.8
	600	10.7	62.6	136.7	134.9
Groundwood C-M-N	75	21.6	73.5	149.5	140.4
	150	18.9	65.3	141.2	132.1
	500	17.0	59.9	135.5	127.1
Groundwood Fine	150	23.6	61.7	137.6	131.2
	300	22.2	58.9	134.4	128.5
	550	22.0	57.3	132.8	127.1
Soda	300	43.3	107.3	216.7	191.2
	700	42.2	104.6	212.7	185.4
Non-Integrated Fine	30	18.0	41.4	59.2	--
	100	18.0	40.2	55.0	50.8
	280	18.0	39.8	52.2	48.1
Non-Integrated Tissue	15	31.8	80.4	92.3	--
	35	31.8	78.5	96.4	--
	110	31.8	77.4	91.9	85.6
	450	31.8	76.7	89.2	82.9
Non-Integrated Tissue (fwp)	15	31.7	107.9	114.0	--
	35	31.7	101.6	107.5	--
	110	31.7	97.1	103.1	94.5
	450	31.7	93.4	99.2	93.6

Table 201

Total Mill Energy Requirements*

Subcategory	Steam Mil. BTU/ton	Elect. KWH/ton	Total KWH/ton	Pre	Additional KWH/T at		
					BPCTCA	BATEA	NSPS
Papergrade Sulfite	23	1250	7985	42	184	237	192
Dissolving Sulfite	23	1600	7735	29	146	245	245
Deink	11	500	3720	26	99	106	106
Dissolving Kraft	24	1050	8075	26	101	224	195
Market Kraft	23	1000	7735	25	83	196	157
BCT Kraft	24	1300	8325	51	112	225	208
Fine Kraft	24	1400	8425	50	92	202	194
Groundwood Chemi-Mech.	17	1700	6680	16	86	161	158
Groundwood Thermo-Mech.	16	1800	6485	11	64	138	136
Groundwood CMN	15	1800	6190	19	60	136	140
Groundwood Fine	15	1900	6290	22	59	134	134
Soda	24	1300	8325	43	108	218	201
Non-Integrated Fine	9	700	3335	18	40	51	53
Non-Integrated Tissue	7	425	2475	32	77	82	88
Non-Integrated Tissue (FWP)	8	425	2765	32	77	86	85

* Cumulative energy requirements

Incineration of sludges produced in the effluent treatment processes can, without appropriate control equipment, result in the discharge of particulates to the atmosphere. However, emission control devices are available to meet state regulatory requirements in most instances. Incinerators are either sold with integral emission control appliances or are equipped with them on installation. Gaseous pollutant emissions from such incinerators are negligible.

Internal controls which effect a reduction in fiber and additive losses, such as savealls, recycling of process waters, and removal of dregs and grits in the kraft recovery process, are not producers of air pollution. On the other hand, recovery of cooking chemicals in the kraft process, which, in addition to its principal function of conserving expensive raw materials and heat, also serves to reduce chemical waste load, produces odorous sulfur compounds. When these escape the recovery furnace to the atmosphere, they become the major air pollution problems of the mill. These emissions and measures to control them are described in a report prepared for an EPA predecessor agency entitled "Control of Atmospheric Emissions in the Wood Pulping Industry" (125).

Noise Potential

There are no official records of public noise problems arising from the operation of effluent treatment works by the subject subcategories of mills. However, on the basis of many year's of observation of industry operations, it can be stated that public complaints engendered by such noise are very infrequent. This is due in all probability to the remote location of most large treatment works or to their confinement, in some instances, to manufacturing or utility areas. Also, the noise level of most of the devices employed for treatment is generally lower than that of some manufacturing machinery.

The sources of noise are for the most part air compressors or mechanical surface aerators supplying air to treatment processes, vacuum pumps and centrifuges involved in sludge dewatering, and fans serving sludge incinerators. With the exception of surface aerators, these devices are most frequently operated in buildings which serve to muffle their noise.

Small surface aerators are generally found in small mills which are more likely to be located closer to habitation. Units of this size, particularly those not driven through gear boxes, produce little noise. The problem of noise emanating from gear boxes is the subject of an extensive investigation by the Philadelphia Gear Company which manufactures many of these units. It is anticipated that this study will lead to a reduction in noise from these sources. Noise produced by the large aerator units which are usually operated away from populated areas is usually neither high-level nor far-carrying.

A new "noiseless" aeration system has been installed in a 32.7-acre reservoir to reaerate 24.5 MGD of waste water from a kraft mill located near an urban area. The system consists of 465 vertical plastic subsurface air pipes supplemented by 195 "air pump" tubes. The only moving parts are blowers to force more than a ton of air per hour into the waste water (160).

It can be concluded that noise produced by equipment used for treating pulp and paper mill effluent is not a major public problem at present. Efforts underway to reduce the noise level of mechanical equipment in general stimulated by industrial health protection programs, will assist in preventing it from becoming one.

Solid Wastes and Their Disposal

Sludge cake resulting from the dewatering of sludge is, to the extent that it could be termed "solid," the only solid waste specifically attendant to the control and treatment technologies practiced by all of the subject subcategories. This subject is covered in Section VII and in a study on solid waste management practices in the pulp and paper industry for EPA's Office of Solid Waste Management Programs (303).

Solid wastes in terms of process residues which require disposal are declining in quantity in some areas of the mills due to more modern practices. The disposal of bark will become less and less a pulp mill disposal problem as the trend to the use of delivered chips, sawdust, etc., intensifies. Where barking is still practiced on a mill's premises, silt is produced in amounts which vary with wet/dry weather, etc., in addition to bark. The bark is most likely to be incinerated in especially designed units by mills in all pulping subcategories except the large bleached kraft mills, or complex mills, which produce sufficient bark to fire a boiler for steam generation. Long washing overflow containing silt and fine bark particles generally joins the steam carrying ash from the mill which is discussed below.

In line with the economic trend of salvaging usable fiber, rejects and screenings are to a greater extent re-refined (groundwood), re-cooked in the chemical pulping processes, or sold. Otherwise, they are incinerated, burned in a bark-fired boiler, or disposed of by landfill. This is also true of broke and trimmings in a paper mill -- they are returned to the process or burned.

Particulate emissions from incineration of bark and other solid wastes can be controlled by effective devices such as bag filters or scrubbers.

Grits and dregs from the causticizing system of kraft and soda recovery plants, inorganic solids, are generally water-carried to a land disposal site.

Intermittent washing of the reaction towers in calcium base sulfite mills (every two months or so) produces a small amount of grits. These are easily dewatered for land disposal or can be sent to ash ponds.

Deink mills do not produce the large quantities of trash which generated in waste paperboard mills because of better quality raw materials. In 1971, deink accounted for only one percent of the industry's solid wastes while the use of waste paper in other processes contributed nine percent (303).

Ash from bark- and coal-fired boilers, screening rejects, in some cases, and other materials as noted above are as a rule discharged hydraulically to ash ponds. There the solids settle and compact and the clear supernatant water is discharged to the mill effluent system. In some instances, ash and rejects are hauled to a disposal area away from the mill site. Wet handling of these materials avoids their being blown into the atmosphere.

Waste paper, garbage, and trash attendant to production or accessory operations and activities are either incinerated on the site or hauled away for disposal by contractors engaged in this business.

Byproduct Recovery

Byproducts can be defined as those materials produced by wood pulping that can be removed from the pulping and/or chemical recovery process and sold. They do not include chemicals recovered and reused in the process such as sodium and sulfur compounds in a kraft operation which are employed in the preparation of fresh cooking liquor.

For the most part, the pulp mill sells the basic material used in marketable by-products to chemical plants which manufacture the final products. These are produced either through purification of the raw materials or by chemical reaction and separation. If preparation of the raw materials for shipment from the pulp mill is required, this operation may contribute a portion of the pulp mill waste load unless the effluent can be absorbed by the recovery plant for its chemical or heat value.

By-Products of Kraft Pulping

Many kraft mills recover two by-products from the pulping process other than chemicals that are reused -- tall oil and crude turpentine (60). These materials are present to the greatest degree in pine species, particularly those common to the south. They are not usually recovered in mills where other woods low in these substances are pulped.

Tall oil is a mixture of the resin and fatty acids present in wood which are saponified during the pulping process and separate from the black liquor during concentration or cooling (162). Southern pine species contain approximately 90 to 150 kg (180 to 300 lb) of this material per kkg (ton) of air dried pulp produced (60). It is skimmed from concentrated black liquor storage tanks in the form of sodium soap (163). Some mills convey the soap directly to tank cars in which it is shipped to chemical plants for use in manufacturing a number of marketable products including detergents, adhesives, paints, disinfectants, special oils, soaps, and plasticizers (164)(163).

Other mills acidulate the soap to produce the oil prior to shipping. This is generally accomplished by adding 30 to 50 percent sulfuric acid to the soap and separating the oil from the dregs by decantation or centrifuging. Some acidulation plants operate on a batch and others on a continuous basis (60). BOD_5 and COD values for tall oil are 0.72 and 1.25 kg (1.58 and 2.76 lb) per kb (lb) of tall oil respectively. The process produces dregs which consist of a strong solution of sodium sulfate together with precipitated lignins and other residues of black liquor origin. These are returned to the pulp mill recovery system in order to reclaim the chemical and heat values contained therein (165). Thus, the wastes from tall oil collection, processing, and shipping are minor in quantity. They consist of wash water from cleaning floors, equipment, and loading platforms and are, for the most part, intermittent in nature.

Pine woods contain from 6 to 18 l of turpentine (1.5 to 4.3 gal.) per kkg (ton) of air dried pulp. The quantity depends upon the specific wood species pulped, tree age, soil conditions, seasonal changes, and climatic conditions as well as the type and length of time of storage (60) (166).

Most of the substance appears in the digester relief condensate from which it is recovered. The gases leaving the digester are passed through a cyclone in which black liquor is separated out for entry into the recovery system. The steam-turpentine mixture then goes to a surface condenser, the condensate from which is sent to a storage tank. There the water and turpentine separate by gravity and the turpentine is decanted off for storage or shipping (167). The water fraction is sewered with the other condensates or, in some instances, disposed of on the land.

Crude turpentine is shipped to chemical plants for rectification after which it is sold for use as a solvent or fractionated to separate specific ingredients. Some of these are used as base compounds in the production of other chemicals (168), such as dimethyl sulfoxide, an excellent industrial solvent (169).

Some turpentine remains in the decanted water which joins the general condensate stream. In some mills anti-dispersants are used to enhance the separation and thus reduce the quantity of turpentine lost to the sewer.

Mill practices which will permit more complete recovery of turpentine and tall oil are forecast. For example, shorter storage of chips or precooking extraction would prevent the loss of turpentine and tall oil by oxygenation prior to pulping. Solvent extraction of the soap from black liquor could improve recovery efficiencies (168).

On the other hand there are factors which will inhibit recovery of these products. Increased use of continuous digesters will reduce the yield of turpentine thus creating a need for an economic method of turpentine recovery from the black liquor in continuous processes. Mixing pine and hardwood black liqucrs reduces the recovery of tall oil and separate liquor tanks will be required (170). Use of more hardwood, sawmill wastes, immature wood, and outside chip storage are other adverse factors (163).

Production of other by-products, such as methanol, acetic acid, tars, etc., from kraft mills on a commercial scale is not yet economically feasible. Effluent limitations and standards are expected to stimulate increased research on by-product recovery in the next decade.

By-Products of Sulfite Pulping

While in recent years the number of sulfite mills producing and marketing by-products has not increased, eight mills continue such production and, in some instances, enjoy a concomitant decrease in waste load (52) (171). Presently about 10 percent of the spent sulfite liquor produced in this country is used and there is little indication that this quantity will increase (172) (173) (174). Sulfite mills marketing by-products are shown in Table 202.

These by-products derive from the spent pulping liquor and digester and evaporator condensates. The liquor products include 1) those which use the whole liquor itself; 2) products made from the liquor sulfonate fraction, 3) and those obtained by fermentation of the sugar fraction. Cymine is separated from the condensates removed from the digester relief system (3) and formic acid, acetic acid and furfural are components of the evaporator condensate (179).

The first class of liquor products is made by treating the raw liquor or evaporating it and bleeding off the concentrate at various consistencies (40-65 percent) for sale. The concentrated liquor of ammonia base sulfite mills can be used directly in tanning (3). Sulfite spent liquor is also sprayed on gravel roads (road binder) to reduce dusting (2) (3).

The lignosulfonates are precipitated from raw liquor by the Howard process (17). These materials can be used as oil well drilling mud, tanning agents, dispersants, and soil improvers. The precipitates can be reacted with other chemicals to produce vanillin and other saleable materials (175) (172) such as dispersing and emulsifying agents, some of which are used in dyeing.

Fermentation products include ethanol and torula yeast which is used as an animal and human food supplement (174). They are produced from the raw liquor after the free sulfur dioxide has been steam stripped and returned to the acid plant.

The only major waste produced in the manufacture of spent sulfite liquor evaporate are the condensates which amount to about 6260 l (1500 gals.) for the liquor equivalent of one kkg (ton) of AD pulp (46). The combined condensates are acid, free of suspended matter, and, if no appreciable carry-over occurs in the evaporators, low in color. They contain considerable BOD_5 due to the presence of formic and acetic acids, alcohols, and aldehydes (46). Preneutralization of the liquor effectively reduces the BOD_5 range from 43 to 75 kg (85 to

Table 202

MILLS MANUFACTURING SPENT SULFITE LIQUOR BYPRODUCTS

Mill Code	Products
070	Ethanol Lignin Products
051	Torula Yeast
061	Lignin Products
402	Lignin Products
063	Evaporate
052	Lignin Products
056	Evaporate
066	Lignin Products

150 lb) per kkg (ton) of AD pulp to 30 to 35 kg (60 to 70 lb) (46)(44). It has been shown that removal of the volatile materials from these condensates by steam stripping, chemical reaction in the vapor phase, or by activated carbon can reduce the COD about 75 to 80 percent (49). If the condensate is free of carry-over, a corresponding reduction in BOD_5 will occur. However, insufficient markets are available for the formic and acetic acids that would be produced at the present time.

The lignosulfonates are separated from raw or concentrated liquor of the following composition:

	Percent of Dry Solids
Lignosulfonic Acid	45-50
Reducing Sugars -	
Hexoses	15
Pentosos	12
Other Carbohydrates	15
Inorganics	5

This separation is made by lime precipitation (176) from the raw liquor or by chemical treatment of evaporate (178). Effluents from precipitation processes contain the wood sugars and other carbohydrates responsible for a large portion of the BOD_5 of the liquor, and for this reason such separations reduce the BOD_5 waste load only about 20 percent. However, since the precipitate contains most of the color bodies, the process removes over 80 percent of this parameter.

There is little data available on specific pollutional values of the effluents from production of marketable products from precipitates. This is because such effluents are not generally segregated and are difficult to relate to production. However, it has been observed that effluent from the manufacture of vanillin is very high in color and susceptible to foaming (172).

Only one mill in the U.S. presently produces ethanol and of the three that once produced torula yeast only two are in operation. After fermentation the spent beer from both processes can be evaporated to produce a substantially sugar-free lignosulfonate solution from which other products can be made. The condensates produced are lower in BOD_5 than those obtained from raw liquor, ranging from 20 to 25 kg (40 to 50 lb) per kkg (ton) of AD pulp. Since ethanol production uses only the hexose sugars, it results in a BOD_5 reduction of less than 25 percent. This reduction is closer to 50 percent in torula yeast production which uses both hexose and pentose sugars. Yeast plant effluent ranges from 12,519 to 28,865 l (3000 to 5000 gal.) for the liquor equivalents of yeast cells. Generally such effluents contain from 1500 to 3500 mg/l of BOD_5 and from 250 to 600 mg/l of total suspended solids.

IMPLEMENTATION REQUIREMENTS

Availability of Equipment

Since 1966, when Federal water pollution control expenditures began, various Federal and private organizations have analyzed the projected levels of water pollution control activity and their economic impact on the construction and equipment industries. As a result, a plethora of studies has been developed which is related to the levels of municipal and industrial water pollution control construction and the respective markets for waste water treatment equipment. Less information is available concerning the actual and anticipated levels of expenditure by any specific industry.

In recent years, the trend in the waste water equipment industry has seen the larger firms acquiring smaller companies in order to broaden their market coverage.

Figure 123 shows graphically past expenditures and projected future outlays for the construction of industrial waste water treatment facilities, as well as total water pollution control expenditures. Obviously, the level of expenditures by industry is related to the Federal compliance schedule. This will increase until industry is in compliance with Federal standards. Once that occurs, the level of spending will return to a level commensurate with the construction of new facilities, replacement of existing facilities, and the construction of advanced waste treatment facilities.

Figure 124 shows past expenditures for and projected future trends in total sales of waste water treatment equipment and the dollar amounts attributable to industrial and municipal sales. This curve closely follows the trend shown in Figure 123.

The data in Figures 123 and 124 related to industrial water pollution expenditures include only those costs external to the industrial activity. Internal process changes made to accomplish water pollution control are not included.

Recent market studies have projected the total available production capacity for water and waste water treatment equipment. Most of them have indicated that the level of sales is currently only 30-40 percent of the total available plant capacity. Several major manufacturers were contacted to verify these figures and indications are that they are still accurate. A partial reason for this overcapacity is that the demand for equipment has been lower than anticipated. Production capacity has increased assuming Federal expenditures in accord with funds authorized by Congress and conformance to compliance schedules.

For the immediate future, increased demands for waste water treatment equipment can be absorbed by the existing overcapacity. Long term requirements will probably necessitate expansion of production capacity in various product lines where the demand is expected to increase dramatically -- specifically, advanced treatment systems and waste solids handling equipment.

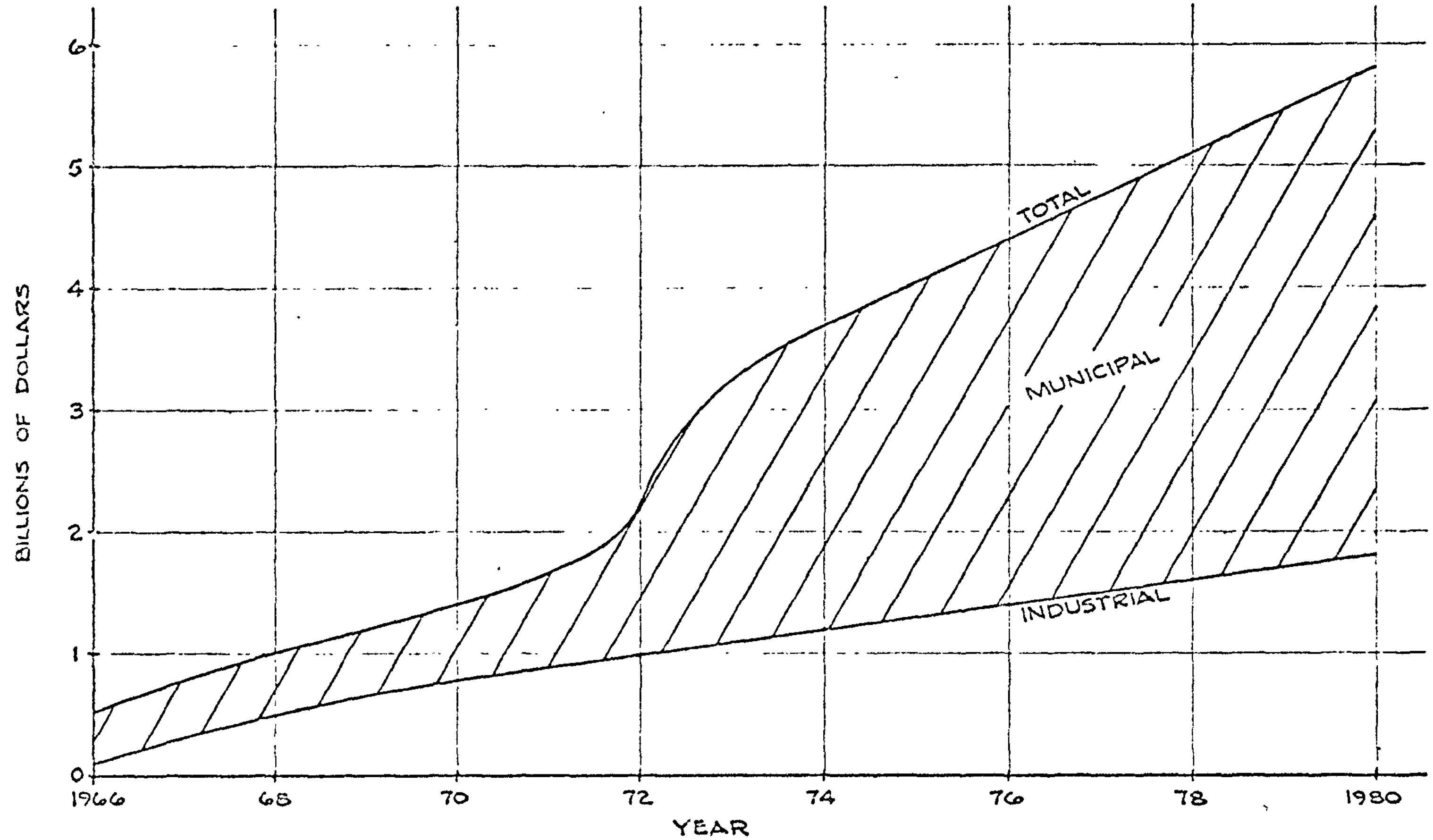


Figure 123

Total Water Pollution Control Expenditures

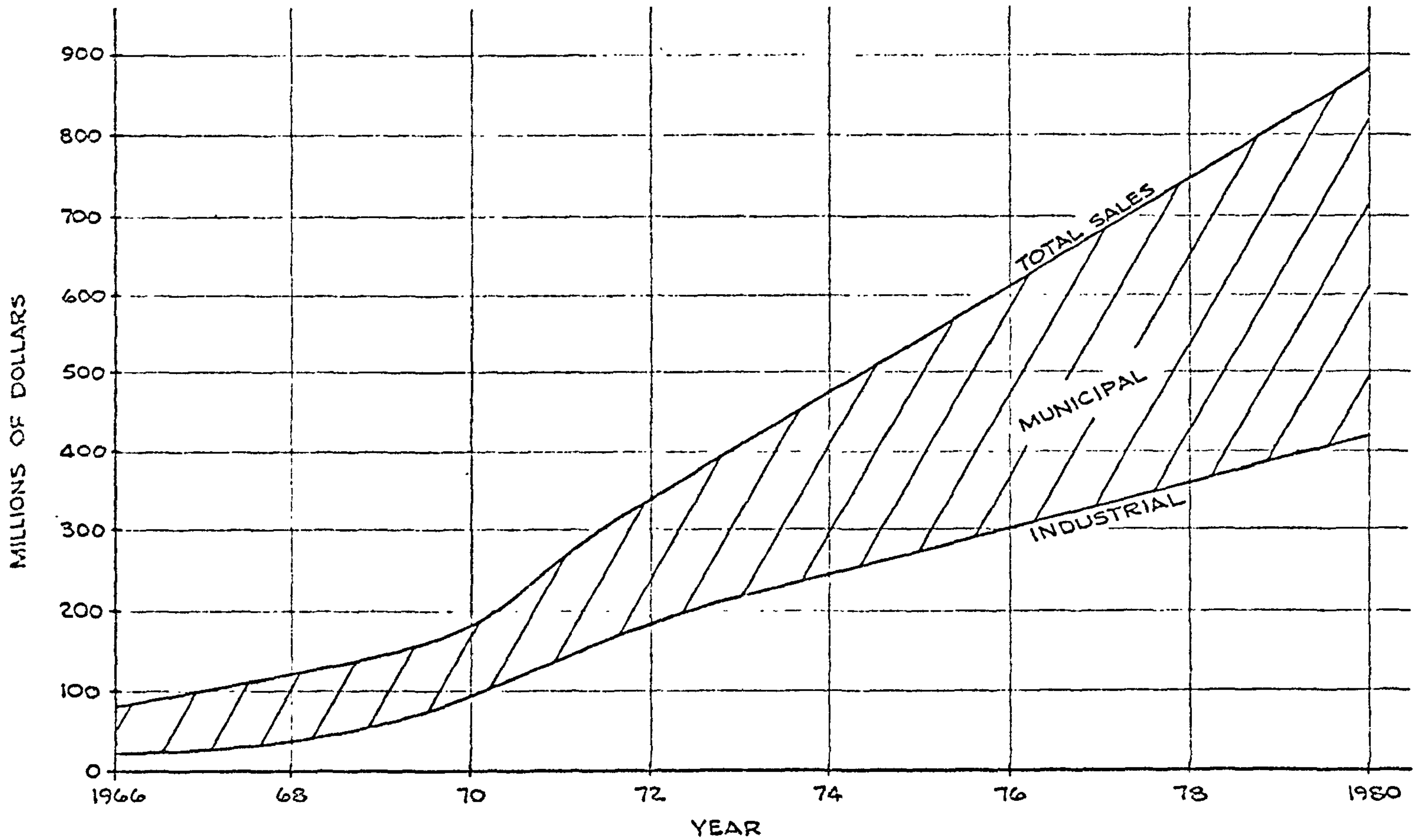


Figure 124

Waste Water Treatment Equipment Sales

It should also be noted that the capacity to produce waste water treatment equipment could be expanded significantly through the use of independent metal fabricators as subcontractors. Even at the present time independent fabricators are used by some equipment manufacturers when work loads are heavy and excessive shipping costs make it desirable to use a fabricator close to the delivery site.

There appear to be no substantial geographical limitations to the distribution of waste water treatment equipment to industry. In various areas, certain suppliers may be more successful than others; however, this seems to be related more to the effectiveness of the sales activities than to geographical limitation. The use of independent metal fabricators as subcontractors to manufacture certain pieces of equipment further reduced geographical limitations.

Equipment delivery schedules may vary substantially depending upon the manufacturer, the current demand, and the specific equipment in question. Obviously, the greater the demand or the more specialized the equipment, the greater the delivery time.

Availability of Construction Manpower

After consultation with the Associated General Contractors of America and other industry groups, it has been concluded that sufficient manpower exists to construct any required treatment facilities. The Bureau of Labor Statistics has been requested to conduct another study.

Construction Cost Index

The most detailed study and careful analysis of cost trends in prior years still leave much to be desired in predicting construction costs through the next ten years.

During the years 1955 through 1965 there was a very consistent price rise. The Engineering News Record (ENR) Construction Cost Index in January 1955 was 644. With slight deviations from a straight line, costs rose at a steady rate to an index of 988 in December 1965. This represented an increased cost of 53.4 percent over an 11 year period of approximately five percent per year.

The first six months of 1966 saw an increase of 6.6 percent then leveled off abruptly cnly to rise sharply again in 1967 at a rate of 6.2 percent, then increasing to 9.4 percent in 1968.

The increase in costs continued to rise at about 10.5 percent per year through 1970. During 1971, construction costs rose at the unprecedented rate of 15.7 percent primarily due to larger increases in labor rates.

With the application of federal wage and price controls in 1972, the rate of increase dropped to 8.6 percent for the year and continued at the same rate during the first six months of 1973. The cost index curve began to level off during the latter part of 1973 resulting in an increase of 6.8 percent for the year.

Cost predictions for extension of ENR Cost Index are confused at this time. ENR in the 1974 first Quarterly Cost Roundup (March 21, 1974) stated, "Predicting cost trends is always difficult, but this year contractors face what is perhaps the most bewildering period in a quarter century."

The commentary continued with the statement "The industry is facing some of the sharpest escalations in costs in recent time -- material as well as labor".

With the termination of price controls, manufacturers are making substantial price boosts to cover proposed expansions for increased capacity as well as actual increased production costs.

These developments have caused ENR to revise its predictions for 1974 increase in Cost Index. In December the predicted increase 12/73 to 12/74 was +4.0% for the Building Cost Index and +5.0% for Construction Cost Index. In ENR, March 21, 1974 issue, the prediction was revised to an increase 12/73 to 12/74 of +6.8% for Building Cost Index and +7.5% for Construction Cost Index. ENR on June 20, 1974, further revised 1974 predicted Building Cost Index increase to 10.3% and Construction Cost Index to 10.0%.

The strong inflationary forces now facing the United States and the rest of the world are the worst hazard to cost predictions. With what has previously been considered a normal rate of inflation, it could be anticipated that expansion of industrial capacity would help to level off current sharp price increases.

In spite of the skyrocketing cost increases during the second quarter of 1974, the long range outlook for the Construction Cost Index would seem to be closer to an annual increase of 8 percent, the bases on which Figure 125 was drawn. Developments in the industry may require adjustments up or down from the projected cost index for current program costs in any particular year.

Land Requirements

Land requirements for a number of external treatment systems have been evaluated and are shown in Figure 126 for a range of plant sizes. Incineration or off-site disposal of dewatered sludge has been assumed. Should sludge lagoons be used on-site, additional land would be required. It should be pointed out that the costs of land were included in the total costs per subcategory presented previously in this section.

Time Required to Construct Treatment Facilities

The time required to construct primary and secondary effluent treatment facilities has been estimated for a range of plant sizes and

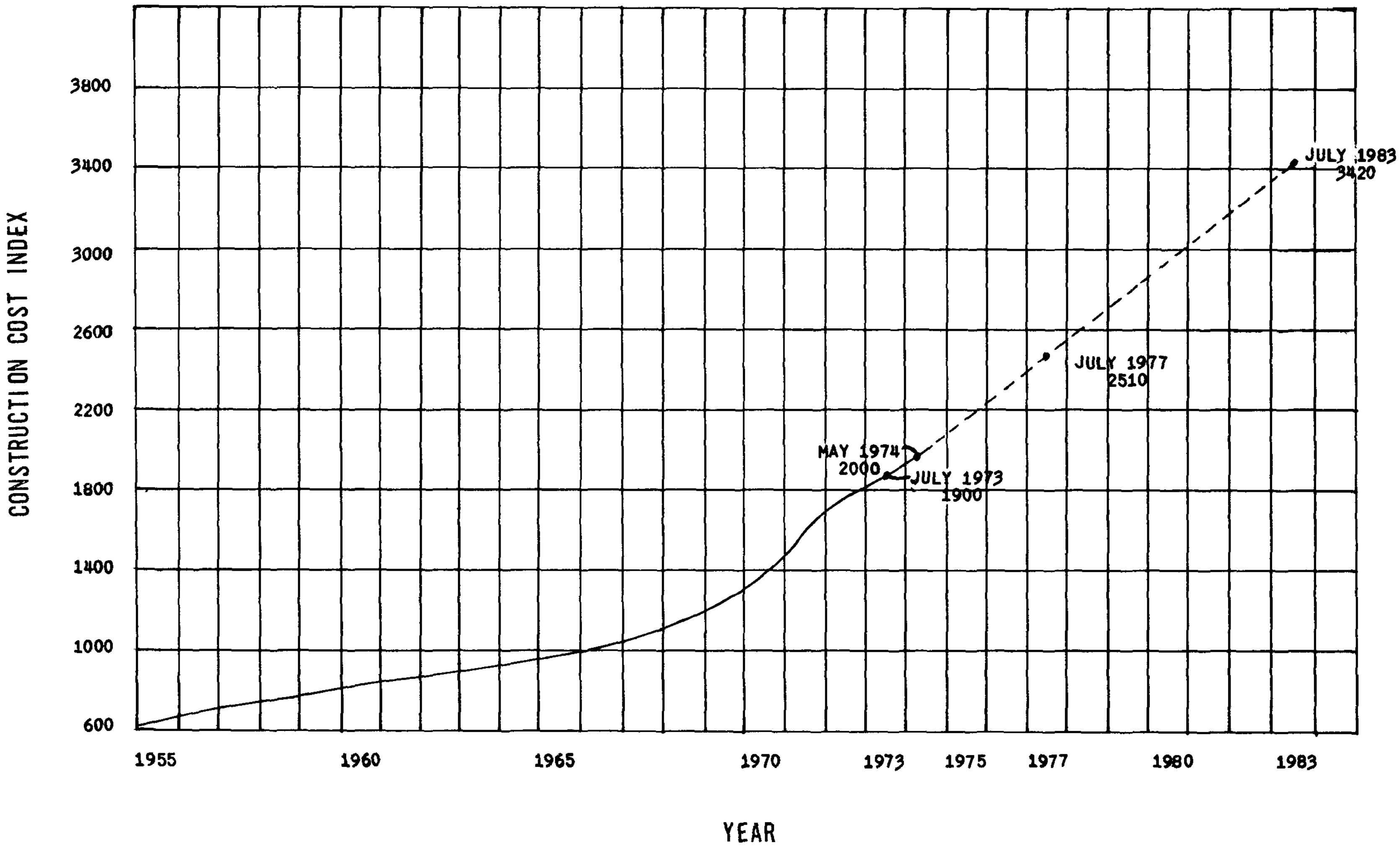
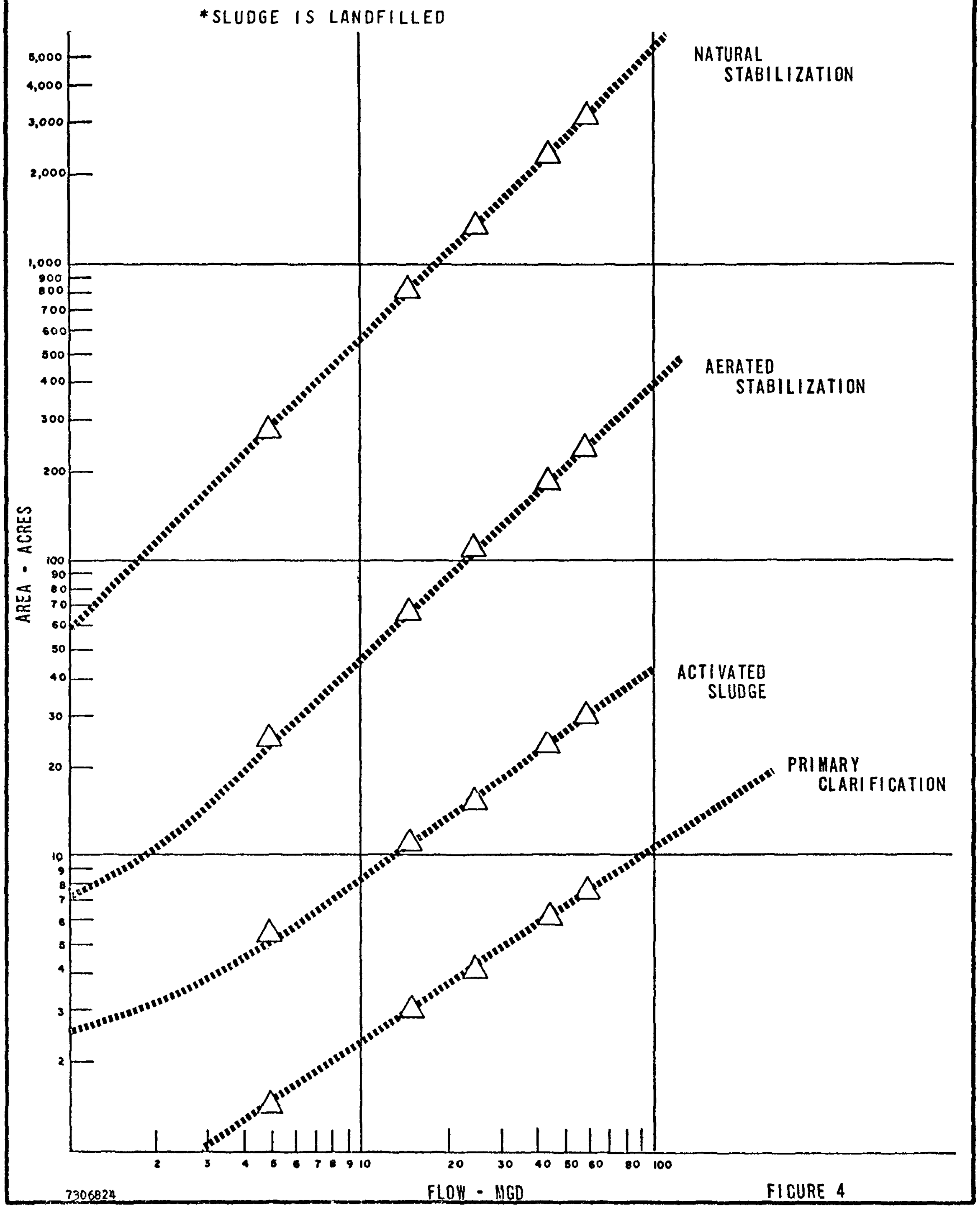


Figure 125
ENGINEERING NEWS RECORD
CONSTRUCTION COST INDEX

Figure 126

MINIMUM AREA REQUIRED FOR WASTEWATER TREATMENT



for two different project contract possibilities. The treatment plant sizes evaluated were under 5 MGD, 5 to 20 MGD, and over 50 MGD. The contract possibilities evaluated were for the engineering and construction to be separate or on a turnkey basis.

A small mill with relatively small effluent volume (see Figure 127) could have its primary and secondary treatment facilities in operation in 2.5 years if the contract was handled on a turnkey basis The majority of the effluent treatment facilities handled with separate engineering and construction contracts, plus the medium and large mills handled on a turnkey basis, would be completed in 2.5 to 4.5 years.

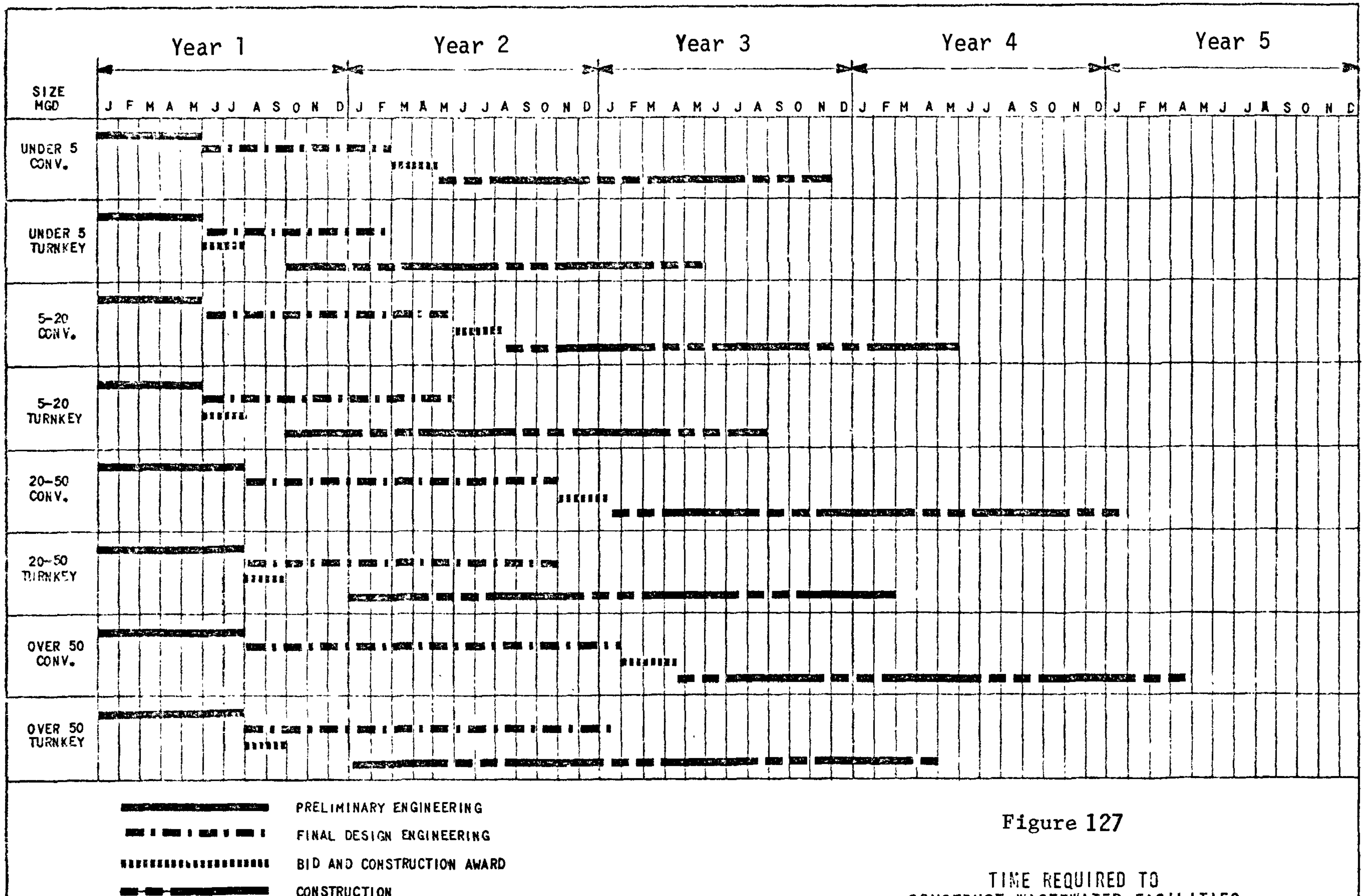


Figure 127

TIME REQUIRED TO
CONSTRUCT WASTEWATER FACILITIES
CONVENTIONAL AND TURNKEY CONTRACTS

SECTION IX

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE (BPCTCA)

INTRODUCTION

The effluent limitations which must be achieved by July 1, 1977, specify the degree of effluent reduction attainable through the application of the BPCTCA, which is generally based upon the average of the best existing performance by plants within the industrial subcategories as discussed in detail below. In addition to the factors mentioned above, consideration was given to:

a. the total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application, including energy requirements.

b. the engineering aspects of the application of various types of control techniques;

c. the size and age of mills

d. process changes;

e. non-water quality environmental impact.

Best Practicable Control Technology Currently Available emphasizes treatment facilities at the end of a manufacturing process, but includes the control technologies within the process itself when the latter are considered to be normal or common practice within an industry.

A further consideration is the degree of economic feasibility and engineering reliability which must be established for the technology to be "currently available." As a result of demonstration projects, pilot plants, and general use, there must exist a high degree of confidence in the engineering and economic practicability of the technology at the time of commencement of construction or installation of the control facilities.

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF BPCTCA

Based upon the information available to the Agency, a determination has been made that the point source discharge limitations for each identified pollutant, as shown in Table 203, can be attained through the application of the Best Practicable Pollution Control Technology Currently Available.

The average of daily values for 30 consective days should not exceed the maximum 30 day average limitations shown. The value for one day should not exceed the daily maximum limitations shown in this table. The limitations shown are in kilograms of pollutant per metric ton of

TABLE 203

BPCTCA
Effluent Limations In kg/kkg(lbs/ton)

Subcategory	Maximum 30 Day Average BOD5	Maximum 30 Day Average TSS	Maximum Day BOD5	Maximum Day TSS
Dissolving Kraft	13.35 (26.7)	19.3 (38.6)	25.65 (51.3)	35.85 (71.7)
Market Kraft	7.9 (15.8)	15.85(31.7)	15.2 (30.4)	29.4 (58.8)
BCT Kraft	6.95 (13.9)	15.1 (30.2)	13.35 (26.7)	28.05 (56.1)
Fine Kraft	5.7 (11.4)	12.4 (24.8)	10.95 (21.9)	23.0 (46.0)
Papergrade Sulfite	19.6 (39.2)	24.0 (48.0)	37.6 (75.2)	44.6 (89.2)
Market Sulfite	20.85 (41.7)	26.65(53.3)	40.0 (80.0)	49.5 (99.0)
Low Alpha Dissolving Sulfite	22.35 (44.7)	27.4 (54.8)	42.9 (85.8)	50.85(101.7)
High Alpha Dissolving Sulfite	26.3 (52.6)	33.65(67.3)	52.3 (104.6)	62.5 (125.0)
GW-Chemi-Mechanical	7.05 (14.1)	10.45(20.9)	13.5 (27.0)	19.45 (38.9)
GW-Thermo-Mechanical	5.0 (10.0)	9.2 (18.4)	9.6 (19.2)	17.05 (34.1)
GW-CMN Papers	4.45 (8.9)	7.9 (15.8)	8.55 (17.1)	14.7 (29.4)
GW-Fine Papers	4.0 (8.0)	7.3 (14.6)	7.7 (15.4)	13.5 (27.0)
Soda	7.2 (14.4)	13.4 (26.8)	13.85 (27.7)	24.8 (49.7)
Deink	9.45 (18.9)	14.2 (28.4)	18.15 (36.3)	26.35 (52.7)
NI Fine Papers	4.25 (8.5)	5.9 (11.8)	8.2 (16.4)	11.0 (22.0)
NI Tissue Papers	6.25 (12.5)	5.0 (10.0)	11.4 (22.8)	10.25 (20.5)
NI Tissue Papers (FWP)	6.4 (12.8)	9.45(18.9)	12.3 (24.6)	17.6 (35.2)

pH for all subcategories shall be within the range 5.0 to 9.0.

Zinc*

Subcategory	Maximum 30 Day Average kg/kkg(lbs/ton)	Maximum Day kg/kkg(lbs/ton)
GW:Chemi-mechanical	0.06 (0.12)	0.12 (0.24)
GW-Thermo-mechanical	0.05 (0.10)	0.105 (0.21)
GW:CMN Papers	0.05 (0.10)	0.105 (0.21)
GW:Fine Papers	0.048 (0.096)	0.095 (0.19)

*Applicable only to mills using zinc hydrosulfite.

production (pounds of pollutant per ton of production). Effluents should always be within the pH range of 5.0 to 9.0.

Production in kkg (tons) is defined as annual tonnage produced from pulp dryers (in the case of market pulp) and paper machines (for paper/board) divided by the number of production days in the 12-month period. Pulp production is to be corrected, if necessary, to the "air dry" moisture basis.

<u>Allowance for Wet Woodyard Operations</u>

Irrespective of the wood pulping subcategories, the allowance for BOD5 and TSS shown below can be added to the above effluent limitations for mills with wet woodyard operations. Application of the additional allowance shall be made only for that portion of the total mill's production attributable to the use of logs, specifically excluding the portion of total production attributable to purchased chips, purchased pulp, or purchased waste paper.

The woodyard operations which qualify for this allowance are the following:

1. Log ponds used for defreezing logs prior to processing.
2. Log transport and defreeze flumes.
3. Log washing.
4. Wet debarking operations.

For mills using any or all of the above operations, the additional allowances for BOD5 and TSS are shown below:

	Max 30 day Average kg/kkg	(lbs/ton)	Max 30 day Average kg/kkg	(lbs/ton)
BOD5	0.5	(1.0)	0.9	(1.8)
TSS	0.75	(1.5)	1.6	(3.2)

<u>IDENTIFICATION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE</u>

Best Practicable Control Technology Currently Available varies among the subcategories. Internal technologies are shown in Tables 132 through 148 of Section VIII, and the external technologies are shown in Table 149. The selected external technology suggested as BPCTCA and the internal technologies employed by the mills in each subcategory are discussed in detail in Section VII and VIII.

It is emphasized here that these technologies are not of themselves required. Due to economic, space, or other factors, many mills may choose to use alternative technologies. Conversely, some mills may choose technologies in addition to those shown. For example, biological treatment is not included for mills in the non-integrated tissue subcategory. The reason is that many of these mills with only primary treatment have achieved equal or better results than some others which also use biological treatment. A specific mill within these subcategories may, howeven, choose biological treatment as the most effective method of meeting the limitations.

RATIONALE FOR THE SELECTION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

Age and Size of Equipment and Facilities

There is a wide range, in both size and age, among mills in the subcategories studied. However, internal operations of most older mills have been upgraded, and most of these mills currently operate very efficiently. The technology for upgrading of older mills is well known within a given subcategory. Studies have also shown that waste treatment plant performance does not relate to mill size. There is no significant variation in either the waste water characteristics or in the waste water loading rates, in kg/kkg (lb/ton), among mills of varying sizes. Figures are presented in Section IV showing the insignificant relationships between raw waste load and mill size.

Processes Employed

All mills within each subcategory studied use the same basic production processes. Although there are deviations in equipment and production procedures, these deviations do not significantly alter the characteristics of the wastewater generated within each subcategory. Treatability of these wastes is similar.

Application of best practicable control technology currently available does not require major changes in existing industrial processes for the subcategories studied. Incorporation of additional systems, treatment processes, and control measures can be accomplished in most cases through changes in piping, and through modifications of existing equipment. Such alterations can be carried out at mills within a given subcategory.

The technology to achieve these effluent limitations is practiced within the subcategories under study. The concepts are proven, available for implementation, and applicable to the wastes in question. The waste treatment techniques are also broadly applied within many other industries. The technology required will necessitate improved monitoring of waste discharges and of waste treatment components on the part of many mills, and may require more extensive training of personnel in the operation and maintenance of waste treatment facilities. However, these procedures are currently practiced in many mills and are common practice in many other industries.

Non-Water Quality Environmental Impact

The technology cited will not create any significant increase in odors, or in noise levels beyond those observed in well-designed municipal waste water treatment systems which currently are being approved by the federal government for construction in populated areas. Further, no hazardous chemicals are required as part of this technology.

Cost of Application in Relation to Effluent Reduction Benefits (Including Energy Requirements)

The total project costs of BPCTCA reflect an increase of production expenses as shown in Tables 151 through 184 of Section VIII. These increases reflect both all internal mill and external waste treatment improvements. They are based on 360 days of production per year. It should be emphasized, however, that most mills have already carried out many of these improvements. Consequently, their increased costs would be less than those shown. The energy requirements associated with the application of pollution control technologies are described in Section VIII. The total estimated cost of BPCTCA for all of the mills is $1.6 billion with associated total effluent reduction of approximately 4,535 kkg (5,000 tons) per day of BOD_5.

RATIONALE FOR SELECTION OF EFFLUENT LIMITATIONS

The rationale used in developing the effluent limitations for BOD_5, TSS, and zinc (groundwood subcategories only), is discussed below for each of the subcategories. Specifically identified are the methods used to select the limitations for the maximum 30 consecutive day average and the daily maximum value for BOD_5 and TSS. To the extent possible, the effluent limitations for both parameters are based on 12 to 24 months of data obtained from nearly 200 mills during this study. The procedure for selecting the mills in each subcategory whose external pollution control facilities demonstrate a high level of performance is also described in this section.

The development of the effluent limitations for each subcategory are discussed in detail in the following paragraphs. The basic approach used in determining the effluent limitations involved the following: (1) the establishment of raw waste loads for each subcategory (see Section V); (2) determination of external treatment performance of the external treatment facilities at mills within each of the subcategories (See Section VII). Where the available data permitted, the performance was measured by the absolute values of the quality of the effluents from the external treatment facilities. Where data were not available, data were incomplete, or the treatment facilities were inadequate for mills within a subcategory, performance was based upon similar subcategories using similar treatment technologies and treating similar waste waters, as discussed in detail below; and (3) establishment of the effluent limitations using the raw waste loads and external treatment performance as identified in the above efforts. Specifically, the average effluent flow volume as determined for each subcategory in Section V was used with the appropriate BOD_5 and TSS concentrations which were determined through analysis of the relationship between influent BOD5 and effluent BOD5 and TSS concentrations as presently being achieved by mills using well designed and operated treatment facilities representative of BPCTCA. The waste water flow (as well as the raw waste BOD5) indicates the extent of inplant control measures in use at mills within the subcategories, and use of the average flow per subcategory in developing the effluent limitations therefore reflects a level of inplant waste water management technologies which are commonly practiced. By using the average flow for each subcategory, mills using a normal level of inplant control measures and well designed and operated external treatment will be able to achieve the effluent limitations through the use of BPCTCA. It should be pointed out that the flow, BOD5, and TSS raw waste loads that were developed in Section V were also used in the development of the costs in Section VIII.

The determination of the BOD5 and TSS concentrations involved thorough evaluations of the external treatment systems at mills within each of the subcategories. In several cases, mills achieved high quality BOD5 concentrations in their effluents while the TSS concentrations were very poor. In nearly every case, the poor performance on TSS can be related directly to poor design and operation of the facilities (i.e. the design was based solely on BOD5 removal without regard to TSS removal).

The effluent limitations were developed on an annual average basis and then multiplied by the variability factors developed in Section VII to determine the maximum 30 consecutive day and maximum day limitations. The variability factors used in determining the effluent limitations are shown in Table 204. The flow values developed in Section V were based upon 12 to 24 months of daily data or more when available. In addition, the final effluent concentrations represent averages of 12 to 24 months or more of daily data for the same data periods as the raw waste load data for each mill. Table 205 presents the flow, BOD5, and TSS values and the corresponding annual average BOD5 and TSS values which were used as the basis of the effluent limitations for each of the respective subcategories. It should again be emphasized that mill sampling, flow measurement, and laboratory analytical techniques were thoroughly evaluated to assure that the mill data used in the development of the effluent limitations was valid. Because of this, some mill data was eliminated from consideration due to various deficiencies. For instance, a number of mills measure TSS by non-standard methods using a paper filter rather than by the standard procedure of using a glass fiber filter. The two analytical procedures yield widely different results and no correlation exists between the two tests. TSS data as measured by non-standard methods were thereby not used in determining effluent limitations. In addition, the operating procedures of the treatment facilities in use by the best mills were examined to determine the adequacy of operation and the impact upon final effluent characteristics. For those mills with adequate designed treatment facilities representative of BPCTCA and inadequate operating procedures during all or part of the time (i.e. shutting down aerators during winter months), the data representing the inadequate operations was not used in determining the effluent limitations.

Table 204

BPCTCA Variability Factors

Bleached Kraft Soda, Groundwood, Sulfite, Deink,
NI Fine Papers, and NI Tissue (fwp) Subcategories

Parameter	Maximum 30 Days	Maximum Day
BOD_5	1.78	3.42
TSS	1.82	3.38

NI Tissue Papers Subcategory

Parameter	Maximum 30 Days	Maximum Day
BOD_5	1.79	3.25
TSS	1.76	3.60

TABLE 205
BASIS FOR BPCTCA EFFLUENT LIMITATIONS

Subcategory	FLOW kl/kkg(kgal/ton)	RWL BOD5 mg/L	Final Effluent (Annual Average) BOD5 mg/L	TSS mg/l	BOD5 kg/kkg(lbs/ton)	TSS kg/kkg(lbs/ton)
BK:Diss.	241.0 (57.8)	228	31	44	7.50 (15.0)	10.60 (21.2)
BK:Mkt	171.0 (41.0)	234	26	51	4.45 (8.9)	8.70 (17.4)
BK:BCT	151.0 (36.2)	251	26	55	3.90 (7.8)	8.30 (16.6)
BK:Fine	133.0 (31.8)	244	24	51	3.20 (6.4)	6.80 (13.6)
Soda	144.0 (34.5)	301	28	51	4.05 (8.1)	7.35 (14.7)
GW:CMP	113.0 (27.0)	846	35	51	3.95 (7.9)	5.75 (11.5)
GW:TMP	99.2 (23.8)	282	28	51	2.80 (5.6)	5.05 (10.1)
GW:Fine	90.9 (21.8)	186	25	44	2.25 (4.5)	4.00 (8.0)
GW:CMN	99.2 (23.8)	175	25	44	2.50 (5.0)	4.35 (8.7)
Sulfite:Paper	220.0 (52.8)	575	50	60	11.00 (22.0)	13.20 (26.4)
Sulfite:Mkt	244.0 (58.5)	504	48	60	11.70 (23.4)	14.65 (29.3)
Low Alpha	251.0 (60.2)	534	50	60	12.55 (25.1)	15.05 (30.1)
High Alpha	247.0 (59.2)	986	60	75	14.80 (29.6)	18.50 (37.0)
Deink	104.0 (25.0)	791	51	75	5.30 (10.6)	7.80 (15.6)
NI Fine	63.4 (15.2)	170	38	51	2.40 (4.8)	3.25 (6.5)
NI Tissue	95.5 (22.9)	121	37*	30*	3.50 (7.0)	2.85 (5.7)
NI Tissue (FWP)	94.2 (22.6)	138	38	55	3.60 (7.2)	5.20 (10.4)

* Basis of effluent limitations was kg/kkg(lbs/ton) analysis, not concentration; see text.

The achievability of the effluent limitations was examined and it was determined that a large number of mills presently comply with the effluent limitations. Compliance with the effluent limitations was examined for mills for which adequate data (one year) were available and for a mill to be considered in compliance, the mill data did not exceed any of the four limitations ((1) maximum 30 day BOD5, (2) maximum daily BOD5, (3) maximum 30 day TSS, and (4) maximum daily TSS) within the year of data. A number of mills were determined to be in non-compliance with the effluent limitations but this does not necessarily mean that those mills will have difficulty in achieving the effluent limitations. Exceeding any one of the four limitations for one day or one month was counted as non-compliance and in many cases, the excursions in the data were determined to be the result of such items as sampling or analysis or operating problems (i.e., power outage, aerators failure). A total of 25 mills complied with both the daily maximum BOD5 and the maximum 30 day BOD5 limitations. Of these 25 mills, 12 mills complied with both the daily maximum TSS and the maximum 30 day TSS limitations; however, TSS data were not available for six of the 25 mills. Of the seven of the 25 mills for which TSS data were available, three mills complied with one of the TSS limitations.

Bleached Kraft Subcategories

Extensive effluent data were available for 32 bleached kraft mills that have biological treatment facilities and the data are summarized for the 32 mills in Table 71 in Section VII. Of the 32 mills, 22 mills were determined to be best mills as discussed in Section VII. The data for the best mills in the bleached kraft subcategories are summarized in Table 206 which presents by subcategory the type of treatment system in use at each mill, the raw waste BOD5 concentration, and final effluent flow, BOD5, and TSS values. The BOD5 and TSS values are presented in both kg/kkg (lbs/ton) and concentrations. Details of the type of treatment system in use by the best mills are shown in Figure 44 in Section VII and are summarized in Table 207.

In the bleached kraft subcategories, 12 mills were in compliance with both the daily maximum BOD5 and the maximum 30 day BOD5 effluent limitations. Of these 12 mills, five mills complied with both the maximum 30 day TSS and the daily maximum TSS limitations; however, data were unavailable for three of the 12 mills. Two of the 12 mills complied with the daily maximum TSS but exceeded the maximum 30 day TSS limitations, and two mills exceeded both the daily maximum TSS and the maximum 30 day TSS limitations. In addition, 7 other mills complied with at least one of the limitations for BOD5 and TSS.

Bleached Kraft Dissolving Pulp Subcategory

Two of the three mills in the bleached kraft dissolving pulp subcategory have biological treatment facilities and both mills were determined to be best mills. As shown in Table 206, the average final effluent concentrations for BOD5 and TSS for the two best mills are 31

TABLE 206
BLEACHED KRAFT SUBCATEGORIES
BEST MILLS: FINAL EFFLUENT CHARACTERISTICS

Mill	Final Effluent Flow kl/kkg(kgal/ton)	Raw Waste BOD5 mg/L	Treatment	Final Effluent BOD5 kg/kkg(lbs/ton)	Final Effluent BOD5 mg/L	Final Effluent TSS kg/kkg(lbs/ton)	Final Effluent TSS mg/L
Dissolving Kraft							
127	230 (55.1)	174	C-ASB	5.6 (11.1)	24	8.1 (16.1)	35
108	252 (60.5)	295	C-ASB	11.1 (20.2)	38	11.8 (23.6)	44
Average	241 (57.8)	235		7.8 (15.7)	31	10.0 (19.9)	39.5
Market Kraft							
114	179(42.9)	276	C-ASB	4.6 (9.2)	26	3.8 (7.5)	21
130	256(61.5)	120	SB-ASB	2.9 (5.8)	11	6.5 (13.0)	25
Average	218(52.2)	198		3.8 (7.5)	18.5	5.2 (10.3)	23
BCT Papers							
105	162(38.9)	224	C-ASB-PS	2.6 (5.1)	16	- (-)	-
109	167(40.0)	213	C-ASB	6.2(12.4)	37	17.0 (34.0)	102
111	137(32.9)	216	C-ASB	3.2 (6.3)	22	6.6 (13.1)	48
121	158(37.9)	189	C-ASB-PS	4.4 (8.7)	28	5.7 (11.3)	36
117	205(49.2)	146	C-ASB	2.5 (5.0)	12	5.2 (10.4)	25
113	141(33.7)	260	C-ASB	4.8 (9.6)	34	- (-)	-
138	131(31.3)	375	C-ASB	3.6 (7.2)	28	7.8 (15.6)	61
125	110(26.4)	288	C-ASB	3.3 (6.5)	30	6.1 (12.2)	55
Average	151(36.3)	239		3.8 (7.6)	26	8.1 (16.1)	54.5

TABLE 206
BLEACHED KRAFT SUBCATEGORIES
BEST MILLS: FINAL EFFLUENT CHARACTERISTICS
(cont.)

Mill	Final Effluent Flow kl/kkg(kgal/ton)	Raw Waste BOD5 mg/L	Treatment	Final Effluent BOD5 kg/kkg(lbs/ton)	Final Effluent BOD5 mg/L	Final Effluent TSS kg/kkg(lbs/ton)		Final Effluent TSS mg/L
Fine Papers								
119	97.2(23.3)	240	C-A	1.1 (2.2)	11	3.3	(6.5)	33
103	171 (40.9)	232	C-ASB-PS	2.3 (4.6)	31	1.6	(3.2)	21
136	120 (28.7)	242	C-A	3.8 (7.6)	32	29.9	(59.8)*	250
106	171 (40.9)	204	C-ASB-PS	3.1 (6.2)	18	3.5	(6.9)	20
166	126 (30.2)	237	C-ASB	3.1 (6.2)	27	5.4	(10.8)	46
101	158 (37.8)	186	C-ASB-PS	1.4 (2.7)	9	2.1	(4.2)	13
107	154 (37.0)	264	C-A-PS	2.8 (5.5)	18	11.0	(21.9)	71
104	219 (52.5)	183	C-A	7.3(14.6)	33	13.6	(27.2)	62
110	100 (24.0)	277	C-ASB-C	3.4 (6.8)	34	7.0	(13.9)	69
120	130 (31.2)	369	C-A	3.6 (7.1)	27	13.8	(27.6)	106
Average	144 (34.7)	243		3.2 (6.4)	24	6.8	(13.6)	49
Average (all mills)	162 (38.9)	237		3.9 (7.8)	25	7.4	(14.7)	47

*Not included in averages.

Table 207
External Treatment Facilities
Bleached Kraft Mills

Mill	C klpd/m2(gpd/ft2)		A hrs	A hp	ASB days	ASB hp	C klpd/m2(gpd/ft2)		PS days
100	27.70	(680)	-	-	4	1185	-	-	7
101	14.26	(350)	-	-	20	850	-	-	15
102	10.96	(269)	-	-	4	750	-	-	16.5
103	18.33	(450)	-	-	20	300	-	-	12.5
104	32.39	(795)	5	1785	-	-	48.89	(1200)	-
105	16.30	(400)	-	-	14	750	-	-	10-12
106	37.89	(930)	-	-	10	400	-	-	58
107	24.44	(600)	3	440	5.5	60	16.30	(400)	-
108	15.15	(372)	-	-	16	3225	-	-	-
109	25.34	(622)	-	-	6	1500	-	-	-
110	19.15	(470)	-	-	13	1020	19.96	(490)	-
111	10.72	(263)	-	-	8	1650	-	-	-
112	NA	(NA)	-	-	3.75	600	25.99	(638)	-
113	19.64	(482)	-	-	15	1990	-	-	-
114	14.26	(350)	-	-	10.5	1400	-	-	9
116	87.80	(2155)	-	-	2	1170	-	-	-
117	20.37	(500)	-	-	14	480	-	-	-

Table 207 cont'd
External Treatment Facilities
Bleached Kraft Mills
Continued

Mill	C klpd/m2	(gpd/ft2)	A hrs	A hp	ASB days	ASB hp	C klpd/m2	(gpd/ft2)	PS days
118	NA	(NA)	4.6	NA	-	-	-	-	-
119	31.00	(761)	7	NA	-	-	19.31	(474)	-
120	28.52	(700)	NA	2000	-	-	NA	(NA)	-
121	21.59	(530)	-	-	3.6	1660	-	-	-
122	24.44	(600)	-	-	12	900	-	-	7
125	24.44	(600)	-	-	10	1300	-	-	197
127	9.94	(244)	-	-	8.5	1920	-	-	24.5
130	NA	(NA)	-	-	7	1080	-	-	-
131	39.07	(959)	-	-	6.5	1250	-	-	-
136	25.56	(652)	6.6	2500	-	-	31.78	(780)	-
138	18.62	(457)	-	-	14.5	1950	-	-	-
501	18.86	(463)	-	-	6	1700	-	-	-

mg/l and 39.5 mg/l, respectively. The effluent limitations were based upon the following values:

Flow	241 kl/kkg (57.8 kgal/ton)
BOD5	31 mg/l
TSS	44 mg/l

The above BOD5 concentration is the average of the best mills in the dissolving kraft subcategory. Since some mills have been experiencing difficulties in achieving low levels of TSS and the TSS value from mill 108 is relatively close to the average for all of the best mills in the bleached kraft subcategories, the TSS concentration from mill 108 was used. The above flow, BOD5, and TSS values were used to compute the annual average BOD5 and TSS values used as the basis of the effluent limitations. The annual average values were multiplied by the variability factors presented in Table 204 in order to determine the maximum 30 consecutive days and maximum day effluent limitations.

Extensive TSS data were not available to determine compliance for one of the mills, and of the two best mills in the bleached kraft dissolving pulp subcategory both have been determined to be in compliance with the daily maximum BOD5 and 30 day average BOD5 the other mill demonstrated compliance with the maximum 30 day TSS limitation and only exceeded the daily maximum limitation on one day out of 150 days of sampling data.

Bleached Kraft Market Pulp Subcategory

Four of the eight mills in the bleached kraft market pulp subcategory have biological treatment facilities and data were available for three of the four mills. As discussed in Section VII, two of the three mills were determined to be best mills. As shown in Table 206, the average final effluent BOD5 and TSS concentrations for the two best mills were 18.5 mg/l and 23 mg/l, respectively. The average raw waste BOD5 concentration for the two best mills was 198 mg/l which is below the average subcategory BOD5 raw waste concentration of 268 mg/l. The BOD5 effluent limitation was therefore based upon mill 114's final effluent concentration of 26 mg/l which takes into account differences in the BOD5 raw waste load. The raw waste BOD5 concentration for mill 114 was 276 mg/l which is just above the subcategory average of 268 mg/l.

The average final effluent TSS concentration for the best mills was 23 mg/l as shown in Table 206. However, the TSS effluent limitation was based upon 51 mg/l because of the difficulty that some mills have been experiencing in achieving low levels of TSS. The value of 51 mg/l was derived from the average final effluent TSS concentration for the best mills in all four bleached subcategories which use either ASB's or A's without extensive post storage ponds as shown in Table 75 in Section VII. The analysis in Section VII of the effluent levels associated with the type of treatment facility showed that final effluent TSS concentrations were lower for mills using ASB's or A's followed by post storage ponds than for mills using only ASB's or A's. Since some mills may not have the land available necessary for installation of post storage ponds, the final effluent TSS value was based upon the capabilities of mills using only ASB's or A's.

The basis for the effluent limitations are therefore the following:

Flow: 171 kl/kkg (41.0 kgal/ton)
BOD5: 26 mg/l
TSS: 51 mg/l

The annual average BOD5 and TSS values as determined from the above were multiplied by the variability factors presented in Table 204 to determine the maximum 30 consecutive day and maximum day effluent limitations.

Of the two best mills in the bleached kraft market pulp subcategory, both were determined to be in compliance with the maximum 30 day BOD5, the daily maximum BOD5, the maximum 30 day TSS, and the daily maximum TSS (except for one day out of 194 sampling days for one of the mills) limitations.

Bleached Kraft BCT Papers Subcategory

As shown in Table 206, the average BOD5 and TSS concentrations for the eight best mills in the bleached kraft BCT papers subcategory were 26 mg/l and 54.5 mg/l, respectively. The average BOD5 raw waste concentration for the best mills was 239 mg/l which is slightly less than the average for the subcategory of 269 mg/l. The raw waste BOD5 concentrations of the best mills and the subcategory average are relatively close and because the final effluent concentration is more impacted by the treatment facility than the raw waste BOD5 as discussed in Section VII, no adjustments in the final effluent BOD5 value were determined to be necessary. For example, mill 138 is achieving a final effluent BOD5 of 28 mg/l with a raw waste BOD5 of 375 mg/l. Moreover, the average raw waste flow for the best mills is 151 kl/kkg (36.3 kgal/ton) which is nearly equal to the subcategory raw waste flow of 151 kl/kkg (36.2 kgal/ton).

The average TSS concentration of the best mills was used as the basis of the TSS effluent limitations and is considered conservative because the TSS value from mill 109 was included in the average even though the treatment system, as discussed in Section VII, had design deficiencies relating to TSS reduction.

The basis for the effluent limitations are therefore the following:

Flow: 151 kl/kkg (36.2 kgal/ton)
BOD5: 26 mg/l
TSS: 55 mg/l

The annual average BOD5 and TSS values as determined from the above values were multiplied by the variability factors in Table 204 in order to determine the maximum 30 day and maximum day effluent limitations.

In the bleached kraft BCT papers subcategory, four of the eight best mills complied with the daily maximum BOD_5 and TSS maximum 30 day BOD_5 limitations. Of these four mills, two complied with both the daily maximum TSS and the maximum 30 day limitations; however, one of the four mills did not have TSS data available, and one mill of the four complied with the maximum 30 day TSS but exceeded the daily maximum TSS on only one day. In addition, one other mill complied with the daily maximum BOD_5, the daily maximum TSS, the maximum 30 day TSS limitations, but exceeded the maximum 30 day BOD_5 limitation due to a two week period of unusually high values.

Bleached Kraft Fine Papers Subcategory

As shown in Table 206, the average BOD_5 and TSS concentrations for the ten of the eleven best mills (excluding mill 112) in the bleached kraft fine papers subcategory were 24 mg/l and 49 mg/l, respectively. The average BOD_5 raw waste load for the ten best mills was 243 mg/l which is nearly equal to the subcategory average of 251 mg/l. The TSS effluent limitations were based upon 51 mg/l instead of the subcategory average of 49 mg/l because of the same reasons given in the above bleached kraft market pulp subcategory discussion.

The basis for the effluent limitations are therefore the following:

Flow:	133 kl/kkg (31.8 kgal/ton)
BOD_5:	24 mg/l
TSS:	51 mg/l

The annual average BOD_5 and TSS values as determined from the above values were multiplied by the variability factors in Table 204 to determine the maximum 30 consecutive day and maximum day effluent limitations.

In the bleached kraft fine papers subcategory, six of the eleven best mills complied with both the daily maximum BOD_5 and the maximum 30 day BOD_5 limitations. Of these six mills, two complied with the daily maximum TSS and the maximum 30 day limitations; however, TSS data were unavailable for one of the six mills; two mills of the six exceeded both the daily maximum TSS and the maximum 30 day average TSS limitations. Also, one mill of the six complied with the maximum 30 day TSS limitation, but exceeded the daily maximum TSS limitation on one day out of 358 sampling days; one additional mill complied with the maximum 30 day TSS and daily maximum TSS limitations but due to aerator failures exceeded the BOD_5 limitations.

Groundwood Subcategories

As discussed in Section VII, data were available for four groundwood mills which have biological treatment systems. Three of these mills were determined to be "best mills", and the mills' effluent data are presented in Table 208. The basic design parameters for the external treatment facilities for the best groundwood mills are presented in Table 209.

Table 208
Groundwood Subcategories
Best Mills

Mill	Final Effluent Flow kl/kkg	(kgal/ton)	Raw Waste BOD5 mg/l	Treatment	Final Effluent BOD5 kg/kkg	(lbs/ton)	mg/l	TSS kg/kkg	(lbs/ton)	mg/l	Subcategory
001	91.8	(22.0)	205*	SB-ASB-C	2.1	(4.1)	22	3.2	(6.4)	35	GW CMP
005	98.0	(23.5)	183	SB-ASB	2.1	(4.1)	21	2.2	(4.4)	22	GW Fine
002	97.2	(23.3)	208	C-A	3.3	(6.5)	33	7.3	(14.6)	75	GW Fine
	Average		197		2.45	(4.9)	25	4.25	(8.5)	44	

*Primary Treatment Effluent

Table 209
External Treatment Facilities
Groundwood Mills

Mill	C klpd/m2(gpd/ft2)		A hrs	A hp	ASB days	ASB hp	C klpd/m2(gpd/ft2)		PS days
001	NA	(NA)	-	-	8	320	-	-	NA
002	18.09	(444)	12	240	-	-	18.09	444	-
003	37.81	(928)	-	-	TF	-	28.40	697	-
005	NA	(NA)	-	-	8	600	-	-	-

The effluent limitations for the GW: CMN and the GW: Fine Papers Subcategories were based upon an average of the final effluent BOD5 and TSS concentrations of the three mills included in Table 208. Mill 001, which is a chemi-mechanical groundwood mill, is included in Table 208 because of the similarity of BOD5 load into biological treatment. Mill 001's raw waste BOD5 is 529, mg/l, as shown in Table 79 in Section VII, and is reduced by primary treatment to 205 mg/l. Thus, mill 001 was included in Table 208 because the treatability of the waste waters are similar to groundwood mill waste waters and the strength of the waste waters receiving biological treatment are similar. The effluent limitations were therefore based upon the demonstrated achievable levels of BOD5 and TSS and the subcategory raw waste flows shown below:

Flow:	90.9 kl/kkg (21.8 kgal/ton)	GW: Fine
Flow:	99.2 kl/kkg (23.8 kgal/ton)	GW: CMN
BOD5:	25 mg/l	
TSS:	44 mg/l	

The effluent limitations for the thermo-mechanical and the chemi-mechanical subcategories were determined using the average raw waste flow values (See Section V) and achievable levels of BOD5 and TSS determined through an examination of the relationships between the influent BOD5 and the effluent qualities. Both subcategories have raw waste BOD5 concentrations which are higher than the other two groundwood subcategories. The thermo-mechanical subcategory raw waste BOD5 is 282 mg/l which is slightly higher than the bleached kraft subcategory raw waste BOD5 levels. Since the biological treatability of groundwood waste waters is similar to bleached kraft waste water as demonstrated by groundwood mills 001, 002, and 005 which reduce their raw waste BOD5 levels of approximately 200 mg/l to approximately 25 mg/l, the effluent limitations were based upon BOD5 levels of 28 mg/l and TSS levels of 51 mg/l. The level of 51 mg/l was demonstrated to be achievable by mills using only ASB's or A's without any post storage or clarifiers. These levels are considered to be conservative since mill 001 has achieved levels of BOD5 and TSS of 22 mg/l and 35 mg/l, respectively, with an influent BOD5 level to biological treatment of 205 mg/l. Data should be available in the near future which will confirm the above levels from two thermo-mechanical mills which employ biological treatment. Mill 041 began operations in the Fall of 1975 and employs oxygen activated sludge, whereas mill 028 is 50% thermo-mechanical and 50% stone groundwood uses conventional activated sludge, and recently began operations. The thermo-mechanical limitations were therefore based upon the following:

Flow:	99.2 kl/kkg (23.8 kgal/ton)
BOD5:	28 mg/l
TSS:	51 mg/l

The estimated raw waste BOD5 levels for the chemi-mechanical subcategory are 846 mg/l (See Section V) which are substantially higher than any of the other groundwood subcategories. Mill 001 has a raw waste BOD5 of 529 mg/l and reduces the BOD5 to 205 mg/l by primary treatment. Thus, some reduction of the raw waste BOD5 of 846 mg/l can be expected but not necessarily as much as mill 001 is demonstrating.

Analysis of the chemi-mechanical waste water treatability as demonstrated by mill 001 and comparison to other subcategories raw waste BOD5 levels resulted in a BOD5 level of 35 mg/l on which the effluent limitations were based. A level of 51 mg/l for TSS was determined similarly to the thermo-mechanical subcategory. The effluent limitations were therefore based upon the following:

Flow: 113 kl/kkg (27.0 kgal/ton)
BOD5: 35 mg/l
TSS: 51 mg/l

The annual average BOD5 and TSS values as determined from the above values for the four groundwood subcategories are shown in Table 205 and were multiplied by the variability factors presented in Table 204 in order to determine the maximum 30 consecutive day and maximum day effluent limitations.

In the groundwood subcategories two of the three best mills complied with the daily maximum BOD5, the 30 day BOD5, the daily maximum TSS, and the 30 day TSS limitations; the third mill had sampling and ammoniator problems which resulted in excursions above the BOD5 and TSS limitations.

The use of zinc hydrosulfite by groundwood mills as a bleaching agent generally results in relatively high zinc levels in the process waste waters. Available data resulting from the mill surveys are shown below:

Mill	Bleaching Agent	Flow kl/kkg (kgal/ton)	Zinc mg/l	Zinc kg/kkg (lbs/ton
002	Na	95.1 (22.8)	0.097	0.009 (0.018)
003	Zn	106 (25.5)	2.63	0.89 (1.77)
005	Zn	94.7 (22.7)	0.390	0.037 (0.074)
013	Na	85.5 (20.5)	0.118	0.010 (0.020)
008	Zn	112 (26.8)	10.5	1.18 (2.35)
010	None	179 (42.9)	0.088	0.016 (0.032)
014	Na	97.6 (23.4)	0.350	0.034 (0.068)
011	Na	48.8 (11.7)	0.196	0.010 (0.019)

Three mills for which data were available used zinc hydrosulfite for brightening the pulp, mills 003, 005, and 008. These mills show distinctly higher levels of zinc in the effluent values. The limitation was based upon mills replacing zinc hydrosulfite with sodium hydrosulfite. Mill 014 had the highest concentration of zinc for the sodium based mills and therefore 0.35 mg/l was used along with subcategory flow values to determine zinc limitations. The maximum 30 consecutive days and maximum day limitations were determined by using variability factors of 1.5 and 3.0, respectively, which reflect raw waste load variability and not the variability of biological treatment systems.

Sulfite Subcategories

The effluent limitations for the sulfite subcategories were determined through a slightly modified methodology than that used for the other subcategories (i.e. bleached kraft) because of (1) the higher raw waste loads associated with the sulfite subcategories,(2) the limited application cf full scale biological treatment systems at sulfite mills, and (3) the biological treatabilities of sulfite mill waste waters. The effluent limitations were determined for each sulfite subcategory by multipling the raw waste flow by the achievable final effluent concentration which is similar to the original methodology. The difference involves the determination of the achievable BOD5 concentrations. The raw waste flow used in the calculations was that determined in Section V. The achievable effluent concentrations were those determined through the analysis in Section VII which examined the influent and effluent BOD5 concentrations for sulfite mills using full scale biological treatment systems as well as for mills using biological treatment pilot plants. The design and operation of treatment facilities treating sulfite mill waste waters were evaluated in order to determine the relationships between influent and effluent BOD5 values for those mills for which extensive data were available.

The sulfite manufacturing process results in much higher BOD5 raw waste loads than most of the other subcategories ranging from less than 100 kg/kkg (200 lbs/ton) to over 200 kg/kkg (400 lbs/ton) with raw waste BOD5 concentrations ranging from less than 400 mg/l to nearly 3,000 mg/l. The subcategory average concentrations range from 500 mg/l to nearly 1,000 mg/l and the raw waste concentrations in the range of 2,000 to 3,000 mg/l are actually associated with the concentrated, low volume waste streams. Some sulfite mills have segregated their waste streams and are treating the high concentration, low volume waste streams in biological treatment systems and treating the low concentration, high volume waste streams by primary treatment. The former waste streams are associated with the pulping operations while the latter are from the papermaking operations. As discussed in Section VII, two mills, mills 053 and 401, are presently treating the highly concentrated waste streams by biological treatment systems and the low concentration streams by primary treatment.

Two mills, mills 051 and 052, are treating all of the waste waters from both the pulping and papermaking operations. However, the treatment facility at mill 052 has been determined to be underdesigned and mill 51's treatment facility has been determined to be operated at less than maximum effectiveness. Mills 006 and 007 treat all of their waste waters in biological treatment facilities but both mills also employ groundwood pulping which has the effect of diluting the raw waste load. Because of the limited application of biological treatment systems representing BPCTCA in the sulfite subcategories, data were used when available from both full scale and pilot plant operations of biological treatment facilities at sulfite mills. The basic design parameters for sulfite mills using full scale biological treatment systems are summarized in Table 210.

The analyses of the influent and effluent data and the biological treatment facilities were discussed in Section VII. The results of a

Table 210
External Treatment Facilities
Sulfite Mills

Mill	C klpd/m2(gpd/ft2)		A hrs	A hp	ASB days	ASB hp	C klpd/m2(gpd/ft2)		PS days
51	20.78	(510)	-	-	10	1600	-	-	-
52	NA	(NA)	-	-	10	374	-	-	-
53	NA	(NA)	24	NA	-	-	19.56	480	-
006	17.52	(430)	-	-	12.6	1200	-	-	-
007	22.33	(548)	-	-	6	1100	-	-	-
401	-	-	-	-	7-8	3200	-	-	-

regression analysis are plotted in Figure 47 in Section VII and the following relationship was determined:

$$BOD5\ \underline{EFF} = 38.95 \text{ Log } BOD5\ \underline{INF} - 58$$

Using the above relationship with the BOD5 raw waste concentrations determined for each sulfite subcategory in Section V, the following achievable BOD5 effluent concentrations were determined:

Papergrade Sulfite	49.4 mg/l
Papergrade Sulfite Market Pulp	47.2 mg/l
Low Alpha Dissolving Sulfite Pulp	48.2 mg/l
High Alpha Dissolving Sulfite Pulp	58.6 mg/l

It should be pointed out that this methodology includes a conservative factor in that the relationship above was determined using influent to secondary treatment and the achievable effluent concentrations were determined using raw waste loads which are generally 10 - 15% higher than biological treatment influent values.

The effluent limitations were therefore determined using the following achievable BOD5 concentrations:

Papergrade Sulfite	50 mg/l
Papergrade Sulfite Market Pulp	48 mg/l
Low Alpha Dissolving Sulfite Pulp	50 mg/l
High Alpha Dissolving Sulfite Pulp	60 mg/l

Data from mill 051 has shown that BOD5 levels less than 50 mg/l can be achieved with full scale biological treatment systems. The annual average BOD5 concentration for mill 051 is 64.7 mg/l, but evaluation of the operation of the treatment system has shown that BOD5 effluent concentrations of less than 50 mg/l can be consistently achieved when operating at design efficiencies. During the winter months, mill 051 shuts down two or three aerators.

The TSS effluent limitations were also determined using the raw waste flow for each sulfite subcategory and achievable TSS effluent concentrations. The achievable TSS concentrations for each subcategory could not be determined in a similar manner as the BOD5 values because final effluent TSS concentrations are impacted by both influent TSS and influent BOD5 as well as the design and operation of the treatment facilities. Extensive data were not available in all cases in order to relate influent and effluent values. Several of the mills using full scale systems measure their TSS by non-standard methods (mills 006, 007, 052, 401). The only available TSS data from full scale operations was from mill 051 and mill 053 which use an aerated stabilization basin and an activated sludge system, respectively. As shown in Table 81 in Section VII these mills were achieving average TSS concentrations of 56 mg/l and 94 mg/l with influent BOD5 concentrations of 388 mg/l and 2645 mg/l, respectively. Mill 051 as pointed out previously was determined to operate the treatment facilites at less than maximum effectiveness. The data from mill 051, however, and mill 053 were used as the basis of the TSS effluent limitations. Examination of the TSS effluent data and BOD5 influent data in relationship to the sulfite subcategory raw waste loads resulted in determining the following achievable TSS concentration which were used as the basis of the effluent limitations.

Papergrade Sulfite	60 mg/l
Papergrade Sulfite Market Pulp	60 mg/l
Low Alpha Dissolving Sulfite Pulp	60 mg/l
High Alpha Dissolving Sulfite Pulp	75 mg/l

Using the raw waste flow value for each of the subcategories as shown in Section V and the appropriate BOD5 and TSS concentrations shown above, the annual average BOD5 and TSS values were determined. The maximum 30 consecutive days and maximum day effluent limitations were determined by multiplying the annual average values shown in Table 205 by the variability factors in Table 204.

In the sulfite subcategories one mill presently complies with the daily maximum BOD5, the maximum 30 day BOD5, and the daily maximum TSS, and the 30 day TSS limitations.

Soda Subcategory

There are presently two mills in the soda subcategory, mills 151 and 152, and a third soda mill, mill 150, has recently shut down operations. Mill 151 discharges its waste waters to municipal treatment and mill 150 used a trickling filter but as discussed in Section VII was ineffective in reducing BOD5 and TSS to acceptable levels. Mill 152 employs an ASB to achieve final effluent BOD5 and TSS qualities of 28 mg/l and 107 mg/l, respectively. The treatment system in use by mill 152 is deficient in the design for TSS reduction as discussed in Section VII even though acceptable levels of BOD5 are being achieved. The basic design parameters for the external treatment facilities in use by mills 150 and 151 are summarized in Table 211.

The effluent limitations were based upon BOD5 and TSS concentrations of 28 mg/l and 51 mg/l, respectively. The BOD5 value of 28 mg/l was that being achieved by mill 152 and is similar to those levels being achieved by mills in the bleached kraft subcategories. Following upgrading of the treatment system for TSS reduction at mill 152, the final effluent BOD5 concentrations will probably be lower due to more effective treatment and solids reduction. The TSS value of 51 mg/l was derived from the bleached kraft fine papers subcategory. The soda manufacturing process is very similar to the bleached kraft manufacturing process (see Section III) and thereby the raw waste characteristics and treatability are similar. Because of the similarities in waste waters and treatabilities and since the treatment facilities at mill 152 are not representative of BPCTCA, the TSS effluent limitations were based upon 51 mg/l which was the basis for the bleached kraft fine papers subcategory TSS effluent limitations.

The basis for the effluent limitations for the soda subcategory are therefore the following:

Table 211
External Treatment Facilities
Soda Mills

Mill	C klpd/m2(gpd/ft2)	A hrs	A hp	ASB days	ASB hp	C klpd/m2(gpd/ft2)	PS days
152	38.70 (950)	-	-	5	600	- -	-
150	43.23 (1061)	-	-	TF	-	35.44 870	-

Flow: 144 kl/kkg (34.5 kgal/ton)
BOD5: 28 mg/l
TSS: 51 mg/l

The annual average BOD5 and TSS values as determined from the above values were multiplied by the variability factors in Table 204 to determine the maximum 30 consecutive days and maximum day effluent limitations.

In the soda subcategory, one mill complies with the daily maximum BOD5, the maximum 30 day average BOD5, and the daily maximum TSS, but has exceeded the maximum 30 day average TSS.

Deink Subcategory

Effluent data for the five deink mills for which data were available with biological treatment facilities are shown in Table 80 in Section VII. Schematics of the external treatment facilities at these mills are presented in Figure 44 and the design parameters are shown in Table 212. The treatment systems used by these mills involve aerated stabilization basins, activated sludge, and a modified activated sludge - aerated stabilization basin system. Mill 300 is located in the Southwest and uses an ASB followed by filtration to achieve total recycle of waste waters. Table 213 presents influent and effluent waste water characteristics for the deink mills which were used as the basis of the effluent limitations and as shown, three of the five deink mills with biological treatment systems were included. Since the deink process can create high raw waste loads and have an effect upon final effluent qualities depending upon the types of waste paper used it was determined to be necessary to increase the reliability of the data base through inclusion of as many mills in Table 213 as appropriate.

The effluent limitations were therefore based upon the following:

Flow: 104 kl/kkg (25.0 kgal/ton)*
BOD5: 51 mg/l
TSS: 75 mg/l

*at 100% deink

The annual average BOD5 and TSS values as determined from the above are shown in Table 205 and were multiplied by the variability factors in Table 204 in order to determine the maximum 30 consecutive day and maximum day effluent limitations.

In the deink subcategory, two mills complied with the daily maximum BOD5 and the maximum 30 day BOD5 limitations. Of these two mills, TSS data were unavailable for one of the mills and the other mill exceeded the daily maximum TSS limitation (4 times out of 359 data points) and the maximum 30 day limitation (one 30 day period was higher than the limitation). One additional mill complied with the maximum 30 day BOD5 and the maximum 30 day TSS limitations, but exceeded the daily maximum TSS (once in 348 days of sampling) and the daily maximum BOD5 limitations.

Table 212
External Treatment Facilities
Deink Mills

Mill	C klpd/m2(gpd/ft2)		A hr	A hp	ASB days	ASB hp	C klpd/m2(gpd/ft2)		PS days
203	30.56	(750)	-	-	7.2	735	-	-	-
204	9.98	(245)	-	-	1.4	180	-	-	-
205	13.85	(340)	-	-	6	180	-	-	-
206	11.41	(280)	-	-	5	1400	19.31	(474)	-
216	21.35	(524)	5.3	NA	-	-	41.80	(1026)	-

Table 213
DEINK SUBCATEGORY
BASIS FOR EFFLUENT LIMITATIONS

Mill	Flow kl/kkg	(kgal/ton)	Raw Waste BOD5 mg/T	Treatment	BOD5 kg/kkg	(lbs/ton)	BOD5 mg/l	TSS kg/kkg	(lbs/ton)	TSS mg/l
206	93.0	(22.3)	683	C-ASB-C	3.7	(7.4)	40	9.9	(19.7)	106
205	67.6	(16.2)	-	C-ASB	4.1	(8.2)	61	-	(-)	-
216	79.2	(19.0)	909	C-A	4.2	(8.3)	52	3.6	(7.2)	45
Average	79.9	(19.2)	796		4.0	(8.0)	51	6.7	(13.4)	75

Non-Integrated Papers Mills Subcategories

Non-Integrated Fine Papers Subcategory

Effluent data for non-integrated fine paper mills are summarized in Table 83 for those mills with primary and are or secondary treatment systems. Schematics are presented for non-integrated fine paper mills with biological treatment facilities in Figure 44 and the design parameters are summarized in Table 213A. Only two mills, 257 and 284, use biological treatment systems for which data were available. The final effluent BOD5 concentrations for mills 257 and 284 were 86 mg/l and 110 mg/l, respectively. In addition, the TSS concentration for mill 284 was 102 mg/l. The average BOD5 concentration for all the mills in Table 83 that have primary treatment facilities was 86 mg/l (excluding mill 279) indicating that primary treatment is not adequate to achieve high quality effluents. The secondary treatment systems in use by mills 257 and 284 were only achieving an average BOD5 concentration of 98 mg/l which is also not a high quality effluent indicating that the biological treatment systems in use by the two mills are not representative of BPCTCA.

Because no mills were demonstrating treatment systems representative of BPCTCA, the effluent limitations were based upon a BOD5 level of 38 mg/l and a TSS level of 51 mg/l. Bleached kraft mills which used external treatment systems representative of BPCTCA achieved final effluent BOD5 levels of 9 to 38 mg/l with raw waste BOD5 of amount 230 to 250 mg/l. Since less effective treatment would be expected through treatment of lower raw waste BOD5 levels (i.e., NI fine papers: 170 mg/l), 38 mg/l was used as the basis of the BOD5 effluent limitations. A level of 51 mg/l was used for the TSS limitations which is the same level as the bleached kraft fine paper subcategory. The BOD5 and TSS levels were based upon the bleached kraft fine papers subcategory levels since similar products are manufactured which result in relatively similar waste waters in regards to the paperaking operations. It should be pointed out that several mills achieve or nearly achieve the effluent limitations using only primary treatment. These mills use extensive inplant controls as an alternative to external controls representative of BPCTCA. The flow basis for the effluent limitations was 63.3 kl/kkg (15.2 kgal/ton) as developed in Section V.

The effluent limitations were therefore based upon the following:

Flow: 63.3 kl/kkg (15.2 kgal/ton)
BOD5: 38 mg/l
TSS: 51 mg/l

The annual average BOD5 and TSS values as determined from the above and shown in Table 205 were multiplied by the variability factors in Table 204 in order to determine the maximum 30 consecutive day and maximum day effluent limitations.

In the NI fine papers subcategory, two mills complied with the daily maximum BOD5, the maximum 30 day BOD5, the daily maximum TSS, and the maximum 30 day TSS limitations. One mill had limited BOD5 data but

Table 213A
External Treatment Facilities
Non-Integrated Fine Mills

Mill	C klpd/m2	(gpd/ft2)	A hrs	A hp	ASB days	ASB hp	C klpd/m2	(gpd/ft2)	PS days
250	8.80	(216)	-	-	9	NA	-	-	-
251	-	(-)	-	-	90	30	-	-	-
257	32.63	(801)	22	150	-	-	32.63	801	-
263	10.06	(247)	-	-	3.5	60	-	-	-

did comply with the daily maximum BOD_5 (data was insufficient for maximum 30 day BOD_5 and TSS comparisons as well as daily maximum TSS). Two mills complied with the maximum 30 day TSS and the daily maximum TSS but exceeded the BOD_5 limitations. One mill complied with the maximum 30 day TSS limitations but exceeded the other limitations.

Non-Integrated Tissue Papers Subcategories

Table 84 shows effluent data for non-integrated tissue mills and is divided into the following three groups: Group 1: 100% purchased pulp, Group 2: Purchased Pulp and Waste Paper, Group 3: 100% Waste paper. BPCTCA for the non-integrated tissue subcategory includes only primary treatment as most of the BOD_5 in the raw waste waters is associated with the fibrous materials (TSS) in the mill waste waters. In these cases, removal of the TSS also removes a large amount of the raw waste BOD_5. Three forms of primary treatment are used by NI tissue mills: (1) clarifiers, (2) dissolved air flotation, and (3) settling basins. Each of these is capable of achieving high quality levels of BOD_5 and TSS in effluents from NI tissue mills. Examination of the BOD_5 and TSS levels achieved by mills in each of the three groups results in the following conclusions:

(1) High quality effluents can be achieved with primary treatment by mills using 100% purchased pulp or by mills using varying proportions of waste paper and purchased pulp.

(2) Mills using 100% waste paper and primary treatment cannot achieve similar quality effluents as mills using purchased pulp with similar treatment systems. This is due to higher levels of soluble BOD_5 in the waste waters of mills using 100% waste paper.

(3) Biological treatment is necessary for mills using 100% waste paper to achieve high quality effluents.

Since biological treatment is not the basis of the limitations for NI tissue mills, the effluent limitations were determined by averaging the final effluent BOD_5 and TSS values in kg/kkg (lbs/ton) rather than using the RWL flow and final concentrations. The NI tissue papers subcategory effluent limitations are based upon the average of group 1 and 2 from Table 84.

The BOD_5 and TSS values which were used as the basis of the effluent limitations for the NI tissue papers subcategory are therefore the following:

BOD_5: 3.5 kg/kkg (7.0 lbs/ton)
TSS: 2.85 kg/kkg (5.7 lbs/ton)

These values were determined from the data presented in Table 214 along with their corresponding concentrations using the subcategory raw waste flow of 95.5 kl/kkg (22.9 kgal/ton). In order to determine the maximum 30 consecutive day and maximum day limitations, the annual average values were multiplied by the variability factors in Table 204 which apply specifically to the NI tissue paper subcategory.

TABLE 214
NI TISSUE MILLS
BASIS FOR EFFLUENT LIMITATIONS

Mill	Flow kl/kkg(kgal/ton)	Raw Waste Load BOD5 kg/kkg(lbs/ton)	Raw Waste Load TSS kg/kkg(lbs/ton)	Treatment	Final Effluent BOD5 kg/kkg(lbs/ton)	Final Effluent TSS kg/kkg(lbs/ton)
308	115.5 (27.7)	16.7 (33.4)	30.1 (60.3)	C	4.5 (9.1)	3.8 (7.7)
325	130.9 (31.4)	- (-)	- (-)	DAF	17.5 (35.1)*	- (-)
318	140.5 (33.7)	- (-)	- (-)	C	3.5 (7.1)	4.6 (9.3)
315	66.3 (15.9)	8.7 (17.4)	25.7 (51.5)N	DAF	4.4 (8.9)	- (-)
306	43.4 (10.4)	- (-)	- (-)	DAF	1.0 (2.0)	- (-)
252	48.0 (11.5)	- (-)	- (-)	C-PS	3.4 (6.9)	1.1 (2.2)
319	120.1 (28.8)	7.3 (14.7)	35.8 (71.7)N	SB	2.5 (5.0)	- (-)
208	61.3 (14.7)	22.8 (45.7)	72.0 (145)	C	6.2 (12.4)	3.2 (6.4)
329	153.9 (36.9)	- (-)	- (-)	C	6.1 (12.2)	3.5 (7.1)
302	50.9 (12.2)	11.7 (23.5)	36.6 (73.3)N	C-PS	3.3 (6.6)	- (-)
310	96.7 (23.2)	7.4 (14.8)	22.4 (44.8)	C	2.7 (5.5)	3.0 (-)
324	94.7 (22.7)	13.6 (27.3)	51.5 (103.0)	SB	1.4 (2.8)	1.5 (3.0)
309	69.6 (16.7)	14.6 (29.3)	25.2 (50.4)N	C	1.9 (3.8)	- (-)
333	133.4 (32.0)	- (-)	- (-)	C	4.8 (9.6)	- (-)
259	73.8 (17.7)	9.6 (19.2)	32.1 (64.3)	C, DAF	3.9 (7.9)	1.9 (3.9)
326	72.6 (17.4)	- (-)	- (-)	C	2.4 (4.9)	- (-)
Average	92.2 (22.1)	12.5 (25.0)	41.7 (83.5)		3.5 (7.0)	2.8 (5.7)

* Not included in averages

Because no mills were demonstrating treatment systems representative of BPCTCA (biological treatment) for NI tissue papers (FWP) mills, the effluent limitations were based upon a BOD5 level of 38 mg/l and a TSS level of 55 mg/l. The bleached kraft segment achieved high quality effluents ranging from 10 - 38 mg/l and since non-integrated tissue (FWP) mills are relatively small and have little experience in achieving high quality levels of BOD5 by biological treatment, 38 mg/l was used as the basis of the BOD5 effluent limitations. A level of 55 mg/l was used for the TSS limitation which was based upon the bleached kraft BCT subcategory because of the similarities of the papermaking operations.

The effluent limitations were therefore based upon the following:

Flow: 94.2 kl/kkg (22.6 kgal/ton)
BOD5: 38 mg/l
TSS: 55 mg/l

The maximum 30 consecutive days and maximum day limitations were determined by multiplying the annual average values determined from the above values by the variability factors shown in Table 204.

In the NI tissue subcategories, four mills complied with the daily maximum BOD5 and the maximum 30 day BOD5 limitations. Of these 4 mills, two complied with both the daily maximum TSS and the maximum 30 day TSS limitations; the other two mills did not have TSS data available. In addition, three mills having limited BOD5 data complied with the daily maximum BOD5 limitation (data was insufficient for maximum 30 day BOD5, and TSS comparisons except for one mill which had limited TSS data and complied with the daily maximum TSS limitation).

PRETREATMENT REQUIREMENTS

No constituents of the effluent discharged from mills within the bleached kraft, groundwood, sulfite, soda, deink, and non-integrated paper mills segment of the pulp, paper, and paperboard point source category have been identified which would interfere with, pass through, or otherwise be incompatible with a well-designed and operated publicly owned biological waste water treatment plant. The exception to this, however, is the discharge of zinc from groundwood mills which use zinc hydrosulfite as a bleaching agent. Pretreatment standards on zinc which are equal to the BPCTCA limitations are proposed for groundwood mills using zinc hydrosulfite. The pretreatment standards can be achieved by substituting sodium hyrosulfite for zinc hydrosulfite in the bleaching process which is commonly practiced by many groundwood mills.

SECTION X

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BATEA)

INTRODUCTION

The effluent limitations predicated on the application of the Best Available Technology Economically Achievable (BATEA) are to be achieved not later than July 1, 1983. These are not based upon an average of the best performance within a given subcategory under study, but have been determined by identifying the best control and treatment technology employed by a mill in a given subcategory, and by applying technologies used by other industries or demonstrated by pilot plant performance on waste waters generated by mills in the pulp and paper industry.

Consideration was also given to:

a. the age and size of equipment and facilities involved;

b. the process employed;

c. the engineering aspects of the application of control technologies;

d. the cost of application in relation to reduction benefits (including energy requirements);

e. the non-water quality environmental impact.

This level of technology emphasizes both internal process improvements and external treatment of waste waters. It will require existing mills to implement programs designed to achieve:

1. Significant restrictions in the volume of waste water generated and reductions in BOD5 and TSS raw waste load through internal reuse and recovery measures;

2. Improvement and modernization of the chemical handling, recovery, and recycle systems employed.

In addition the application of more advanced water treatment processes will be required to meet the BATEA limitations.

EFFLUENT REDUCTION ATTAINABLE THROUGH APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Based upon the information available to the Agency, the point source discharge limitations for each identified pollutant are shown in Table 215 and may be attained through the application of Best Available Technology Economically Achievable.

TABLE 215
BATEA
Effluent Limitations in kg/kkg(lbs/ton)

Subcategory	Maximum 30 Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Dissolving Kraft	5.8 (11.6)	3.95(7.9)	11.15(22.3)	7.35(14.7)
Market Kraft	3.55(7.1)	2.6 (5.2)	6.8 (13.6)	4.8 (9.6)
BCT Kraft	3.0 (6.0)	2.05(4.1)	5.8 (11.6)	3.8 (7.6)
Fine Kraft	2.55(5.1)	1.75(3.5)	4.95(9.9)	3.25(6.5)
Papergrade Sulfite	8.9 (17.8)	3.0 (6.0)	17.1 (43.2)	5.6 (11.2)
Market Sulfite	10.05(20.1)	3.45(6.9)	19.3 (38.6)	6.4 (12.8)
Low Alpha Dissolving Sulfite	11.4 (22.8)	3.35(6.7)	21.9 (43.8)	6.25(12.5)
High Alpha Dissolving Sulfite	13.8 (27.6)	4.75(9.5)	26.5 (53.0)	8.8 (17.6)
GW-Chemi-Mechanical	3.9 (7.8)	1.65(3.3)	3.15(6.3)	3.1 (6.2)
GW-Thermo-Mechanical	2.1 (4.2)	1.45(2.9)	4.05(8.1)	2.65(5.3)
GW-CMN Papers	1.85(3.7)	1.45(2.9)	3.55(7.1)	2.65(5.3)
GW-Fine Papers	1.75(3.5)	1.35(2.7)	3.35(6.7)	2.55(5.1)
Soda	2.55(5.1)	1.75(3.5)	4.95(9.9)	3.25(6.5)
Deink	2.6 (5.2)	2.7 (5.4)	5.05(10.1)	4.95(9.9)
NI Fine Papers	1.35(2.7)	0.7 (1.4)	2.6 (5.2)	1.3 (2.6)
NI Tissue Papers	2.15(4.3)	1.1 (2.2)	4.15(8.3)	2.05(4.1)
NI Tissue Papers(FWP)	1.9 (3.8)	1.0 (2.0)	3.7 (7.4)	1.85(3.7)

pH for all subcategories shall be within the range 5.0 to 9.0.

TABLE 215
BATEA
Effluent Limitations in kg/kkg(lbs/ton)
(cont.)

Color

Subcategory	Maximum 30 Day Average kg/kkg(lbs/ton)	Maximum Day kg/kkg(lbs/ton)
Dissolving Kraft	125 (250)	250 (500)
Market Kraft	95.0 (190)	190 (380)
BCT Kraft	65.0 (130)	130 (260)
Fine Kraft	65.0 (130)	130 (260)
Soda	65.0 (130)	130 (260)

Zinc*

Subcategory	Maximum 30 Day Average kg/kkg(lbs/ton)	Maximum Day kg/kkg(lbs/ton)
GW:Chemical-mechanical	0.048 (0.096)	0.095 (0.19)
GW:Thermo-mechanical	0.0415(0.083)	0.085 (0.17)
GW:CMN Papers	0.0395(0.079)	0.085 (0.17)
GW:Fine Papers	0.0415(0.083)	0.075 (0.15)

*Applicable only to mills using zinc hydrosulfite.

The average of daily values for 30 consecutive days should not exceed the maximum 30 day average limitations shown in Table 215. The value for any one day should not exceed the daily maximum limitations shown in this table. The limitations shown are in kilograms of pollutant per metric ton of production (pounds of pollutant per ton of production). Effluents should always be within the pH range of 5.0 to 9.0.

Production in kkg(tons) is defined as annual tonnage produced from pulp dryers (in this case of market pulp) and paper machines (for paper/ board) divided by the number of production days in the 12-month period. Pulp production is to be corrected, if necessary, to the "air dry" moisture basis.

Effluent limitations will be established at a later date for ammonia nitrogen for mills in the sulfite and dissolving sulfite subcategories using an ammonia base. No specific limitation has been developed because of the limited availability at this time of meaningful data. Indications are that discharges in the range of 1 to 3 kg/kkg (2 to 5 lb/ton) can occur. No technology for the removal of nitrogen has been applied within the pulp and paper industry. Effluent limitations have not been established for ammonia nitrogen as it is not considered to be economically achievable at this time for these two subcategories.

Effluent limitations for color will be developed for all sulfite and dissolving sulfite mills at a later date. Sparse data indicate that color discharges from these mills contain 200 to 250 kg/kkg (400 to 500 lb/ton). No technology for removing color from these effluents is presently available or in a stage of development which is foreseen to be available by 1983. Thus, limitations for color have not been established because it is not considered to be economically achievable for these two subcategories at this time.

IDENTIFICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The Best Available Technology Economically Achievable consists of the Best Practicable Control Technology Currently Available as defined in Section IX and discussed in Sections VII and VIII of this report. It also includes the additional internal mill improvements and external advanced waste water treatment practices as discussed in detail in Section VII and VIII.

It is emphasized here that these technologies are not of themselves required. Due to economic, space, or other factors, many mills may choose to use alternative technologies.

RATIONALE FOR THE SELECTION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Age and Size of Equipment and Facilities

There is a wide range, in both size and age, among mills in the subcategories studies. However, internal operations of most older mills have been upgraded, and most of these mills currently operate very efficiently. The technology for updating of older mills is well established, and does not vary significantly from mill to mill within a given subcategory. As discussed in some detail in Sections IV and V, there is little or no basis for quantifying the effect of age, size, or geographical location, on the quantity or quality of the waste water generated by mills within a subcategory.

Processes Employed

All mills within each subcategory studied use the same basic production processes. Although there are deviations in equipment and production procedures, these deviations do not significantly alter the characteristics of the waste water generated. The treatability of these wastes is similar.

Application of BATEA may require major changes in existing industrial processes for the subcategories studied. Incorporation of additional systems, treatment processes, and control measures can be accomplished in most cases through changes in piping, and through design modifications to existing equipment. Such alterations can be carried out by mills within a given subcategory.

Engineering Aspects of the Application of Control Technologies

Much of the technology to achieve these effluent limitations is practiced within the pulp and paper industry by outstanding mills in a given subcategory. Sufficient research and pilot work has been carried out on color removal to demonstrate the feasibility of achieving the effluent limitations. The technology required for all best available treatment and control systems will necessitate sophisticated monitoring, sampling, and control programs, as well as properly trained personnel.

Cost of Achieving Effluent Reduction (and Energy Requirements)

The total projected costs of BATEA reflect an increase of production expenses as shown in Tables 151 through 184 of Section VIII. These increases include both internal control and external waste improvements and they are based on 360 days of production per year. It should be emphasized however, that some mills have carried out many of these improvements and, consequently, their increased costs would be less than those shown. The total incremental cost of achieving the BATEA effluent limitations for all mills is approximately one billion dollars.

The energy requirements associated with the application of pollution control technologies are developed in Section VIII and shown in Tables 197 to 201.

Non-Water Quality Environmental Impact

The technology cited will not create any significant increase in odors, or in noise levels beyond those observed in well-designed municipal waste water treatment systems which currently are being approved by the federal government for construction in populated areas. Further, no hazardous chemicals are required as part of this technology. Further discussion of non-water quality environmental impacts is included in Section VIII.

RATIONALE FOR SELECTION OF EFFLUENT LIMITATIONS

The rationale used in developing the effluent limitations for BOD_5, and TSS is discussed below for each of the subcategories as is the rationale for the color limitations for the bleached kraft and soda subcategories. Specifically identified are the methods used to establish the limitations for the maximum 30 consecutive day average and the daily maximum value for BOD_5, TSS, and color.

The BATEA effluent limitations were based upon the capabilities of the internal and external pollution control technologies identified in Section VII and VIII.

The general approach in determining the effluent limitations is given below:

1. The best mill or mills within each subcategory were identified from a standpoint of raw waste loads.
2. The best mill or mills were evaluated to determine that the mill or mills were representative of other mills within the subcategory.
3. The extent of internal controls at the best mill or mills was then thoroughly evaluated to determine the general relationships between raw waste load and internal controls.
4. Estimates of possible raw waste load reductions, if any, were made for the mills which would be a result of installation of additional internal controls identified as BATEA in Section VII and VIII that were not in use by the best mills.
5. The raw waste load achievable by the best mill or mills in each subcategory by the use of BATEA was thus established.
6. The effluent reduction performances of the identified external treatment systems were than used in conjunction with the established raw waste load per subcategory to determine the effluent limitations.

The maximum 30 consecutive days and maximum day limitations were determined by multiplying the annual average values by the variability factors shown in Table 216. The development of the variability factors is discussed in Section VII.

Table 217 summarizes the BATEA raw waste loads and Table 218 summarizes the flow values, BOD5, and TSS concentrations for each subcategory which were used as the basis for the BATEA limitations.

Bleached Kraft Subcategories

Dissolving Kraft Subcategory

The dissolving kraft raw waste load was based upon mill 127 which had the following flow, BOD5, and TSS raw waste loads:

Flow: 229.3 kl/kkg (55.0 kgal/ton)
BOD5: 40 kl/kkg (80 lbs/ton)
TSS: 87.5 kl/kkg (175 lbs/ton)

Evaluation of the inplant controls presently in use at mill 127 and the additional controls identified as BATEA in Section VII and VIII resulted in the following estimates of RWL reduction:

Flow: 12.5 kl/kkg (3.0 kgal/ton)
BOD5: 2.5 kg/kkg (5.0 lbs/ton)
TSS: 2.5 kg/kkg (5.0 lbs/ton)

Thus, the BATEA RWL for the dissolving kraft subcategory were the following:

Flow: 216.8 kl/kkg (52.0 kgal/ton)
BOD5: 37.5 kg/kkg (75.0 lbs/ton)
TSS: 85.0 kg/kkg (170.0 lbs/ton)

Mill 127 presently achieves 24 mg/l BOD5 in the final effluent from the aerated stabilization basin which is the best quality effluent of the two mills in the dissolving kraft subcategory that have biological treatment facilities. This level of BOD5 is, however, higher than that achieved by many other bleached kraft mills of comparable raw waste BOD5 concentrations. Table 219 presents BOD5 and TSS concentration for the top eight bleached kraft mills which were derived from Table 206 in Section IX. As shown, the averages for BOD5 and TSS for the "best of the best" external treatment systems are 13.5 mg/l and 31 mg/l, respectively. The range for final effluent BOD5 is from 9 to 18 mg/l with raw waste BOD5 ranging from 120 mg/l to 264 mg/l. The average BOD5 raw waste for the eight mills was 201 mg/l and the bleached kraft dissolving pulp subcategory average BOD5 raw waste was 173 mg/l. It should be pointed out that mill 127's present BOD5 raw waste is 174 mg/l. Improved operation of the external treatment system and the addition of effluent coagulation and filtration as identified as BATEA in Section VIII should allow mill 127 to achieve an average BOD5 concentration of 15 mg/l (as demonstrated by the mills in Table 219 which do not even use filtration). Filtration of biological treatment effluents reduces TSS to levels between 5 to 10

Table 216

BATEA Variability Factors

Bleached Kraft Soda, Groundwood, Sulfite, Deink,
NI Fine Papers, and NI Tissue (fwp) Subcategories

Parameter	Maximum 30 Days	Maximum Day
BOD_5	1.78	3.42
TSS	1.82	3.38

NI Tissue Papers Subcategory

Parameter	Maximum 30 Days	Maximum Day
BOD_5	1.79	3.25
TSS	1.76	3.60

TABLE 217
SUBCATEGORY RAW WASTE LOADS
BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Subcategory	FLOW kl/kkg(kgal/ton)	BOD5 kg/kkg(lbs/ton)	BOD5 mg/L	TSS kg/kkg(lbs/ton)	TSS mg/L
BK:Diss.	217 (52.0)	37.5 (75.0)	173	85.0 (170)	392
BK:Mkt	142 (34.0)	26.5 (53.0)	187	65.0 (130)	458
BK:BCT	113 (27.0)	26.0 (52.0)	231	46.5 (93.0)	413
BK:Fine	95.9 (23.0)	23.5 (47.0)	245	46.5 (93.0)	485
Soda	95.9 (23.0)	30.0 (60.0)	313	65.0 (130)	678
GW:CMP	91.3 (21.9)	79.5 (159)	871	22.5 (45.0)	246
GW:TMP	79.2 (19.0)	26.5 (53.0)	334	25.0 (50.0)	316
GW:Fine	75.1 (18.0)	16.0 (32.0)	213	45.0 (90.0)	600
GW:CMN	79.2 (19.0)	16.0 (32.0)	202	45.0 (90.0)	568
Sulfite:Paper	167 (40.0)	75.0 (150)	450	75.0 (150)	450
Sulfite:Mkt	188 (45.0)	100 (200)	533	30.0 (60.0)	160
Low Alpha	183 (44.0)	115 (230)	627	85.0 (170)	463
High Alpha	172 (41.2)*	212.5 (425)	1237	85.0 (170)	330
Deink	73.4 (17.6)	82.5 (165)	1124	178.5 (357)	2432
NI Fine	38.4 (9.2)	9.5 (19.0)	248	30.0 (60.0)	782
NI Tissue	60.5 (14.5)	10.0 (20.0)	165	28.0 (56.0)	463
NI Tissue (FWP)	53.8 (12.9)	13.0 (26.0)	242	110.5 (221)	2054

* BOD5 only, TSS RWL Flow = 258 kl/kkg(61.8 kgal/ton)

TABLE 218
BASIS FOR BATEA EFFLUENT LIMITATIONS

Subcategory	FLOW kl/kkg(kgal/ton)	RWL BOD5 mg/L	Final Effluent (Annual Average) BOD5 mg/L	TSS mg/l	BOD5 kg/kkg(lbs/ton)	TSS kg/kkg(lbs/ton)
BK:Diss.	217.0 (52.0)	173	15	10	3.25 (6.5)	2.15 (4.30)
BK:Mkt	142.0 (34.0)	187	14	10	2.00 (4.0)	1.40 (2.80)
BK:BCT	113.0 (27.0)	231	15	10	1.70 (3.4)	1.15 (2.30)
BK:Fine	95.9 (23.0)	245	15	10	1.45 (2.9)	0.95 (1.90)
Soda	95.9 (23.0)	313	15	10	1.45 (2.9)	0.95 (1.90)
GW:CMP	91.3 (21.9)	871	24	10	2.20 (4.4)	0.90 (1.80)
GW:TMP	79.2 (19.0)	334	15	10	1.20 (2.4)	0.80 (1.60)
GW:Fine	75.1 (18.0)	213	13	10	1.00 (2.0)	0.75 (1.50)
GW:CMN	79.2 (19.0)	202	13	10	1.05 (2.1)	0.80 (1.60)
Sulfite Paper	167.0 (40.0)	450	30	10	5.00 (10.0)	1.65 (3.30)
Sulfite:Mkt	188.0 (45.0)	533	30	10	5.65 (11.3)	1.90 (3.80)
Low Alpha	183.0 (44.0)	627	35	10	6.40 (12.8)	1.85 (3.70)
High Alpha	172.0 (41.2)*	1237	45	10	7.75 (15.5)	2.60 (5.20)
Deink	73.4 (17.6)	1124	20	20	1.45 (2.9)	1.45 (2.90)
NI Fine	38.4 (9.2)	248	20	10	0.75 (1.5)	0.38 (0.77)
NI Tissue	60.5 (14.5)	165	20	10	1.20 (2.4)	0.60 (1.20)
NI Tissue (FWP)	53.8 (12.9)	242	20	10	1.10 (2.2)	0.55 (1.10)

* BOD5 only, TSS Flow = 258 kl/kkg(61.8 kgal/ton)

TABLE 219
BLEACHED KRAFT MILLS
BEST OF THE BEST MILLS (mg/L)

Mill	Subcategory	Treatment	Raw Waste BOD5	Final Effluent BOD5	Final Effluent TSS
101	Fine-Mkt	C-ASB-PS	186	9	13
130	Mkt	SB-ASB	120	11	25
119	Fine	C-A	240	11	33
117	BCT	C-ASB	146	12	25
112	Fine	C-ASB-C	224	13	139N
105	BCT	C-ASB-PS	224	16	-
106	Fine-Mkt	C-ASB-PS	204	18	20
107	Fine-Mkt	C-A-PS	264	18	71
		Average	201	13.5	31

mg/l as discussed in Section VII. In addition to TSS reduction, approximately 20% to 25% of the BOD5 is removed by filtration. The effluent limitations were thereby based upon 15 mg/l BOD5 and 10 mg/l TSS.

Market Kraft Subcategory

The market kraft subcategory raw waste load was essentially based upon three mills, 130, 114, and 140. Mills 140 and 139 have flow volumes of 79.2 kl/kkg (19.0 kgal/ton) and 85.1 kl/kkg (20.4 kgal/ton), respectively. The other market kraft mills cannot necessarily be expected to achieve these flow values and thereby the flows used for BATEA limitations were based upon mill 114 which had a flow of 172.6 kl/kkg (41.4 kgal/ton). Evaluation of the internal, controls in use by mill 114 resulted in estimates of flow reductions of about 29.2 kl/kkg (7.0 kgal/ton). The BOD5 raw waste load was based on mills 130 and 140. Evaluation of the inplant controls in use at mills 114, 130, and 140 resulted in estimates that BOD5 reductions of 5.0 kg/kkg (10.0 lbs/ton) could be achieved by BATEA internal controls not yet in use by mill 130 and that the BOD5 levels were achievable as demonstrated by mill 140. The estimated raw waste loads for BATEA were the following:

Flow:	141.8 kl/kkg (34.0 kgal/ton)
BOD5:	26.5 kg/kkg (53.0 lbs/ton)
TSS:	65.0 kg/kkg (130 lbs/ton)

The above estimated raw waste load is similar to that presently being achieved by mill 185 as shown in Table 51 in Section V. The raw waste flow at mill 185 is presently 143 kl/kkg (34.2 kg/kkg) and the raw waste BOD5 is presently 32.4 kg/kkg (64.7 lbs/ton). Application of BATEA inplant controls not presently in use at mill 185 should allow the mill to achieve a raw waste load lower than the above BATEA raw waste load. The effluent limitations for BATEA were based upon 10 mg/l TSS and 14 mg/l BOD5 in conjuction with 141.8 kl/kkg (34.0 kgal/ton). As discussed previously, the capabilities of the coagulation and filtration systems results in levels of TSS in effluents of 5 - 10 mg/l TSS. The average of mill 130 and mill 114 final effluent BOD5 values was 18 mg/l. Application of filtration technologies will reduce effluent BOD5 by approximately 20% to 25%. The BOD5 effluent limitations were thereby based upon 14 mg/l. The subcategory average BOD5 raw waste load is 187 mg/l whereas the average of mills 130 and 114 is 235 mg/l indicating that the BOD5 levels are achievable.

Bleached Kraft - BCT Papers Subcategory

The BCT Papers Subcategory raw waste load was based upon mill 111 which had the following flow, BOD5, and TSS raw waste loads:

Flow:	134.7 kl/kkg (32.3 kgal/ton)
BOD5:	30.8 kg/kkg (61.6 lbs/ton)
TSS:	51.5 kg/kkg (103 lbs/ton)

The internal controls presently in use by mill 111 are shown below:

- Knots collection and disposal
- Decker filtrate for brown stock washer showers
- Jump stage countercurrent washing
- Evaporator surface condenser
- Evaporator boilout tank
- Alarms on chemical tanks
- Paper machine vacuum saveall
- Paper machine high pressure showers
- Paper machine white water showers
- Vacuum pumps seal water reuse
- Pulp mill spill collection from tanks, equipment, and drains
- Mechanical conveyor for log transport
- Fourth stage brown stock washer
- Close-up screen room
- Causticizing area spill collection system
- Evaporator condensate for causticizing makeup
- Lime mud storage pond
- Cooling water segregation and reuse
- Paper mill stock spill collection system
- Pulp mill spill collection from washers

Evaluation of the internal controls in use by mill 111 in relationship to the present raw waste loads and estimating the raw waste load reductions possible by installation of any BATEA internal technologies not used by mill 111 and by more intensive process control to further reduce impacts or raw waste load resulted in the estimates of RWL reductions for mill 111 are given below.

Flow:	20.9 kl/kkg (5.0 kgal/ton)
BOD5:	5.0 kg/kkg (10.0 lbs/ton)
TSS:	5.0 kg/kkg (10.0 lbs/ton)

Thus, the RWL for the BCT Papers Subcategory used in developing the BATEA effluent limitations and the costs of achieving the limitations are the following:

Flow:	112.6 kl/kkg (27.0 kgal/ton)
BOD5:	26.0 kg/kkg (52.0 lbs/ton)
TSS:	46.5 kg/kkg (93.0 lbs/ton)

The BATEA effluent limitations were based upon 10 mg/l TSS, 15 mg/l BOD5, and 112.6 kl/kkg (27.0 kgal/ton) as shown in Table 218. Use of coagulation and filtration systems treating the biological treatment effluent will achieve at least 10 mg/l TSS as discussed in Section VII. Mills 117 and 105 are presently achieving BOD5 effluent levels of 16 mg/l and 12 mg/l, respectively, with an average of 14 mg/l. The average BOD5 raw waste for mills 117 and 105 is 185 mg/l whereas the subcategory average is 231 mg/l. Because the average raw waste load for mills 117 and 105 is less than the subcategory average, the BOD5 effluent limitations were based upon 15 mg/l which takes into account a 20% to 25% reduction in BOD5 achieved by the application of filtration technologies.

Bleached Kraft - Fine Papers Subcategory

The bleached kraft fine papers subcategory raw waste loads which were used in determining the BATEA effluent limitations and the costs of achieving the limitations were based upon mill 119 which had the following RWL:

Flow:	97.2 kl/kkg	(23.3 kgal/ton)
BOD5:	23.4 kg/kkg	(46.7 lbs/ton)
TSS:	46.5 kg/kkg	(92.9 lbs/ton)

The internal controls presently in use by mill 119 are shown below:

Knots collection and disposal
Decker filtrate for brown stock washer showers
Jump stage countercurrent washing
Evaporator surface condenser
Evaporator boilout tank
Black liquor storage tank spill collection
Vacuum pumps seal water reuse
Alarms on chemical tanks
Paper machine high pressure showers
Paper machine white water showers
Use of steam in drum barkers
Fourth stage brown stock washer
Close-up screen room
Pulp mill spill collection from washers
Pulp mill spill collection from tanks, equipment, and drains
Causticizing area spill collection system
Evaporator condensate for causticizing makeup
Lime mud storage pond
Cooling water segregation and reuse
Paper mill stock spill collection system

Evaluation of the internal controls identified in Sections VII and VIII as BATEA and those presently in use by the mill showed that the mill was already achieving effluent raw waste loads representative of the BATEA. Thus, the BATEA effluent limitations were based upon mill 119 and, the mill's RWL were rounded to the following:

Flow:	95.9 kg/kkg	(23.0 kgal/ton)
BOD5:	23.5 kg/kkg	(47.0 lbs/ton)
TSS:	46.5 kg/kkg	(93.0 lbs/ton)

The BOD5 and TSS concentrations on which the BATEA effluent limitations were based were 15 mg/l and 10 mg/l, respectively. The TSS level of 10 mg/l has been discussed previously. The BOD5 effluent limitations were based upon evaluation of the effluent levels presently being achieved by the following mills in conjunction with the application of filtration technologies which remove 20% to 25% of the remaining BOD5.

Mill	Treatment	Raw Waste BOD5 (mg/l)	Final Effluent BOD5 (mg/l)

101	C-ASB-PS	186	9
119	C-A	240	11
112	C-ASB-C	224	13
106	C-ASB-PS	204	18
107	C-ASB-PS	264	18
Average		224	14

The average subcategory raw waste load is 245 mg/l whereas the average of above mills is 224 mg/l. The BOD5 effluent limitations were based upon 15 mg/l which takes into account the differences in raw waste load and the BOD5 reductions associated with the filtration technologies.

Color Limitations

The color effluent limitations were based upon the color data presented in Table 49 in Section V. Analysis of the data in the table shows four significant levels of color: (1) Dissolving kraft, (2) Market kraft, (3) BCT Papers, and (4) Fine Papers. The raw waste color loads for the above subcategories are the following: 415 kg/kkg (830 lbs/ton), 310 kg/kkg (620 lbs/ton), 225 kg/kkg (450 lbs/ton), and 150 kg/kkg (300 lbs/ton), respectively. It should be pointed out that the data used in determining these color RWL is the highest of stream 09 or stream 79 data per mill in Table 49. The dissolving kraft and market kraft RWL were based upon mills 127 and 114, respectively, whereas the BCT RWL was based upon mills 105, 125, and 117. Mills 101, 110, 106, 116, and 119 were used as the basis for the fine paper's RWL.

As identified in Sections VII and VIII, the "minimum lime" process for color removal was suggested for application to the caustic extraction effluent and a portion of the decker effluent. Color data obtained from surveyed mills were insufficient to establish reliable color values for those streams. As discussed in Section VII, however, the minimum lime process can attain a 90 to 94 percent color reduction (260) (261). Comparable streams treated by the massive lime process can achieve similar results (247).

At these levels of color reductions in the extraction and decker effluents, total mill raw waste color is reduced approximately 72% (232). By BATEA internal controls such as extensive spill control and more efficient liquor recovery, it is estimated that at least 10% additional color reduction will occur. Thus, minimum lime and BATEA controls should reduce raw waste color loads by over 80%. Applying 80% reduction to the subcategory RWL given above resulted in the color values based upon annual averages. Variability factors of 1.5 and 3.0 which were based upon full scale operations of color removal technologies at kraft mills for maximum 30 consecutive days and maximum day to annual average, respectively, were used to determine the effluent limitations. The RWL used in calculating the limitations for BCT and Fine subcategories was based upon 212.5 kg/kkg (425 lbs/ton) which was an average of six mills manufacturing various proportions of BCT papers, fine papers, and market pulp. This RWL was used because of the relatively large range of color RWL for mills producing varying proportions of fine papers and market pulp.

Soda Subcategory

The soda subcategory raw waste load used in developing costs and in determining the BATEA effluent limitations was based upon mills 151 and 152. The average flow for mill 151 and the average BOD5 RWL for mill 152 are shown below:

FLow:	117.6 kl/kkg (28.2 kgal/ton)
BOD5:	34.0 kg/kkg (68.0 lbs/ton)

Evaluation of the internal controls used at these mills and those additional internal controls identified in Section VIII as BATEA resulted in the following estimates of flow and BOD5 reductions:

Flow:	20.85 kl/kkg (5.0 kgal/ton)
BOD5:	4.0 kg/kkg (8.0 lbs/ton)

The TSS RWL demonstrated by mill 150 was used as the basis for the TSS RWL even though mill 150 has closed because TSS data was unavailable for mill 151 and mill 152 had very high TSS losses. The resulting RWL used in determining the BATEA effluent limitations and costs are given below:

Flow:	95.9 kl/kkg (23.0 kgal/ton)
BOD5:	30.0 kg/kkg (60.0 lbs/ton)
TSS:	65.0 kg/kkg (130 lbs/ton)

As discussed previously in Section VII, the application of internal controls are generally specific for the reduction of one pollutant parameter (BOD5 and TSS) or for the reduction of flow. However, there are controls, such as use of the decker filtrate on the brown stock washers, that reduce both flow and BOD5. These points are briefly discussed here in support of the determination of the soda subcategory RWL which used three mills as the basis for the three respective parameters. The internal controls for TSS reduction are very specific for reduction of the loss of TSS and thus it would be expected that relationships between TSS and flow or BOD5 would not generally exist. Similarly, inplant controls can be applied which reduce flow without impacting BOD5 (i.e., cooling water segregation) or reduce BOD5 without impacting flow (i.e., more efficient liquor recovery). The wide variations in the RWL from the soda mills indicates that the inplant controls at each of the mills are specific for reduction of one of these parameters. Thus, application of the BATEA inplant controls would reduce the RWL to at least the level of control indicated by the flow, BOD5, and TSS levels presently achieved by the three respective mills. Further support for this analysis is that the estimated BATEA RWL for the soda subcategory are similar to the bleached kraft fine papers subcategory RWL as would be expected since the manufacturing processes are similar at mills within the two subcategories.

Mill 152 presently achieves 28 mg/l BOD5 with an aerated stabilization basin of five days of detention time. Increasing the extent of the biological treatment will probably be necessary for mill 152 to achieve BPCTCA TSS limitations and in so doing improved BOD5 reduction should occur. The BATEA limitations are based upon BOD5 levels of 15 mg/l as demonstrated by bleached kraft mills. The level of 15 mg/l was selected as a conservative estimate of the capabilities of the BATEA external technologies including biological treatment and coagulation and filtration. It should be pointed out that the average of the top eight bleached kraft mills was 13.5 mg/l as shown in Table 219. The TSS effluent limitations were based upon 10 mg/l as discussed previously for the bleached kraft subcategories.

The color limitations for the soda subcategory were the same as the bleached kraft BCT and fine papers subcategories because the soda manufacturing process is similiar to these two subcategories and color raw waste load data was not available for mills in the soda subcategory.

Groundwood Subcategories

GW: Chemi-Mechanical Subcategory

The raw waste load for the chemi-mechanical subcategory used in determining the BATEA effluent limitations and the costs were based upon mill 001 which had the following RWL after adjusting for purchased pulp:

Flow:	84.7 kl/kkg (20.3 kgal/ton)
BOD5:	48.5 kg/kkg (97.0 lbs/ton)
TSS:	23.3 kg/kkg (46.6 lbs/ton)

More recent data for mill 001 has shown significant decreases in flow accomplished by in plant control measures and was used as the basis for the BATEA RWL. BOD5 data was unavailable for the most recent period but it is estimated that BOD5 would be reduced by the additional BATEA internals by 3.5 kg/kkg (7.0 lbs/ton). The BATEA raw waste load for mill 001 is given below:

Flow:	75.1 kl/kkg (18.0 kgal/ton)
BOD5:	45.0 kg/kkg (90.0 lbs/ton)
TSS:	22.5 kg/kkg (45.0 lbs/ton)

The groundwood chemi-mechanical limitations are based upon 100% chemi-mechanical production; therefore, contributions from purchased pulp and waste paper were removed. Calculating the RWL due to chemi-mechanical pulp and paper manufacturing, the basis for the BATEA limitations was derived.

Flow:	91.3 kl/kkg (21.9 kgal/ton)
BOD5:	79.5 kg/kkg (159 lbs/ton)
TSS:	22.5 kg/kkg (45 lbs/ton)

During the most recent data period for which data were available (April through August 1974), mill 001 has achieved an average of 5.6

mg/l BOD5 and 10.9 mg/l TSS with a treatment system consisting of a aerated stabilization basin followed by chemical addition coagulation, and clarification. The BATEA effluent limitations wer based upon a reduction in the BOD5 concentration from 35 mg/l (BPCTCA to 30 mg/l (estimated concentration for the best mill) and th addition of filtration to achieve final effluent concentrations fo BOD5 of 24 mg/l and TSS of 10 mg/l. These values are based upon 100% chemi-mechanical pulp and paper process.

GW: Thermo-mechanical Subcategory

The thermo-mechanical subcategory raw waste load was based up estimates BOD5 loads for companies starting new mills and waste wat data developed from thermo-mechanical mills in Sweden. Data for thermo-mechanical mill in Sweden showed flows and BOD5 loads of 17. to 27.2 kl/kkg (4.1 to 6.6 kgal/ton) and 21.3 kg/kkg (42.5 lbs/to were reported. Since the thermo-mechanical process will be install at existing GW Fine and CMN mills, the higher flow rate of GW CMN w transferred to the thermo-mechanical subcategory. Modified existi plants are not expected to be able readily achieve the flow rates the new thermo-mechanical mills in Sweden. The following RWL valu were therefore selected as conservative estimates of the therm mechanical subcategory RWL:

Flow:	78.3 kl/kkg (19.0 kgal/ton)
BOD5:	26.5 kg/kkg (53.0 lbs/ton)
TSS:	25.0 kg/kkg (50.0 lbs/ton)

There are very few mills in this country presently using the therm mechanical pulping process and effluent data is not available from a mill operating biological treatment facilities which has a significa portion of the total pulp production produced by the thermo-mechanic process. As demonstrated by mill 001 in the chemi-mechanic subcategory which has a substantially higher RWL of 529 mg/l a achieves a final effluent BOD5 of 5.6 mg/l (based upon 5 months data, April thru August) using biological treatment followed by clariflocculator, and by several mills in the bleached kra subcategories where effluent BOD5 qualities of 10 -17 mg/l a achievable with biological treatment and thereby the BOD5 BAT effluent limitations were based upon 15 mg/l. The TSS limitatio were based upon 10 mg/l as discussed previously.

GW: Fine Papers Subcategory

The groundwood: fine papers subcategory raw waste load was based up mill 13 which had a flow of 83.0 kl/kkg (19.9 kgal/ton) and a r waste BOD5 of 13.5 kg/kkg (27.0 lbs/ton). Two mills, 19 and 21, h flows less than mill 13 but the C & F content of their final produ was 35% and 20%, respectively, which could have the effect of loweri their water use per kkg (ton) of product. Thus, the BATEA flow ra was based upon mill 13. Evaluation of the inplant controls used mill 13 and those additional controls identified as BATEA in Secti VIII result in estimating that 74.9 kl/kkg (18.0 kgal/ton) w achievable. Because mill 13's BOD5 of 13.5 kg/kkg (27.0 lbs/ton) w significantly lower than the other mills with 10-15% C & F, the BAT raw waste BOD_5 and TSS were estimated by the internal controls used by mill 005 which used 10% C & F were evaluated. It was estimated that the additional BATEA controls identified in Section VIII would reduce the average BOD_5 to 16.0 kg/kkg (32.0 lbs/ton). The TSS raw waste load was based on an estimate involving the TSS reduction capabilities of the BATEA internal controls upon the average BPCTCA raw waste load. It was estimated that the added controls could achieve at least 45.0 kg/kkg (90.0 lbs/ton). Thus, the BATEA RWL are the following:

Flow:	74.9 kl/kkg (18.0 kgal/ton)
BOD_5:	16.0 kg/kkg (32.0 lbs/ton)
TSS:	45.0 kg/kkg (90.0 lbs/ton)

Data for mill 005 shows that 13 mg/l BOD_5 and 21 mg/l TSS are presently being achieved by the mill's aerated stabilization basin. Addition of filtration systems will further decrease these levels. The BATEA effluent limitations were thereby based upon 13 mg/l BOD_5 and 10 mg/l TSS.

GW: CMN Papers Subcategory

The groundwood: CMN papers subcategory was based upon an average of mills 009 and 014 raw waste loads because of the relatively wide spread between the raw waste loads, i.e. mill 009's flow and BOD_5 RWL was 52.9 kl/kkg (12.7 kgal/ton) and 19.6 kg/kkg (39.2 lbs/ton) whereas mill 014's RWL was 107.6 kl/kkg (25.8 kgal/ton) and 12.0 kg/kkg (24.0 lbs/ton). Evaluation of the in plant controls used by these mills and those BATEA internal controls identified in Section VIII resulted in selection of the following RWL:

Flow:	79.0 kl/kkg (19.0 kgal/ton)
BOD_5:	16.0 kg/kkg (32.0 lbs/ton)
TSS:	45.0 kg/kkg (90.0 lbs/ton)

Since none of the mills in the GW: CMN Subcategory have biological treatment, the BOD_5 concentration used for the BOD_5 effluent limitations was based upon mill 014 in the GW: fine papers subcategory which was achieving 13 mg/l BOD_5. The TSS effluent limitation was based upon 10 mg/l as discussed previously.

Groundwood Subcategories Zinc Limitations

The zinc limitations for the groundwood subcategories are based upon the BATEA flow values and 0.35 mg/l zinc as in the BPCTCA limitations.

<u>Sulfite Subcategories</u>

Papergrade Sulfite Subcategory

The BATEA raw waste load for the papergrade sulfite subcategory was based upon mill 062 which had raw waste flow and BOD_5 values of 193 kl/kkg (46.2 kgal/ton) and 74.5 kg/kkg (149 lbs/ton), respectively. Mill 062 was determined to be the most representative papergrade sulfite mill using BATEA inplant controls, some of which include vacuum drum pulp washing, full SSL recovery, and surface condensors.

Evaluation of the inplant controls in use by mill 062 and furthe: possibilities of RWL reduction by installation of BATEA interna. controls not in use by mill 062 resulted in the following BATEA RWL:

Flow: 167 kl/kkg (40.0 kgal/ton)
BOD5: 75.0 kg/kkg (150 lbs/ton)
TSS: 75.0 kg/kkg (150 lbs/ton)

The above TSS RWL was based upon mill 066 since TSS data wa unavailable from mill 062.

The effluent limitations were based upon BOD5 and TSS concentratio of 30 mg/l and 10 mg/l, respectively. The application of filtrati technologies achieves TSS levels in final effluents of 5 to 10 mg, and removes 20-25% of the remaining BOD5.

Improved operation of the biological treatment facilities and t application of filtration technologies should allow effluent BO levels of 30 mg/l to be achieved as shown by the relationsh determined in Section VII. While some mills have stated that BOD5 R of 75.0 kg/kkg (150 lbs/ton) will be difficult to achieve even thou mill 062 is presently achieving that level, the mills can use mo: effective external treatment to achieve the effluent limitation: This is demonstrated by mill 053 which has a BOD5 RWL of 96.0 kg/k (192 lbs/ton) and achieves a final effluent BOD5 of 3.45 kg/kkg (6. lbs/ton) using effective primary and biological treatment syste which is substantially less than 5.0 kg/kkg (10.0 lbs/ton) on whi the effluent limitations were based.

Papergrade Sulfite Market Pulp Subcategory

The BATEA raw waste load for the papergrade sulfite market pu subcategory was based upon evaluation of the internal controls in u by mill 056 and estimating further reductions associated with BAT internal controls not presently in use by mill 056. The BATEA RWL a: shown below:

Flow: 188 kl/kkg (45.0 kgal/ton)
BOD5: 100 kg/kkg (200 lbs/ton)
TSS: 30 lbs/ton (60 lbs/ton)

The BOD5 and TSS effluent limitations were based upon 30 mg/l and mg/l, respectively, as discussed above for the papergrade sulfi subcategory.

Low Alpha Dissolving Sulfite Pulp Subcategory

The BATEA raw waste load for the low alpha dissolving sulfite p subcategory was based upon an evaluation of the inplant controls use at mill 512 and an estimation of the RWL reductions that could achieved by application of BATEA inplant controls not presently in by mill 512. The present RWL at mill 512 was the following:

Flow: 203 kl/kkg (48.6 kgal/ton)
BOD5: 136.5 kg/kkg (273 lbs/ton)

The above evaluation resulted in the following reductions in the present RWL at mill 512:

Flow: 19.2 kl/kkg (4.6 kgal/ton)
BOD5: 21.5 lbs/ton (43.0 lbs/ton)

Thus, the BATEA RWL for the low alpha dissolving sulfite pulp subcategory were the following:

Flow: 183 kl/kkg (44.0 kgal/ton)
BOD5: 115 kg/kkg (230 lbs/ton)

The BATEA RWL TSS was based upon mill 511 since TSS data was not available for mill 512. The TSS RWL was 85.0 kg/kkg (170 lbs/ton).

The BOD5 and TSS effluent limitations were based upon 35 mg/l and 10 mg/l, respectively. As discussed previously, the application of filtration technologies results in TSS levels of 5 to 10 mg/l in final effluents and a 20 to 25% reduction in BOD5. An extensive biological treatment pilot plant operation at mill 512 resulted in an average final effluent BOD5 concentration of 47 mg/l. The relationship determined in Section VII, the pilot plant data, and the application of filtration shows that a level of 35 mg/l BOD5 is achievable. Thus, the BOD5 final effluent concentration of 35 mg/l was used as the basis of the effluent limitations.

High Alpha Dissolving Sulfite Pulp Subcategory

The BATEA raw waste load for the high alpha dissolving sulfite pulp subcategory was based upon mill 403 which is presently the one mill of the three in the subcategory which has full SSL recovery using vacuum drum washing and surface condensors. The present RWL at mill 403 is shown below:

Flow: 258 kl/kkg (61.8 kgal/ton)
BOD5: 244 kg/kkg (487 lbs/ton)

Evaluation of the inplant controls in use by mill 403 and estimating the RWL reduction associated with the application of additional BATEA controls not presently in use by the mill resulted in the following BATEA RWL:

Flow: 172 kl/kkg (41.2 kgal/ton)
BOD5: 212.5 kg/kkg (425 lbs/ton)

The BATEA controls at mill 403 include segregation of BOD5 bearing streams from TSS bearing streams and cooling waters. The above flow estimate accounts for the BOD5 bearing streams.

The fiber bearing streams not containing appreciable amounts of BOD5 are estimated to be 85.9 kl/kkg (20.6 kgal/ton) which is the difference between the present RWL flow and the above BATEA flow. In addition, it is estimated that 85.9 kl/kkg (20.6 kgal/ton) of non-contact cooling waters are discharged from mill 403.

The BOD5 and TSS effluent limitations were based upon 45 mg/l and 10 mg/l, respectively. The application of filtration technologies results in TSS levels in the final effluents of 5 to 10 mg/l and reduction of BOD5 by 20 to 25%. The BOD5 BATEA RWL is 1,237 mg/l which is higher than the BPCTCA RWL of 986 mg/l. The relationship determined in Section VII between influent BOD5 concentrations and effluent BOD5 concentrations for biological treatment systems at sulfite mills shows that 62 mg/l BOD5 would be achieved with an influent BOD5 of 1,237 mg/l. Improved operation of the biological treatment facilities should allow a final BOD5 of 60 mg/l or less to be achieved and application of filtration technologies should reduce the final effluent BOD5 to at least 45 mg/l. The BOD5 effluent limitations were determined using 45 mg/l and the above BATEA RWL flow of 172 kl/kkg (41.2 kgal/ton) whereas the TSS effluent limitations were determined using 10 mg/l and the above BATEA flow plus the flow representing the fiber bearing streams which equaled 258 kl/kkg (61.8 kgal/ton).

Deink Subcategory

The deink subcategory flow used as the basis for BATEA effluent limitations was based upon mill 217 which deinks all of its pulp. However, the use of 25% clays and fillers in the paper by mill 217 may result in a lower flow (kl/kkg (kgal/ton) than deink mills making tissue papers. Since the use of clays and fillers do not contribute significantly to flow, Mill 217's flow of 55 kl/kkg (13.2 kgal/ton) was recalculated excluding clays and fillers from the production in order to be comparable to mills producing tissue papers which do not use clays and fillers. The resulting flow value for mill 217 is 73.4 kl/kkg (17.6 kgal/ton). As discussed in Section V, the deink raw waste BOD5 and TSS are related to the type of waste paper used, and therefore BATEA BOD5 and TSS raw waste loads used were the same used as for BPCTCA. Thus, the BATEA RWL are the following:

Flow:	73.4 kl/kkg (17.6 kgal/ton)
BOD5:	82.5 kg/kkg (165 lbs/ton)
TSS:	178.5 kg/kkg (357 lbs/ton)

The BATEA effluent limitations were based upon BOD5 and TSS levels of 20 mg/l. This level of BOD5 and TSS takes into account the high RWL and the variabilities of RWL associated with deinking operations.

Non-Integrated Paper Mills Segment

N.I. Fine Papers Subcategory

The NI fine papers subcategories raw waste loads were developed by evaluation of the raw waste loads at 10 mills in relation to the extent of internal controls at each mill. Since flow is an indicator of the extent of in plant controls at NI paper mills, the mills which achieved lower flow rates than the BPCTCA average of 62.4 kl/kkg (15. kgal/ton) were arranged in ascending order as shown below:

Mill	Flow	BOD5	TSS
	kl/kkg (kgal/ton)	kg/kkg (lbs/ton)	kg/kkg (lbs/

284	25.8	(6.2)	7.6	(15.2)	30.4	(60.7)
261	26.3	(6.3)	8.7	(17.3)	-	(-)
279	37.5	(9.0)	-	(-)	-	(-)
255	37.9	(9.1)	-	(-)	-	(-)
272	37.9	(9.1)	10.9	(21.8)	-	(-)
276	39.2	(9.4)	19.2	(38.3)	38.5	(76.9)
257	40.0	(9.6)	9.2	(18.3)	-	(-)
266	49.2	(11.8)	12.8	(25.6)	(22.9)	(45.7)
250	53.8	(12.9)	-	(-)	-	(-)
402	57.5	(13.8)	7.5	(15.0)	(43.6)	(87.1)
Ave	40.4	(9.7)	10.8	(21.6)	33.8	(67.6)

Examination of the flow values above show two definite breaks, below 37.5 kl/kkg (9.0 kgal/ton) and above 40.0 kl/kkg (9.6 kgal/ton).

The BATEA flow was thereby based upon an average of those mills within that range, mills 279, 255, 272, 276, and 257. The average flow rate was 38.3 kl/kkg (9.2 kgal/ton) which was used in determining the BATEA effluent limitations and in determining the costs. The BATEA BOD5 raw waste load of 9.5 kg/kkg (19.0 lbs/ton) was based upon an average of all the mills presented above excluding mill 276 whose BOD5 was much higher than all of the other values. Because of a lack of data, the BATEA TSS raw waste load of 30.0 kg/kkg (60.0 lbs/ton) was essentially the same as the BPCTCA TSS raw waste load. It should be noted that this estimate was used for purposes of developing costs of the BATEA external controls and does not necessarily reflect the capabilities of the BATEA internal controls.

The BATEA effluent limitations were based upon 38.3 kl/kkg (9.2 kgal/ton) and BOD5 and TSS levels of 20 mg/l and 10 mg/l, respectively. BOD5 levels of 10 - 17 mg/l have been shown to be achievable by mills using biological treatment systems in other subcategories. However, the effluent limitations were based upon a conservative 20 mg/l. The rationale for the TSS level of 10 mg/l has been discussed previously.

NI Tissue Papers Subcategory

The BATEA raw waste load for the NI tissue papers subcategory was developed in a similar manner as the NI fine papers subcategory raw waste load. The mills presently achieving lower flow rates than the BPCTCA average of 95.7 kl/kkg (23.0 kgal/ton) were arrayed in ascending order as shown below:

Mill	Flow		BOD5		TSS	
	kl/kkg	(kgal/ton)	kg/kkg	(lbs/ton)	kg/kkg	(lbs/ton)
306	43.4	(10.4)	-	(-)	-	(-)
252	48.0	(11.5)	-	(-)	-	(-)
302	50.9	(12.2)	11.8	(23.5)	-	(-)
208A	61.3	(14.7)	22.9	(45.7)*	72.5	(145)
315	66.3	(15.9)	8.7	(17.4)	-	(-)
309A	69.6	(16.7)	14.7	(29.3)*	-	(-)

326	72.6	(17.4)	-	(-)	-	(-)
259A	73.8	(17.7)	9.6	(19.2)	32.2	(64.3)
Ave	60.5	(14.5)	10.0	(20.0)	-	(-)

*Not included in average

The BATEA flow was thus an average of eight mills with better than the BPCTCA average flow rate. The BOD5 of 10.0 kg/kkg (20.0 lbs/ton) was based upon three of the above eight mills that were achieving better than the average BPCTCA BOD5 raw waste load were used as the basis for the BATEA BOD5 raw waste load. The TSS raw waste load of 28.0 kg/kkg (56.0 lbs/ton) was based upon an average of mills 259A, 310, and 308 whose TSS levels demonstrated relatively high control of TSS.

The BATEA effluent limitations were based upon 60.5 kl/kkg (14.5 kgal/ton) and BOD5 and TSS levels of 20 mg/l and 10 mg/l, respectively. The rationale for selection of the BOD5 and TSS levels was as previously discussed for the NI fine papers subcategory.

NI Tissue Papers (fWP) Subcategory

The NI Tissue Papers (fwp) Subcategory BATEA flow was based upon the average of the best two mills (of the four mills surveyed). Flow rates for mill 330, 79.2 kl/kkg (19.0 kgal/ton), and mill 313, 27.9 kl/kkg (6.7 kgal/ton) were averaged to obtain the BATEA flow basis of 53.8 kl/kkg (12.9 kgal/ton). The BOD5 and TSS raw waste loads used in developing the costs presented in Section VIII were based upon mills 330 and 313. The BATEA effluent limitations are based upon BOD5 and TSS levels of 20 mg/l and 10 mg/l, respectively. The rationale for selection of the BOD5 and TSS levels was previously discussed for the NI fine papers subcategory.

SECTION XI

NEW SOURCE PERFORMANCE STANDARDS (NSPS)

INTRODUCTION

This level of technology is to be achieved by new sources. The term "new source" is defined in the Act to mean "any source, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance."

The New Source Performance Standards (NSPS) are predicated on the application of the Best Available Demonstrated Technology (BADT). These standards are thus not based upon an average of the best performance within a given subcategory under study, but have been determined by identifying the best demonstrated control and treatment technology employed by mills in given subcategory. Consideration was also given to:

a. The type of process employed and process changes;
b. Operating methods;
c. The engineering aspects of the application of control technologies;
d. the cost of application (including energy requirements);
e. The non-water quality environmental impact;
f. Use of alternative raw materials and mixes of raw materials;
g. Use of dry rather than wet processes (including substitution of recoverable solvents for water);
h. Recovery of pollutants as by-products.

EFFLUENT REDUCTIONS ATTAINABLE THROUGH THE APPLICATION OF NEW SOURCE PERFORMANCE STANDARDS

Based upon the information available to the Agency, the point source discharge standards for each identified pollutant are shown in Table 220 and can be attained through the application of appropriate internal and external control technologies.

The average of daily values for 30 consecutive days should not exceed the maximum 30 consecutive days average standards shown in Table 220. The value for any one day should not exceed the daily maximum standards shown in the table. The standards shown are in kilograms of pollutant per metric ton of production (pounds of pollutant per ton of production). Effluents should always be within the pH range of 5.0 to 9.0.

Production in kkg (tons) is defined as annual tonnage produced from pulp dryers (in the case of market pulp) and paper machines (for paper/ board) divided by the number of production days in the 12-month period. Pulp production is to be corrected, if necessary, to the "air dry" moisture basis.

TABLE 220
NEW SOURCE PERFORMANCE STANDARDS
kg/kkg(lbs/ton)

Subcategory	Maximum 30 Day Average BOD5	Maximum 30 Day Average TSS	Maximum Day BOD	Maximum Day TSS
Dissolving Kraft	6.1 (12.2)	8.35(16.7)	11.75(23.5)	15.5 (31.0)
Market Kraft	2.65(5.3)	2.9 (5.8)	5.15(10.3)	5.35(10.7)
BCT Kraft	3.7 (7.4)	5.0 (10.0)	7.05(14.1)	9.3 (18.6)
Fine Kraft	2.55(5.1)	3.75(7.5)	4.95(9.9)	7.0 (14.0)
Papergrade Sulfite	4.65(9.3)	2.9 (5.8)	8.95(17.9)	5.35(10.7)
Market Sulfite	4.65(9.3)	2.9 (5.8)	8.95(17.9)	5.35(10.7)
Low Alpha Dissolving Sulfite	11.15(22.3)	10.0 (20.0)	21.45(42.9)	18.6 (37.2)
High Alpha Dissolving Sulfite	13.8 (27.6)	9.45(18.9)	26.5 (53.0)	17.6 (35.2)
GW-Chemi-Mechanical	3.9 (7.8)	3.3 (6.6)	7.5 (15.0)	6.15(12.3)
GW-Thermo-Mechanical	2.3 (4.6)	3.15(6.3)	4.45(8.9)	5.85(11.7)
GW-CMN Papers	2.0 (4.0)	3.15(6.3)	3.85(7.7)	5.85(11.7)
GW-Fine Papers	1.9 (3.8)	3.0 (6.0)	5.6 (7.4)	5.6 (11.2)
Soda	3.15(6.3)	4.3 (8.6)	6.0 (12.0)	7.95(15.9)
Deink	3.9 (7.8)	4.0 (8.0)	7.5 (15.0)	7.45(14.9)
NI Fine Papers	1.35(2.7)	1.4 (2.8)	2.6 (5.2)	2.6 (5.2)
NI Tissue Papers	2.15(4.3)	2.2 (4.4)	4.15(8.3)	4.1 (8.2)
NI Tissue Papers(FWP)	1.9 (3.8)	1.95(3.9)	3.7 (7.4)	3.65(7.3)

pH for all subcategories shall be within the range 5.0 to 9.0.

Zinc *

Subcategory	Maximum 30 Day Average kg/kkg(lbs/ton)	Maximum Day kg/kkg(lbs/ton)
GW:Chemi-mechanical	0.048 (0.096)	0.095 (0.19)
GW:Thermo-mechanical	0.0455(0.091)	0.09 (0.18)
GW:CMN Papers	0.0455(0.091)	0.09 (0.18)
GW:Fine Papers	0.044 (0.088)	0.09 (0.18)

*Applicable only to mills using zinc hydrosulfite.

Performance standards will be established for ammonia nitrogen for ammonia base mills in the sulfite and dissolving sulfite subcategories at a later date. No specific standard has been developed because of the limited availability at this time of meaningful data. Indications are that discharges in the range of 1.0-3.0 kg/kkg (2.0-5.0 lb/ton) can occur. No technology for the removal of nitrogen has been applied within the pulp and paper industry.

Performance standards for color established for BATEA are not included for NSPS since the technology has not been demonstrated to the degree necessary in terms of engineering and performance for the subcategories included in these regulations.

IDENTIFICATION OF TECHNOLOGY FOR NEW SOURCE PERFORMANCE STANDARDS

The technology available for New Source Performance Standards consists of the Best Available Demonstrated Technology (BADT) which includes extensive application of internal control technologies and external waste water treatment practices as identified in Sections VII and VIII. Technology for nitrogen and color removal has not been demonstrated to the degree necessary for application to the effluents generated by mills in the pulp and paper industry. Such technologies, therefore, are not included among those required to achieve NSPS. BADT technology does include the utilization of mechanical clarification and chemical coagulation equipment following biological treatment and prior to discharge. The effectiveness of this external technology has been demonstrated by at least one mill included in this study. It should be pointed out that filtration of biological treatment effluents is not included as a technology for NSPS because filtration of biological treatment effluents has not been fully demonstrated to the degree necessary at this time for general application to new pulp and paper mills

Excluding the nitrogen and color removal technologies it is expected that new source mills will be able to realize maximum efficiency in the application of Best Available Demonstrated Technology. New source mills have an advantage over existing mills in that implementing internal control measures such as recovery, recycle, reuse, and spill control systems can be more readily incorporated at the initial engineering design stage than into existing mills.

RATIONALE FOR SELECTION OF TECHNOLOGY FOR NEW SOURCE PERFORMANCE STANDARDS

Type of Process Employed and Process Changes

No new in-plant processes are proposed as a means of achieving New Source Performance Standards for the subcategories studied. It will be mandatory, however, to use the well-known concepts associated with selective water use, cascading reuse, and water segregation practices at the engineering design stage if NSPS are to be achieved by a new production facility.

Operating Methods

Significant revisions in operating methods, both in-plant and at th waste water treatment facility, beyond those normally practiced mills representative of BPCTCA will be necessary. These improvemen are not beyond the scope of well-trained personnel, and are current being practiced in other industries. The primary areas of operation change will be in the assignment of supervisory responsibility for t performance of recycle, reuse, and spill control systems, as well for achieving optimal performance of waste water treatment facilitie

Engineering Aspects of the Application of Control Technologies

Much of the technology to achieve these performance standards is pra ticed within the pulp and paper industry by outstanding mills in given subcategory. The technology level of the best availab demonstrated technology will necessitate sophisticated monitorin sampling, and control programs, as well as properly trained personne

Cost of Application Energy Requirements)

The total projected costs of NSPS are shown in Tables 151 through 1 of Section VIII. These costs include both internal control a external waste treatment improvements incorporated in the engineeri design of the plant. They are based on 360 days of production p year.

The energy requirements associated with the application of polluti control technologies are developed in Section VIII and shown in Tabl 197 to 201.

Non-water Quality Environmental Impact

The technology cited will not create any significant increase odors, or in noise levels beyond those observed in well-design municipal waste water treatment systems which currently are bei approved by the federal government for construction in populat areas. Further, no hazardous chemicals are required as part of th technology. Further discussion of the non-water environmental impac associated with the BADT is presented in Section VIII.

Use of Alternative Raw Materials and Mixes of Raw Materials

The raw materials requirements for a given mill in each of t subcategories studied do vary, depending upon supply and demar desired end product, and other conditions. However, alteration of r materials as a means of reducing pollutants is not considered feasib over the long term even though such a change could possibly reali benefits of short duration in a given instance. A possible excepti to this could be the development of alternatives for the use ammonia as a base if an effective and economical method for removal nitrogen does not become available through further study.

Use of Dry Rather Than Wet Processes (Including Substitution of Recoverable Solvents for Water)

For the subcategories studied, it was determined that technology for dry pulping or papermaking processes does not exist nor is it in a sufficiently viable experimental stage to be considered here.

Recovery of Pollutants as Byproducts

As discussed in Sections VII and VIII of this report, recovery of some potentially polluting materials as by-products is economically feasible and is practiced to a limited extent by mills included in this study. It is anticipated that these performance standards will motivate increased research on recovering other materials for by-product sale the recovery of which is not presently economically feasible.

RATIONALE FOR SELECTION OF NEW SOURCE PERFORMANCE STANDARDS

The NSPS are based upon raw waste loads presently being achieved by the best mill or mills within each subcategory and the application of the best available demonstrated technology (BADT) presently being operated by mills in each respective subcategory. Where no mills are operating treatment systems representative of BADT in a subcategory, the standards are based upon the subcategories treating similar waste waters and using technology representative of BADT. The NSPS were determined use raw waste flow values and achievable effluent BOD_5 and TSS concentrations as demonstrated by the application of BADT. In determining the appropriate achievable BOD_5 levels which were used as the basis of the BOD_5 standards, the raw waste BOD_5 levels were carefully evaluated in order to take into account any impacts of the raw waste BOD_5 upon the final effluent BOD_5 levels. The BADT for all subcategories includes internal controls, biological treatment, and chemical addition, coagulation, and clarification technologies. The TSS NSPS were based upon an effluent level of 20 mg/l which has been demonstrated to be achievable using chemical addition, coagulation, and clarification technologies which also reduce the BOD_5 levels in biological treatment effluents by 20 to 25%.

It should be pointed out that no color standards were developed for the bleached kraft and soda subcategories because the color removal technology has not been fully demonstrated at this time. In addition, the TSS standards were based upon chemical addition, coagulation, and clarification technologies instead of filtration, because filtration technologies treating biological treatment effluents which were included in BATEA have not been demonstrated in the pulp and paper industry.

Tables 221 and 222 summarize for each subcategory the BADT raw waste loads and the flow, BOD_5, and TSS values used as the basis of the NSPS, respectively. The annual average values were multiplied by the variability factors shown in Table 223 in order to determine the maximum 30 consecutive days and maximum day standards. The determination of variability factors were discussed in Section VII.

TABLE 221
SUBCATEGORY RAW WASTE LOADS
BEST AVAILABLE DEMONSTRATED TECHNOLOGY (NSPS)

Subcategory	FLOW kl/kkg(kgal/ton)	BOD5 kg/kkg(lbs/ton)	BOD5 mg/L	TSS kg/kkg(lbs/ton)	TSS mg/
BK:Diss	229 (55.0)	40.0 (80.0)	174	87.0 (174)	37
BK:Mkt	79.2 (19.0)	27.5 (55.0)	347	72.5 (145)	91
BK:BCT	138 (33.0)	29.5 (59.0)	214	53.0 (106)	38
BK:Fine	103 (24.8)	22.0 (44.0)	213	64.5 (129)	62
Soda	117 (28.0)	34.0 (68.0)	291	65.0 (130)	55
GW:CMP	91.3 (21.9)	79.5 (159)	871	22.5 (45.0)	24
GW:TMP	86.3 (20.7)	28.0 (56.0)	324	48.5 (97.0)	56
GW:Fine	83.0 (19.9)	13.15(26.3)	158	41.4 (82.8)	49
GW:CMN	86.3 (20.7)	16.0 (32.0)	185	45.0 (90.0)	52
Sulfite:Paper	79.2 (19.0)	96.0 (192)	1212	80.0 (160)	101
Sulfite:Mkt	79.2 (19.0)	96.0 (192)	1212	80.0 (160)	101
Low Alpha	157 (37.6)*	130 (260)	829	85.0 (170)	30
High Alpha	172 (41.2)**	244 (487)	1417	85.0 (170)	33
Deink	73.4 (17.6)	82.5 (165)	1124	178.5 (357)	243
NI Fine	38.4 (9.2)	9.5 (19.0)	248	30.0 (60.0)	78
NI Tissue	60.5 (14.5)	10.0 (20.0)	165	28.0 (56.0)	46
NI Tissue (FWP)	53.8 (12.9)	13.0 (26.0)	242	110.5 (221)	205

* BOD5 flow only, total flow = 275 kl/kkg (66.0 kgal/ton)
** BOD5 flow only, total flow = 258 kg/kkg (61.8 kgal/ton)

TABLE 222
BASIS FOR NSPS

Subcategory	FLOW kl/kkg(kgal/ton)	RWL BOD5 mg/L	Final Effluent (Annual Average) BOD5 mg/L	TSS mg/l	BOD5 kg/kkg(lbs/ton)	TSS kg/kkg(lbs/ton)
BK:Diss.	229.0 (55.0)	174	15	20	3.45 (6.9)	4.60 (9.2)
BK:Mkt	79.2 (19.0)	347	19	20	1.50 (3.0)	1.60 (3.2)
BK:BCT	138.0 (33.0)	214	15	20	2.05 (4.1)	2.75 (5.5)
BK:Fine	103.0 (24.8)	213	14	20	1.45 (2.9)	2.05 (4.1)
Soda	117.0 (28.0)	291	15	20	1.75 (3.5)	2.35 (4.7)
GW:CMP	91.3 (21.9)	864	24	20	2.20 (4.4)	1.85 (3.7)
GW:TMP	86.3 (20.7)	324	15	20	1.30 (2.6)	1.75 (3.5)
GW:Fine	83.0 (19.9)	158	13	20	1.10 (2.2)	1.65 (3.3)
GW:CMN	86.3 (20.7)	185	13	20	1.10 (2.2)	1.75 (3.5)
Sulfite:Paper	79.2 (19.0)	1212	33	20	2.60 (5.2)	1.60 (3.2)
Sulfite:Mkt	79.2 (19.0)	1212	33	20	2.60 (5.2)	1.60 (3.2)
Low Alpha	157.0 (37.6)*	829	40	20	6.25 (12.5)	5.50 (11.0)
High Alpha	172.0 (41.2)**	1417	45	20	7.75 (15.5)	5.15 (10.3)
Deink	73.4 (17.6)	1124	30	30	2.20 (4.4)	2.20 (4.4)
NI Fine	38.4 (9.2)	248	20	20	0.75 (1.5)	0.75 (1.5)
NI Tissue	60.5 (14.5)	165	20	20	1.20 (2.4)	1.20 (2.4)
NI Tissue (FWP)	53.8 (12.9)	242	20	20	1.10 (2.2)	1.10 (2.2)

* For TSS NSPS, Flow = 275 kl/kkg(66.0 kgal/ton)
** For TSS NSPS, Flow = 258 kl/kkg(61.8 kgal/ton)

Table 223

BADT Variability Factors

Bleached Kraft Soda, Groundwood, Sulfite, Deink,
NI Fine Papers, and NI Tissue (fwp) Subcategories

Parameter	Maximum 30 Days	Maximum Day
BOD_5	1.78	3.42
TSS	1.82	3.38

NI Tissue Papers Subcategory

Parameter	Maximum 30 Days	Maximum Day
BOD_5	1.79	3.25
TSS	1.76	3.60

Bleached Kraft Subcategories

Bleached Kraft Dissolving Pulp Subcategory

The raw waste load used as the basis for the NSPS for the bleached kraft dissolving pulp subcategory was based upon mill 127 which has the raw waste load shown below:

Flow:	230 kl/kkg (55.1 kgal/ton)
BOD5:	40.0 kg/kkg (80.0 lbs/ton)
TSS:	87.0 kg/kkg (174 lbs/ton)

Mill 127 is presently achieving a final effluent BOD5 value of 24 mg/l with an influent raw waste BOD5 value of 174 mg/l using an aerated stabilization pond. Table 219 in Section X presents influent and effluent BOD5 data for bleached kraft mills considered to represent the best of the best in effluent qualities. As shown in the table, the eight mills achieve final effluent BOD5 levels averaging less than 14 mg/l with an average BOD5 raw waste load of 201 mg/l. Improved operation of the biological treatment facilities at mill 127 and the application of chemical addition, coagulation, and clarification which removes 20 to 25% of the remaining BOD5 should result in effluent levels of 15 mg/l of BOD5. In addition, chemical addition, coagulation, and clarification will reduce TSS levels to 20 mg/l in the final effluent.

The NSPS were therefore based upon the following:

Flow:	229 kl/kkg (55.0 kgal/ton)
BOD5:	15 mg/l
TSS:	20 mg/l

The above values were used to determine annual average values for BOD5 and TSS which were multiplied by the variability factors in Table 223 in order to determine the maximum 30 consecutive days and maximum day standards.

Bleached Kraft Market Pulp Subcategory

The raw waste load used as the basis for the NSPS for the bleached kraft market pulp subcategory were based upon mill 140 which has the following raw waste load:

Flow:	(18.9 kgal/ton)
BOD5:	(55.4 lbs/ton)
TSS:	(145 lbs/ton)

The external treatment system at mill 140 consists of an aerated stabilization basin with approximately 21 days of detention time as shown in Figure 44 in Section VII. However, the final effluent BOD5 level being achieved during the period for which data were available averaged 98 mg/l and it appears that the ASB was underaerated. The mill has added additional aerators to ASB during more recent operations. Two other bleached kraft market pulp mills, mills 130 and 114, use ASBs to achieve effluent BOD5 levels of 11 mg/l and 26 mg/l, respectively. The average raw waste BOD5 for the two mills was 2(mg/l which is less than the NSPS bleached kraft market pu subcategory BOD5 raw waste level of 347 mg/l. Mill 138 (20% mark pulp, 80% BCT papers) uses an ASB to achieve final effluent BO levels averaging 28 mg/l with a raw waste BOD5 level of 375 mg/l whi is slightly higher than the average subcategory BOD5 level of 3 mg/l. Based upon effluent reductions as demonstrated at mill 138, t subcategory raw waste load, and applying chemical additio coagulation, and clarification which removes 20-25% of the remaini BOD5 in the biological treatment effluent, the BOD5 NSPS were bas upon 19 mg/l. The TSS NSPS were based upon 20 mg/l becau application of chemical addition, coagulation, and clarificati results in effluent levels of 20 mg/l.

The NSPS were therefore based upon the following:

Flow:	79.2 kl/kkg (19.0 kgal/ton)
BOD5:	19 mg/l
TSS:	20 mg/l

The above values were used to determine annual average BOD5 and T levels which were multiplied by the variability factors in Table 2 to determine the maximum 30 consecutive days and daily maxim standards.

Bleached Kraft BCT Papers Subcategory

The raw waste load for the bleached kraft BCT papers subcategory w based upon mill 111 which had the following raw waste load:

Flow:	137 kl/kkg (32.9 kgal/ton)
BOD5:	29.7 kg/kkg (59.3 lbs/ton)
TSS:	53.0 kg/kkg (106 lbs/ton)

Several mills in Table 52 in Section V have raw waste flow values le than mill 111 but the other mills produce some market pulp in additi to BCT papers. Mill 111 is therefore the most representative mi producing BCT papers.

The treatment system at mill 111 consist of an ASB which achiev effluent BOD5 levels averaging 22 mg/l. Two bleached kraft mil producing BCT papers are shown in Table 219 which presents data f mills with external treatment systems achieving effluent leve considered to be the "best of the best." Mills 117 and 105 achie average BOD5 final effluent levels of 12 mg/l and 16 mg/ respectively, with an average of 14 mg/l. The average BOD5 raw was load for the two mills was 185 mg/l which is less than the B/ bleached kraft BCT papers subcategory raw waste BOD5 of 214 mg/ Improved operation of mill 111's biological treatment system comparable effluent reduction effectiveness as mills 117 and 105 ε application of chemical addition, coagulation, and clarification wh: reduces the remaining BOD5 in biological treatment effluents by 20 25% will allow achievement of 15 mg/l BOD5. As discussed previous: chemical addition, coagulation, and clarification will achiε effluent TSS levels averaging 20 mg/l.

The NSPS were therefore based upon the following:

Flow:	138 kl/kkg (33.0 kgal/ton)
BOD5:	15 mg/l
TSS:	20 mg/l

The above values were used to determine annual average BOD5 and TSS levels which were multiplied by the variability factors shown in Table 223 in order to determine the maximum 30 consecutive days and maximum day standards.

Bleached Kraft Fine Papers Subcategory

The raw waste load for the bleached kraft fine papers subcategory was based on the following mills:

Mill	Flow		BOD5		TSS	
	kl/kkg	(kgal/ton)	kg/kkg	(lbs/ton)	kg/kkg	(lbs/ton)
118	107	(25.7)	20.3	(40.6)	-	-
119	97.2	(23.3)	23.4	(46.7)	46.5	(92.9)
134	106	(25.4)	35.9	(71.8)*	82.5	(165)
Average	103	(24.8)	21.9	(43.7)	64.5)	(129)

*Not included in average

The BOD5 raw waste load of mill 134 was not included in the subcategory average because it was substantially higher than the raw waste loads being achieved through inplant controls at mills 118 and 119.

As shown in Table 219 in Section X, five bleached kraft mills producing fine papers achieve effluent levels representing the "best of the best." The NSPS were based upon the BOD5 levels presently being achieved by the five mills which are shown below:

Mill	RWL BOD5 (mg/l)	Final Effluent BOD5 (mg/l)
101	186	9
119	240	11
112	224	13
106	204	18
107	264	18
Average	224	14

The average subcategory RWL was 213 mg/l and since the average of the above mills was 224 mg/l, no adjustment for achievable effluent concentrations was necessary. The above mills are presently achieving effluent BOD5 levels which are better than most other bleached kraft mills with comparable raw waste loads and because of this, the BOD5 NSPS were based upon 14 mg/l. The level of 14 mg/l BOD5 has been demonstrated to the achievable even without the added 20 to 25% reduction in BOD5 which is achieved by application of chemical addition, coagulation, and clarification of biological treatment effluents. In addition chemical addition, coagulation, and clarification results in TSS effluent levels of 20 mg/l.

The NSPS were therefore based upon the following:

Flow: 103 kl/kkg (24.8 kgal/ton)
BOD5: 14 mg/l
TSS: 20 mg/l

The above values were used to determine annual average levels of BOD and TSS which were multiplied by the variability factors in Table 22 to determine the maximum 30 consecutive day and daily maximum standards.

Soda Subcategory

The BADT raw waste load for the soda subcategory was based primarily upon mill 151 which the following raw waste load:

Flow: 118 kl/kkg (28.2 kgal/ton)
BOD5: 52.5 kg/kkg (105 lbs/ton)

TSS data were unavailable for mill 151 and while the above flow value represents good inplant controls, the raw waste BOD5 represents a higher level than should be achieved using the inplant controls identified in Sections VII and VIII for new sources. Mill 15 achieves a BOD5 raw waste load of 34.0 kg/kkg (68.0 lbs/ton) which represents an acceptable level using inplant controls but has a raw waste flow of 170 kl/kkg (40.7 kgal/ton). The NSPS raw waste load was based upon both mills and is shown below:

Flow: 117 kl/kkg (28.0 kgal/ton)
BOD5: 34.0 kg/kkg (68.0 lbs/ton)
TSS: 65.0 kg/kkg (130 lbs/ton)

The above TSS RWL was based upon mill 150 since the TSS RWL at mill 151 was over twice the level achieved by mill 152 which represents a minimum of TSS inplant controls. Mill 152 presently achieves an effluent BOD5 averaging 28 mg/l with an aerated stabilization basin. As discussed in Section VII, the primary clarifier and the ASB at mill 152 were not representative of BPCTCA. Upgrading and improved operations of the treatment facilities at mill 152 and application of chemical addition, coagulation, and clarification technologies which reduce BOD5 in biological treatment effluents by 20 to 25% would result in an achievable BOD5 level of 15 mg/l. Chemical addition, coagulation, and clarification also reduces TSS levels to 20 mg/l.

The NSPS were therefore based upon the following:

Flow: 117 kl/kkg (28.0 kgal/ton)
BOD5: 15 mg/l

TSS: 20 mg/l

The above values were used to determine annual average BOD5 and TSS levels which were multiplied by the variability factors in Table 223 in order to determine the maximum 30 consecutive days and maximum day standards.

Sulfite Subcategories

Papergrade Sulfite Subcategory

The NSPS for the papergrade sulfite subcategory were based upon mill 053 which had the following raw waste load:

Flow: 79.2 kl/kkg (19.0 kgal/ton)
BOD5: 96.0 kg/kkg (192 lbs/ton)
TSS: 80.0 kg/kkg (160 lbs/ton)

Mill 053 is the newest existing papergrade sulfite mill, built in 1968, and produces tissue papers using inplant control technologies which represent the best available demonstrated technology. Within the process mill 053 uses two stages of vacuum drum pulp washing to recover 95-98% of the spent sulfite liquor. The mill has segregated process water systems for the pulp mill and for the paper mill and as a result the waste waters from the two sources are treated in separate treatment systems. The waste waters from the pulp mill are low in volume and high in BOD5 concentration and are treated in an activated sludge system. The waste waters from the paper mill are treated by primary treatment since the BOD5 in the waste waters is primarily associated with the fibrous solids which are removed in primary treatment. The combined discharge from both treatment systems resulted in the following BOD5 and TSS values:

BOD5: 3.45 kg/kkg (6.9 lbs/ton)
TSS: 7.45 kg/kkg (14.9 lbs/ton)

Since mill 053 uses some purchased pulp in the manufacturing process as a supplementary source of fiber, the raw waste and final effluent flow, BOD5, and TSS values were adjusted to reflect on-site production of 100% of the pulp used to make paper. This adjustment was necessary because of the impact upon the waste water values when examined on a kiloliters or kilograms per 1000 kilograms basis (kgal or lbs per ton). The above values of BOD5 and TSS correspond to the following concentrations of 44 mg/l and 94 mg/l, respectively. Application of chemical additive, coagulation, and clarification should remove 20-25% of the BOD5 and attain an TSS level of 20 mg/l. Thus, the NSPS were based upon the following:

Flow: 79.2 kg/kkg (19.0 kgal/ton)
BOD5: 33 mg/l
TSS: 20 mg/l

The above values were used to determine annual average BOD5 and TSS levels which were multiplied by the variability factors in Table 223 in order to determine the maximum 30 consecutive days and maximum day standards.

Papergrade Sulfite Market Pulp Subcategory

The papergrade sulfite market pulp subcategory NSPS are the same as the papergrade sulfite subcategory. As discussed in Section IV, the major impact on sulfite mill raw waste loads is the degree of spent liquor recovery and a new sulfite market pulp mill can include an adequately sized recovery system which would minimize the raw waste load. In addition, a new mill has the advantages of being able to segregate the low volume, highly concentrated pulp mill waste waters from the dilute white water system of the pulp dryers. Thus, similar waste water systems and treatment systems as mill 053 can be installed at new sulfite market pulp mills.

Low Alpha Dissolving Sulfite Pulp Subcategory

The NSPS raw waste load for the low alpha dissolving sulfite pulp subcategory was based upon mill 511 which had the following raw waste load:

Flow: 275 kl/kkg (66.0 kgal/ton)
BOD5: 130 kg/kkg (260 lbs/ton)
TSS: 92.5 kg/kkg (185 lbs/ton)

Segregation of the BOD5 bearing waste waters from the TSS bearing waste waters and cooling waters at mill 511 would allow a new mill to treat the highly concentrated, low volume waste waters rather than treating the entire mill effluent. The NSPS were thereby determined using the following raw waste load for the BOD5 bearing streams:

Flow: 157 kl/kkg (37.6 kgal/ton)
BOD5: 130 kg/kkg (260 lbs/ton)

The raw waste flow of the other waste waters was 118 kl/kkg (28.4 kgal/ton). The BADT TSS RWL was based on mill 511 which had a TSS RWL of 85.0 kg/kkg (170 lbs/ton).

The NSPS were determined using the relationship for sulfite waste waters which was determined in Section VII. The influent BOD5 level using the above values for segregated waste streams would be 829 mg/l and application of biological treatment followed by chemical addition, coagulation, and clarification which removes 20 to 25% of the BOD5 in the biological treatment effluent should result in an effluent BOD5 level of approximately 40 mg/l. Chemical addition, coagulation, and clarification also achieves effluent TSS levels of 20 mg/l.

The NSPS were therefore based upon the following:

Flow: 157 kl/kkg (37.6 kgal/ton)
BOD5: 40 mg/l

Flow: 275 kl/kkg (66.0 kgal/ton)
TSS 20 mg/l

It should be pointed out that mill 512 had a comparable BOD5 raw waste load to mill 511 and a substantially lower raw waste flow as showed in Table 42 in Section V. However, information and data were unavailable to determine the effluent raw waste values for segregating the waste waters. The above values were used to determine annual average BOD5 and TSS levels which were multiplied by the variability factors in Table 223 in order to determine the maximum 30 consecutive days and maximum day standards.

High Alpha Dissolving Sulfite Pulp Subcategory

The NSPS for the high alpha dissolving sulfite pulp subcategory were based upon segregation of BOD5 and TSS bearing streams from cooling water streams similarly to the low alpha dissolving sulfite pulp subcategory. Mill 403 which was used as the basis of the NSPS had the following raw waste load:

Flow: 258 kl/kkg (61.8 kgal/ton)
BOD5: 244 kg/kkg (487 lbs/ton)

Segregation of the waste streams would result in biological treatment of 172 kl/kkg (41.2 kgal/ton) of the raw waste flow which would have a BOD5 raw waste level of 1417 mg/l.

The relationship determined in Section VII shows that the application of biological treatment to the waste water flow of 172 kl/kkg (41.2 kgal/ton) and chemical addition, coagulation, and clarification to the entire effluent flow of 258 kl/kkg (61.8 kgal/ton) should achieve BOD5 and TSS levels of 45 mg/l and 20 mg/l, respectively.

The NSPS were therefore based upon the following:

Flow: 172 kl/kkg (41.2 kgal/ton)
BOD5: 45 mg/l

Flow: 258 kl/kkg (61.8 kgal/ton)
TSS: 20 mg/l

The above values were used to determine annual average BOD5 and TSS levels which were multiplied by the variability factors in Table 223 in order to determine the maximum 30 consecutive days and maximum day standards.

Deink Subcategory

As previously discussed, the deink manufacturing process can be considered as a cleaning process in removing impurities from the waste paper and as such relatively high BOD5 and TSS loadings can occur as a function of the raw materials used therefore, BOD5 and TSS raw waste loads for NSPS are the same as BPCTCA raw waste loads. Mill 217 demonstrated the lowest flow rate of the three 100% deink mills and was used as the flow basis for NSPS. Since the market for waste paper can vary and the types of waste paper available to deink mills can vary, the NSPS were increased slightly from the effluent levels normally considered achievable with the technology identified. Thus, BOD5 and TSS levels of 30 mg/l were used as the basis for NSPS for the deink subcategory.

Groundwood: Thermo-mechanical Subcategory

The groundwood: thermo-mechanical subcategory NSPS were based upon the BPCTCA raw waste load rather than the BATEA raw waste load. Thermo-mechanical pulping is relatively new in this country and thus the BPCTCA raw waste load reflects the best demonstrated technology presently used by thermo-mechanical mills.

Groundwood: Fine Papers Subcategory

The groundwood: fine papers subcategory NSPS flow, and BOD5 were based on the average of mills 13 and 20. TSS raw waste was based upon only mill 20 since mill 13 did not have measured non-standard TSS.

Flow: 83.0 kl/kkg (19.9 kgal/ton)
BOD5: 13.2 kg/kkg (26.3 lbs/ton)
TSS: 41.4 kg/kkg (82.8 lbs/ton)

Application of biological treatment and chemical addition, coagulation, and clarification to the raw waste load should achieve the following effluent basis:

Flow: 83.0 kl/kkg (19.9 kgal/ton)
BOD5: 13 mg/l
TSS: 20 mg/l

Groundwood: CMN Papers Subcategory

Raw waste load BOD5 and TSS are based upon an evaluation of the subcategory and internal controls available for new sources. The NSPS flow for the groundwood CMN subcategory is based upon mill 016, 86.3 kl/kkg (20.7 kgal/ton). The resultant raw waste load basis is:

Flow: 86.3 kl/kkg (20.7 kgal/ton)
BOD5: 16 kg/kkg (32.0 lbs/ton)
TSS: 45 kg/kkg (90.0 lbs/ton)

Since none of the mills in the GW: CMN subcategory have biological treatment, the BOD5 concentration used for the BOD5 effluent limitations was based upon mill 014 in the GW: fine papers subcategory which was achieving 13 mg/l BOD5. The TSS effluent limitation was based upon 20 mg/l as discussed previously.

The NSPS were therefore based upon the following:

Flow: 86.3 kl/kkg (20.7 kgal/ton)
BOD5: 13 mg/l
TSS: 20 mg/l

PRETREATMENT REQUIREMENTS

No constituents of the effluents discharged from mills within the bleached kraft, groundwood, sulfite, soda, deink, and non-integrated paper mills segment of the pulp, paper, and paperboard point source category have been identified which would interfere with, pass through, or otherwise be incompatible with a well-designed and operated publicly-owned biological waste water treatment plant. The exception to this, however, is the discharge of zinc from groundwood mills which use zinc hydrosulfite as a bleaching agent. Pretreatment standards on zinc which are equal to the BPCTCA limitations are proposed for groundwood mills using zinc hydrosulfite. The pretreatment standards can be achieved by substituting sodium hydrosulfite for zinc hydrosulfite in the bleaching process which is commonly practiced by many groundwood mills.

SECTION XII

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SECTION XIV

GLOSSARY

Active alkali

A measure of the strength of alkaline pulping liquor indicating the sum of caustic soda and sodium sulfide expressed as Na_2O.

Air Dry (AD) Ton

Measurement of production including a moisture content of 10 percent by weight.

Bark

The protective covering of a tree.

Barking

Removal of bark from logs in a wet or dry process.

Black Liquor

Spent liquor recovered from a kraft digester up to the point of its introduction into the recovery plant.

Bleaching

The brightening and delignification of pulp by addition of chemicals such as chlorine.

Blow

Ejection of the chips from a digester.

Boil-Out

A procedure, usually utilizing heat and chemicals, to clean equipment such as evaporators, heat-exchangers, and pipelines.

Breaker Stack

Two rolls, one above the other, placed in the dryer section of a paper machine to compact the sheet and smooth out its surface defects.

Broke

Partly or completely manufactured paper that does not leave the machine room as salable paper or board; also paper damaged in finishing operations such as rewinding rolls, cutting, and trimming.

Calender Stack

Two or more adjacent and revolving rolls which provide even calipe: control of the sheet and the final finishing of its surface.

Cellulose

The fibrous constituent of trees which is the principal raw material: of paper and paperboard.

Chest (or Stock Chest)

Tank used for storage of wet fiber or furnish.

Chips

Small pieces of wood used to make pulp.

Color Unit

A measure of color concentration in water using NCASI methods.

Consistency

A weight percent of solids in a solids-water mixture used in the manu- facture of pulp or paper.

Cooking

Heating of wood, water, and chemicals in a closed vessel unde pressure to a temperature sufficient to separate fibrous portion o wood by dissolving lignin and other nonfibrous constituents.

Cooking Liquor

The mixture of chemicals and water used to dissolve lignin in woo chips.

Countercurrent Washing

Pulp washing in which fresh water is added only at the last stage an the effluent from this stage is then used as wash water for tl previous stages.

Decker

A mechanical device used to remove water or spent cooking liquor frc pulp, and to thicken pulp consistency.

Digester

A pressure vessel used to cook wood chips in the presence of cooking liqucr and heat.

Digestion

Cooking of chips in the above manner.

Dregs

The inert rejects from the green liquor clarifier of a pulp mill.

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.

Fines

Fiber fragments produced by fiber cutting in beaters.

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 chemicals recovered from the kraft process water and weak liquor preparatory to causticizing.

Grits

Unreactive materials mechanically removed from the causticizing of kraft and soda green liquor and disposed of as solid waste.

Headbox

The area of the paper machine from which the stock flows through a sluice onto the wire.

Integrated

A term used to describe a pulp and paper mill operation in which all or some of the pulp is processed into paper at the mill.

Lignin

A non-degradable organic compound of wood.

Newsprint

Paper made largely frcm groundwood pulp, with a small percentage o: chemical pulp added for strength, used chiefly in the printing of newspapers.

Packing Water

See Gland Water.

Prehydrolysis

Pre-steaming of chips in the digester prior to cooking; usually asso ciated with improved bleaching of kraft pulp.

Pulp

Cellulosic fibers after conversion from wood chips.

Pulper

A mechanical device resembling a large-scale kitchen blender used t separate fiber bundles in the presence of water prior to papermaking.

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.

Rejects

Material unsuitable for pulp or papermaking which has been separated in the manufacturing process.

Save-all

A mechanical device used to recover papermaking fibers and other suspended solids from a waste water or process stream.

Screenings

Rejects separated from useable pulp by a device such as a screen.

Side-Hill Screens

Steeply sloped, 60-mesh screens.

Spent Cooking Liquor

Cooking liquor after digestion containing lignaceous as well as chemical materials.

Stock

Wet pulp with or without chemical additions.

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.

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.

1 Stainless Steel

1 Stainless Steel is steel with the following composition:

Carbon	0.08 percent maximum
Manganese	2.00 percent maximum
Silicon	1.00 percent maximum
Chromium	18.00-20.00 percent
Nickel	11.00-10.00 percent
Molybdenum	3.00- 4.00 percent
Remainder Iron	

Virgin Wood Pulp (or fiber)

Pulp made from wood, as contrasted to waste paper sources of fiber.

Wet Laps

Rolls or sheets of pulp of 30-45 percent consistency prepared in a process similar to papermaking; facilitates transportation of market pulp.

Wet Strength Additives

Chemicals such as urea and melanine formaldehydes used in papermaking to impart strength to papers used in wet applications.

White Liquor

Liquors made by causticizing green liquors; cooking liquor.

White Water

Water which drains through the wire of a paper machine which contains fiber, filler, and chemicals.

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.

SECTION XV

TERMINOLOGY INDEX

A.	Activated Sludge
A.	When associated with a mill code, refers to new data
AD Pulp	Air Dried Pulp
ADT	Air dry tons
APHA	American Public Health Association
API	American Paper Institute
APS	anti-pollution sequence
ASB	Aerated Stabilization Basin
atm	atmospheres
AWT	Advanced Waste Treatment
B.	Board or Paperboard
BATEA	Best Available Technology Economically Achievable
BCT	Paperboard, Coarse, Tissue
BK	Bleached Kraft
BOD or BOD_5	Biochemical Oxygen Demand (five-day)
BPCTCA	Best Practicable Control Tehcnology Currently Available
BTU	British Thermal Units
C	Clarifier
C	Coarse
°C	degrees Centigrade
C+F	Clays and Fillers
CMN	Coarse, Molded, Newsprint
CMP	Chemi-mechanical Pulp
COD	Chemical Oxygen Demand
cu m/min	Cubic meters per minute

cu. m./kkg	Cubic meters per 1000 kilograms
D	De-ink
DAF	Dissolved Air Flotation
Diss.	Dissolving
DO	Dissolved Oyxgen
E. Coli.	Escherica Coliform
ENR	Engineering News Record
F	Fine
FACET	Fine Activated Carbon Effluent Treatment
°F	degrees Fahrenheit
Fwp	from waste paper
"G"	Gravity
gal	gallons
gpd/sq. ft.	gallons per day per square foot
gpm	gallons per minute
GW	Groundwood
ha	hectare, 10,000 meter squared
hp	horsepower
IDOD	Immediate Dissolved Oxygen Demand
IJC	International Journal Commission
in. Hg	inches of Mercury
JTU	Jackson Turbitity Units
kg	kilogram, 1000 grams
kg BOD/kg MLUSS/day	kilogram of BOD per kilograms of MLVSS per day
kg/ha surface area/day	kilograms per hectare of surface area per day
kg/kkg	kilograms per 1000 kilograms

kg/sq cm	kilograms per square centimeter
kgal	1000 gallons
kgal/ton	1000 gallons per ton
kkg	1000 kilograms, metric ton
kw	kilowatt
L	liter
Lpd/sq. m.	liters per day per square meter
L/kkg	liters per 1000 kilograms
L/min.	liters per minute
Liquor Recovery	C - Collected B - By-products I - Incinerated
lb	pound
lb/ac/day	pound per acre per day
mgd	million gallons per day
mg/l	milligrams per liter
MKT	market
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MM	Maximum Month
mu	millimicrons
N	News
N(NSM)	non-standard methods when associated with data
N.A.	Not Available
NAB	Natural Aeration Basin
NCASI	National Council for Air and Stream Improvement
NI	Non-Integrated
nm	nano meters, 10- meters

NOV	Number of Values Reported
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
NSSC	Neutral Sulfite Semi-chemical
P	Pulp
PCB	Polychlorinated biphenyl
PCU	Platinum Color Units
PP	Purchased Pulp
ppm	parts per million
PS	Post Storage
psig	pounds per square inch gage
RBS	Rotating Biological Surface
rpm	revolutions per minute
RWL	Raw Waste Load(s)
S	Sulfite
SB	Settling Basin
Set Slds	Settleable Solids
SO	Soda
SSL	Spent Sulfite Liquor
Std. Meth.	Standard Methods
T	Tissue
TAPPI	Technical Association of the Pulp and Paper Industry
TC	Total Carbon
TDS	Total Dissolved Solids
Temp	Temperature
TMP	Thermo-mechanical Pulp
TOC	Total Organic Carbon

TOD	Total Oxygen Demand
TOM	Total Otganic Matter
ton	1000 pounds (short ton)
tpd	tons per day
TS	Total Solids
TSS	Total Suspended Solids
turbid	Turbitity
TVS	Total Volatile Solids
Type Condenser	V - Vapor Recompression S - Surface Condenser B - Barometric Condenser
UK	Unbleached Kraft

Table 224

Conversion Table

MULTIPLY (ENGLISH UNITS)		by		TO OBTAIN (METRIC UNITS)
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
acre	ac	0.405	ha	hectares
acre - feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram - calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories/kilogram
cubic feet/minute	cfm	0.028	cu m/min	cubic meters/minute
cubic feet/second	cfs	1.7	cu m/min	cubic meters/minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Fahrenheit	°F	0.555(°F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liters
gallon/minute	gpm	0.0631	l/sec	liters/second
horsepower	hp	0.7457	kw	kilowatts
inches	in	2.54	cm	centimeters
inches of mercury	in Hg	0.03342	atm	atmospheres
pounds	lb	0.454	kg	kilograms
million gallons/day	mgd	3785	cu m/day	cubic meters/day
mile	mi	1.609	km	kilometer
pound/square inch (gauge)	psig	(0.06805 psig+1)*	atm	atmospheres (absolute)
square feet	sq ft	0.0929	sq m	square meters
square inches	sq in	6.452	sq cm	square centimeters
tons (short)	ton	0.907	kkg	metric tons (1000 kilograms)
yard	yd	0.9144	m	meters

* Actual conversion, not a multiplier

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