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17446

January 1989

ESKISEHIR TEXTILE MILL WASTE WATER TREATMENT PLANT

SI/TUR/88/801

Republic of Turkey

Report on a visit to Turkey*

to advise Sumerbank on

Industrial Wastewater Treatment

21 - 30 Nov. 1988

Prepared for the Government of Turkey
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Sorab J. Arceivala,
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REPORT ON A VISIT TO TURKEY FOR SUMERBANK INDUSTRIAL WASTEWATER TREATMENT

BACKGROUND

In response to public opinion for better environmental protection, industrial wastewater treatment for safe disposal is being given increasing importance in Turkey.

The Sumerbank which runs several cotton textile and woolen mills, leather tanning and shoe manufacturing units as well as porcelain pottery and other units, is aware of the need to play its part in environmental protection and is seeking advice on economical and practical ways of wastewater treatment and disposal.

The consultant's present visit to Turkey from 21-30 November 1988 was restricted to two Sumerbank factories : Eskisehir Textile Mill and Baykoz Leather Tanning Unit, to gather data followed by design work in his Bombay office to prepare the proposed scheme for waste water treatment.

TERMS OF REFERENCE

The Consultant's terms of reference included :

1. Review of existing treatment facilities at Eskisehir Textile Mills, and identification of the most suitable wastewater treatment system for currently disposing to the Porsuk River and later if possible to the proposed sewers of Eskisehir town.

2. Visit to the Leather Tanning factory at Baykoz, Istanbul, for identification of the most suitable wastewater treatment system for currently disposing to the Bosphorus and later if possible to the proposed sewers of Baykoz town.

During the visit to Sumerbank, however, its officials requested that besides identifying treatment methodology details of the proposed treatment schemes including their design criteria, important specifications of the treatment units, etc. be given to assist Sumerbank in proceeding further in the matter.

VISITS MADE

The Consultant was provided briefing at a meeting held in the UNIDO/Ankara office by Dr. Kamal Hussein, SIDFA, on Tuesday 22 November 1988, when Docent Dr. Mrs. Semra Siber Uluatam from the Middle East Technical University, was also present. Thereafter, the Consultant was further briefed at the Sumerbank General Directorate, Projects Department, by their staff (See list of persons met).

The two factories were then visited in the remaining days, first at Eskisehir and then at Baykoz, to see the actual site conditions and discuss and obtain data from the factory authorities.

TWO REPORTS

As each factory has its own set of waste disposal problems and proposed solutions, two separate reports are being provided herewith to facilitate distribution and follow-up action.

ACKNOWLEDGEMENT

The Consultant is greatly indebted to the various Sumerbank officials who made very efficient arrangements for his visits and meetings. Thanks is also expressed to Dr. M. Kamal Hussein, UNIDO, for his assistance in the mission.

PERSONS MET BY THE CONSULTANT

The persons met by the Consultant during his visit include the following:

SUMERBANK GEN. DIRECTORATE

Mrs. Harika Turkes, Asst. Manager, Projects Dept.
Mrs. Saziye Balku, Chief Engineer, Wastewater Section
Mrs. Fusun Yucel, Chemical Engineer

ESKISEHIR TEXTILE FACTORY

M. Baluent Akis, Tekstil Muh
Teoman Ulugtekin, Director of Administration
M. Necati Gursoz, Technical Director
Mevlut Saritas, Electrical-Mechanical Chief
Necat Kirkpantur, Mechanical Engineer
Erman Akbay, Printing Preparation Section

ESKISEHIR PROVINCE AND OTHER OFFICIALS

Bahaeddin Guney, Governor
Sezai Aksoy, Mayor
Provincial level heads of Health Ministry, DSI,
Industries Dept., Agriculture and Sugar Factory

BAYKOZ LEATHER FACTORY, ISTANBUL

Onural Dogantepe, Muessese Muduru
Ali Karcier, Technical Director

UNIDO/UNDP, ANKARA

Dr. M. Kamal Hussein, SIDFA
Doc-Dr. Mrs. Semra Siber Uluatam (by invitation)

ESKISEHIR TEXTILE MILLS
INDUSTRIAL WASTEWATER TREATMENT

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1. The Existing Situation

   - General
   - Products and Processes
   - Wastewater Quantity and Characteristics

2. Existing Treatment Facilities

   - Operating difficulties
   - Performance in Colour Removal

3. Wastewater Disposal Standards Applicable and Proposed Strategy for Treatment

4. Proposed Improvements to Effluent Treatment Plant

   - General
   - Comments on Original Plant Design
   - Suggested improvements
   - Important Specifications of Treatment Units
   - Operating Costs (Power, Chemicals, Staff)
   - Check list of new items to be provided

5. Experiments with Use of Cinders (CURUF) for Colour Removal

6. Recommended Stagewise Work Programme.

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* Based on a visit to Turkey by UNIDO Consultant Mr. S.J. Arceivala, from 21-30 Nov. 1988.

ESKISEHIR TEXTILE MILLS
INDUSTRIAL WASTEWATER TREATMENT

1. THE EXISTING SITUATION

(i) General

The Eskisehir Textile Mills built 22 years ago include spinning, weaving and printing. The unit employs 1229 persons at present and exports seven million meters of cloth every year.

The discharge of untreated wastewaters from the mills to the Porsuk River has attracted several complaints from the Eskisehir Municipality and the Esksehir Provincial Governor, besides other agencies such as the DSI and the Iller Bankasi. An effluent treatment plant (ETP) was designed around 1980 through METU/ERTOK and only the civil part was built in 1983-1984. The corresponding mechanical-electrical part of the plant was to be taken up in 1984-1985 but was differed as the Iller Bankasi was meanwhile planning a sewer system for the town and it was hoped to be able to discharge the Mills' effluent into these sewers. The treatment plant thus remained incomplete.

However, at the insistence of the Provincial Governor, the factory began to use the treatment plant (even in its incomplete condition) from about August 1988 and now urgently wishes to take further steps to complete the treatment plant as may be minimum necessary for meeting pollution control requirements.

(ii) Products and Processes

The cloth production in 1987 has been as under :

Cloth	1987 Production
Grey	17.646,916 metres
Dyed/Printed	25,314,900 metres

Details are given in Tables 1 and 2.

The various production processes and sequences used in cloth manufacture are listed in Table 3. The raw and auxilliary materials used yearly are listed in Table 4 .

Table 1. GREY CLOTH PRODUCTION

1987 Y ili Ham Bez Uretimi
(Fiili) - actual

461	Penye Luks Empirme	1.966.486 metres in 1987
463	Jet Poplin Empirme	1.256.099 metres
464	Goksu Empirme	4.683.219 metres
469	Jet Poplin Empirme	3.825.669 metres
4611	Penye Saten Empirme	895.243 metres
4613	Poly. pop. Empirme	395.464 metres
4615	Saten Dosemelik	781.237 metres
4616	Gomleklik Flanel	407.195 metres
4651	Poly. Krep. Empirme	289.535 metres
4653	Viskon Empirme	739.023 metres
4657	Bahor Krep. Empirme	827.358 metres
4669	Pamuklu Viskon Empirme	362.473 metres
4671	Luks Krep. Empirme	606.092 metres
	Digerleri	611.823 metres
	TOPLAM	17.646.916 metres

Table 2 PRINTED AND DYED CLOTH

1987 Y ili Mamul Bez Uretimi
(Fiili) - actual

461	Penye Luks Empirme	2.084.800 metres in 1987
463	Jet Poplin Empirme	2.926.700 metres
464	Goksu Empirme	6.945.800 metres
469	Divitin Empirme	4.114.200 metres
4611	Penye Saten Empirme	1.072.900 metres
4615	Saten Dos	809.700 metres
4616	Gomleklik Flanel	606.700 metres
4651	Poly. Krep. Empirme	107.000 metres
4653	Viskon Empirme	896.800 metres
4657	Bahor Krep. Empirme	795.800 metres
4669	Viskon atkuli Pop. Empirme	382.100 metres
4671	Luks Krep. Empirme	520.900 metres
	Digerleri	4.051.500 metres
	TOPLAM	25.314.900 metres

TABLE 3

II. PRODUCTION PROCESSES

PRODUCTS / MACHINARY	461 %100 Cotton Printed Cloth(combed)	462 %100 Cotton Printed cloth(kreton)	463 %100 Cotton Printed cloth(jet poplin)	464 %100 Cotton Göksu printed cloth	464 %100 Cotton Viscolen	466 %100 Cotton Pyjama cloth	467 %100 Cotton Printed cloth(semi panama)	468 %100 Cotton Printed cloth (flannel)	469 %100 Cotton Jet raised printed cloth	4611 %100 Cotton Satin printed cloth(combed)	4613 %50+%50 PES-VIS Printed Cloth	4614 %100 Cotton Special Upholstery	4615 %100 Cotton Satin Upholstery	4616 %100 Cotton Flannel Shirting	4651 %50+%50 PES-VIS Crepe printed cloth	4653 %100 VIS. Printed cloth(Viscose)
Shearing cropping	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Singeing	2	2	2	2	2	2	2	-	-	2	2	2	2	-	2	2
Desizing	-	-	-	-	-	-	-	-	-	-	3	-	-	-	3	-
Mercerizing	3	3	3	3	3	3	3	2	2	3	-	3	3	-	-	-
Scouring	4	4	4	4	4	4	4	3	3	4	-	4	4	3	-	-
Rope washing	5	5	5	5	5	5	5	4	4	5	4	5	5	4	4	5
Chloride impregnation	6	6	6	6	6	6	6	5	5	6	5	6	6	5	5	6
J-Box Developing	7	7	7	7	7	7	7	6	6	7	6	7	7	6	6	7
e washing	8	8	8	8	8	8	8	7	7	8	7	8	8	7	7	8
Acid impregnation	9	9	9	9	9	9	9	8	8	9	8	9	9	8	8	9
J-Box Developing	10	10	10	10	10	10	10	9	9	10	9	10	10	9	9	10
J-Box washing	11	11	11	11	11	11	11	10	10	11	10	11	11	10	10	11
Alkalization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Stock	12	12	12	12	12	12	12	11	11	12	11	12	12	11	11	12
Calendering	13	13	13	13	13	13	13	12	12	13	12	13	13	12	12	13
Cylinder Drying	-	14	-	-	14	14	14	13	13	14	-	14	14	13	-	-
Stenter Drying	14-18 22	14 19	14-18 22	22 14-18	14-17 21	14 19	14 18	16 20	16 20	14 18	13-17 22	14 18	14 18	16 20	13 17-22	18 14
Hotflue Machine	-	14	-	-	-	14	-	13	13	-	-	-	-	13	-	-
Raising machine	-	-	-	-	15	-	-	14	14	-	-	-	-	14	-	-
Rolling	-	15	-	-	-	15	-	-	-	-	-	-	-	-	-	-
Thermosol Range	15	-	15	15	-	-	-	-	-	-	14-19 23	-	-	-	14 19-23	19
Roll Printing	-	16	-	-	-	16	-	17	17	-	-	-	-	17	-	-
Filmdruk	19	16	19	19	18	16	15	17	17	15	18	15	15	17	18	15
Steaming Range	16 20	17	16 20	16 20	19	17	16	18	18	16	15 20	16	16	18	15 20	16
.ing-Drying(open width)	17 21	18	17 21	17 21	16 20	18	17	15 19	15 19	17	16 21	17	17	15 19	16 21	4-17
Calendering	23	20	23	23	22	20	19	--	-	19	-	19	19	-	-	-
Sanforizing	-	-	-	-	-	-	-	-	-	-	24	-	-	-	24	20
Doubling	24	21	24	24	23	21	20	21	21	20	25	20	20	21	25	21
Rolling	25	22	25	25	24	22	21	22	22	21	26	21	21	22	26	22

3- RAW AND AUXILIARY MATERIALS

TABLE 4

3.1. RAW MATERIALS

Cotton 3286 ton/year

Polyester Mixture 143 tons/year

3.2. DYESTUFFS

VAT DYES

	Annual Cons.
İndanthren gelb 5GF	176 kg.
" " 5GFD	206
Cibanon gold gelb RK	601
Orange brill.solanthren FJR	43
İnd.brill.orange RK	115
Ecarlete solanthren F2J	28
İndt. scharlach BDC	260
" brill.rosa R	364
" " violet RRD	66
" rot " RRN	63
" braun RRD	114
Bruno solindone R-2G	8
İndt. oliv grün BD	425
" brill.grün FFBD	242
QF durindon print.blae 4BC	636
Brom indigo P	6
Gris solanthere 4Bİ	190
Youhacthrene grey BGPPFD	17
Cibanon grau BG-MD	93
Cibadurck schwarz TL	17
İndt.druck schwarz LF	1060
" schwarz LFD	300
	5030 kg.

AZO DYES

Ultrazol I-AS	195
Naphtanilide CB supra	57
Echt orange GC	22
Diazo scarlet RC basse	148
Echt rot TR basse	102
Diazo fast blue VB	272
	796 kg.

REACTIVE DYES

- Procion yellow P4G	350
Cibanan brill.gelb 2GPN	425
Remazol gelb FGH	404
Cibacron gold gelb 2RA	993
Levafix gold gelb PN-R	3801
Pro.orange P-2R	927
Cibacron orange 4RA	2590
" " 71034	13
Remazol brill.orange GD	51
" " " 3R	92
Xiron brill.orange RHD	200
Cibacron brill.rot 3BP	212
Cibacron scharlach 81137	1365 k
" brill.rot BD	193
Remazol brill.rot GD	561
-" rot BB	209
Solidazol rot PRB	804
Xiron scarlet RHD	1393
Proc.red P-4BN	249
Basilen brill.rot P3B	1864
Xiron brill.rot 4BHD	73
Cibacron rot 3B	100
Procion violet P3R	544
Remazol brill.violet 5R	635
Drimaren violet P2RL	25
Cibacron violet 2BP	112
Proc.brown P4RD	160
Cibacron braun 6R-P	719
" " 4GRA	708
Remazol braun 3G	67
Cibacron braun 6R	123
Remazol druck grün 3GT	54
Proc.blau H5R	1010
Remazol türkiş blau G	2315
Cib.blau 2RA	850
" brill.blau 3RP	1650
Proc.blue P3RN	937
" turquoise SP-2G	500
Ostazin navy blue H5R	250
Cib.türkiş blau GFP	510
Xiron blue 2R-HD	1654
Levafix brill.blau PNRL	205
Basilen türkiş blau PGR	1565
Cib.blau 2R	950
Reactive navy blau H5R	487
Cib.blau 3R	1576
Rem.dring marine blau RR	328
Remazol schwarz B	727
Proc.black HN /PN)	3733
Ostazin black HN	950
Cib.schwarz 2PD	26151
Remazol schwarz VB	280
Sumufix black B	1898
	68542 kg

PİGMENTS

Helizarin gelb SGR	5	kg.
Sandye sup.yellow GSR	17	
Ryu-dye gold yellow R	129	
Helizarin orange S-3G	14	
Monaprin kırmızı FG-T	45	
İmperon rot K-G 3RT	10	
Sandye sup.pink F5B	15	
Galakol braun F-3R	13	
Monaprin mavi BXT	53	
Orgaprin siyah B	34	
	335	

DİSPERSE DYES

Tetranese yellow P5R	121	kg.
Palanil gelb 5GL	22	
Samaron gelb braun HRSL	86	
Duranol brill.red T2B-300	13	
Dispersol rot C-3B	57	
Palanil scharlach RR	4	
Terasil scharlach GR	45	
Foron rubin SE-GFL	7	
Foron scharlach SBW	20	
" brill.violet S3RL	32	
Palanil gelb braun REL	37	
Brun jaune foron S2RFL	22	
Palanil brill.blau BGF	152	
Terasil brill.blau 3RL	4	
Samaron marina blau HB	171	
Celliton schwarz BRD	165	
" " BRD-H	85	
	1043	kg.

TOTAL.......... 75.746 kg.

3.3. CHEMICALS

Acetic acid	1384 kg.
Oxalic acid	133
Chromic acid	320
Nitric acid	970
Sulphuric acid	44240
Hydrochoric acid	388
Nitric acid	52
NaOH (solid)	48408
NaOH (lig.)	1322776
Sodium Acetate	163
$Na_2 S_2 O_4$	200
$NaH CO_3$	24948
$Na_2 CO_3$	14881
Naclo	102830
$Na NO_2$	128
$NA BO_3$	2495
Sodium Silicate	3047
NaCl	542141
$N_2 S_2 O_5$	2320
$N_2 S_2 O_4$	30
$K_2 CO_3$	5419
$NH_4 Cl$	12
$Mg Cl_2$	449
$Al_2 (SO_4)_3$	293
$Ti O_2$	1120
Talc Powder	50
$Fe Cl_3$	835
Glucose	225
Glycerine	4400
Urea	146994
Gum	947
Butyl acetate	506
$H_2 O_2$	83
	2.273.187 Kg

3.4. AUXILIARIES

Şardonteks FT	25
Waschpolen Nİ	3546
Solfet	2180
Demülsol H	35
Setamon	905
Rongalit C	7092
Sel dissol vant B	652
Helizerin binder UD	463
Linagol	5984
Lutekso1 HD-70	100
Setalon A	777 kg.
Leucotrop W konz	117
Ludigol AT	6380
Bruggolit C	2050
Aguazym conc	100
Reaktif rezerve	126
Kienalon OL-SS	50
Becrolin	50
Emülgatör 325	5636
Ultrator RN	5
Polietilen emüls.Ni	960
Luprimol SIG	5
Kleber Ni	15919
Argofix BYD	375
Palanil brill.weib R	[illegible]50
Lamiteks S	19280
Leucotrop EFR	10
Fixapret CPA	2230
Kaurit AB-I	3100
Orgaprint EMU	200
Fluolite BWT	141
Kayateks	48466
Manuteks RS	8200
Aktipol PAC	620
Colloid 100	140
Sapvinil 509	4000
Tinapol 2BT	450
Emprint CE fine	393
Karboksi metil selüloz	550
Unipal 2-BT	500
Aktiprint E	6500
Teksolen N	986
Teksol FH	1095
Akticol	100
Setalan SW	66
Gemsol 100-T	25
Gemsoft 8S	500
PVA-300	170
Euteks EB-F	2
Ultrafix thinner adhesive	45
Ultrazol photo solition	15
Ultrafix adhs.solition	120
Schamlonenlack M40/3B	265
Crom.special celatine	12
Metilen klonür	280
SCR-31 stripper	90
" 55 lacquen HFL	320

Diazastabilizatör DH-2	3 kg.
Sensitizer S	20
SCR-162	1250
SCR-163-C	1250
SCR-512	50
SCR-521	50
Patteks	35
Desmodur RFT	1
Rotalack N-70 blue	10
Ultrafix hardener	13
Corn starch	171624
Leomin 2319	525
Britisch gummi	100
Variteks PU-250	13400
Encolin E	350
Viskolin ST	200
Orinor R-308	31
Trinatrium phosphate	2100
	2.616.652 Kg

(iii) Wastewater Quantity and Characteristics

(a) Industrial Wastewater

The industrial wastewater flow has been estimated by three different agencies at different times as follows :

Agency	cu.m./day
1. METU/ERTOK report (1980)	5,600 + 1400 Tolerance
2. Actual water consumption in 24 hrs as per Mills' records (1987)	5,300
3. Iller Bankasi measurements (incl. domestic sewage) in day time shift 8 AM - 4 PM (1986)	4,812

After discussion, it was felt that for treatment plant design purposes, the industrial wastewater flow should be assumed as 5600 cu.m./day only.

(b) Domestic Sewage

The domestic sewage flow could be estimated as follows :

1229 persons x 150 l/day	185 cu.m./day
45 families on campus x 5 x 300 l/d	68
Canteen & miscellaneous	150
	403 cu.m/day

Thus, total flow (industrial + domestic) = 6000 cu.m./day

(c) Wastewater Characteristics

Wastewater characteristics have been studied from time to time by different agencies such as METU (1977-78) and the DSI/WHO/UNDP project on Porsuk River (1978-80), and by the Sumerbank's own R and D Centre in Bursa alongwith Iller Bankasi in 1985-86. All these results have been tabulated in Table .

The analysis results show that the wastewater is alkaline in character and pH adjustment will be necessary. The waste also has a relatively high proportion of solids. The BOD value ranges around 230 mg/l in two of the studies while in the METU study it appears to reach 970 mg/l. But the corresponding COD value of 750 mg/l in the METU study appears to make its BOD result doubtful. All the three studies agree on the COD values. Hence, the BOD value is more likely to be around 230-300 mg/l only. This is reasonable to expect where water is used everywhere on a once-through basis and no reuse is practised.

There is some discrepancy in the results of nitrogen and phosphorus and only a few values of these parameters are available. Textile wastes are sometimes known to be deficient in nutrients like nitrogen. But this situation can be easily remedied, if necessary, by artificial addition of nitrogen compounds or by the addition of domestic sewage which is relatively rich in the nutrients required for biological treatment.

The Eskisehir Textile Mill waste has a considerable degree of colour problem and colour removal has also to be aimed at during treatment along with the other parameters mentioned above.

TABLE 5: WASTEWATER CHARACTERISTICS AND DISCHARGE STANDARDS

Parameter	DSI/WHO Project 1978 - 80			Sumerbank Lab. In Bursa + Iller Bankasi (1985 - 86)			METU (1977 - 78)	General Sewer Standards where Town sewage is biologically treated	SU URUNLERI (FISHERIES)	Effluent Stds. For Cotton Tex. (Env. Prot. Law)
	Min.	Av.	Max.	Min.	Av.	Max.				
Temp. degree C	17	28	35	24	27	31	29.8 deg. C	40 deg. C		
pH	8.7	10.2	11.5	6.5	10.61	12	10.3	6.5 - 10	6 - 9	6 - 9
BOD 5 days	100	229	500	64	137	220	970	-	50	60
COD	148	477	1056	252	788	2000	750	4000	70	200
TKN		-		29.8	69	106	19			
NH3 - N	0.5	5.1	11	3.6	11	43	-			
NO2 - N	0.14	0.47	0.88		-		4.8			
NO3 - N	0.75	2.1	5	3.5	3.6	3.7	5.4			
PO4		-		1.5	6.1	15	-			
Total Solids		-		400	2269	6100	1850			
Total Dissolved Solids	697	834	970	1682	2001	2313	-			
Suspended Solids (TSS)	253	1615	6050	35	196	450	500	500	200	120
Settleable Solids	0.7	8.8	40.4	0.6	1.5	2.2	-			
Alkalinity, Phenolphthalein	0	81	210	85	490	1230	520			
Alkalinity, M.O.	70	383	610	342	585	1156	1100			
Total Hardness as CaCO3	60	366	1200		-		345			
Oil and Grease		-		332	1438	5229	-	250	30	10
Sulfate								1000		
Phenol								20	5	
Total Chromium										1

(d) Reuse of Wastewater

At the present time, no reuse of wastewater is practised with or without treatment. This is primarily because water is available in plentiful from the adjoining Porsuk River. Secondly, reuse would necessitate some carefully planned separation of relatively cleaner wastewaters from certain operations (e.g. the last wash of a sequence of 2 or 3 washes) to facilitate its reuse without treatment in some other operations where use of absolutely clean water is not essential (e.g. first internal wash after kiering).

This kind of judicious reuse is likely to give about 15-20% reduction in water usage which can be very useful where shortage of water is experienced which is not the case in Eskisehir at present.

Moreover, the wastewater treatment plant structures have all been built already for a larger flow than the mill is likely to produce. Hence, the economy aspect of reuse of water is not so favourable and reuse may be considered later. Present efforts should be focussed on operating the exsiting treatment plant properly to produce an effluent acceptable to the controlling authorities.

2. EXISTING TREATMENT FACILITIES AND DIFFICULTIES EXPERIENCED

(a) The Existing Plant

The existing wastewater treatment plant has been designed for a flow of 7000 cu.m./day (290 cu.m./day) and has the following sequence of units. But, as stated earlier only civil structures exist; no mechanical-electrical work including proper inter-connecting piping has been carried out:

- First neutralizzation tank (for using flue gas)
- Second neutralization tank (for using H_2SO_4)
- Alum dosing and mixing tanks
- Primary sedimentation
- Aeration
- Secondary sedimentation
- Gravel bed (oxidation filter)
- Sludge drying bed
- Final effluent sump and channel to river

The layout of the plant is shown in Fig. 1.

(b) Operating Difficulties :

Under severe pressure from the local authorities, the incomplete structures have been put to use since the last three months (August 1988) to give the effluent whatever treatment it can give under the circumstances. Thus, the following is being done :

- Acid, alum and sodium hypochlorite are dosed out of tempor-rily set up drums directly on the effluent channel.

- A mixer has also been set up temporarily in the channel.

- The primary sedimentation tanks are used but the settled sludge is difficult to remove as no scrapers exist, and much manual effort has to be put in. The result is that sludge has accumulated in the tanks and the settling function has become relatively ineffective.

- To remedy this situation, the aeration tanks (without aerators) are being used as additional settling tanks by allowing the overflow from the above primary sedimentation tanks to come to the aeration tanks where further settlement occurs. No sludge withdrawal arrangement exists as the aeration tanks are flat-bottomed and accumulated sludge will eventually have to be removed manually by putting the aeration tanks out of action one by one. Anyway, presently, the aeration tanks are helping to settle out the alum sludge and provide contact time for action of sodium-hypochlorite added earlier. Thus, some treatment is being achieved here mainly by way of some colour removal.

- The flow from the aeration tanks then goes to the gravel bed or so-called "oxidation filter". The flow distribution in this unit is poor as all the flow enters from one side. The percolated flow from the bottom of this unit finally gravitates to the Porsuk River through a sump and channel. The real utility of this unit is difficult to establish.

It is clear that since the last three months the Mill authorities are making heroic efforts to run the plant inspite of its shortcomings. Considerable use of chemicals is made as can be seen from the following data, since major emphasis is on colour removal:

Chemical	Kg/day	Cost TL/kg	Total Cost/day
Alum	500	347	173,500
H2SO4 (50%)	300	85	25,500
Sodium Hypochlorite	1008	229	230,832
Polyelectrolyte	-	-	-
			429,832
Add Electricity and Labour			100,000
		TOTAL	529,832 TL/day

(c) Performance in Colour Removal

What is the resulting performance of the plant under such difficult conditions?

A set of samples were taken during the consultant's visit and sent to Bursa R and D Centre for analysis. The results are given in Table 5(a).

Meanwhile, the Consultant had samples taken in bottles and photographed to show the progressive removal of colour as treatment is given. This is shown in Fig. 2.

Fig. 2. Visual Improvement in Effluent Quality as a result of treatment.

(1) The incoming raw wastewater sample is blackish in colour (owing to dyes used). It is dosed with alum, acid and sodium hypochlorite

(2) Sample taken at outlet of primary sedimentation tank. The waste is still very blakish (because these tanks are filled with sludge and settling is poor)

(3)& (4) The waste becomes lighter in colour as settlement progresses in the "aeration" tanks. There are no aerators in these tanks and they merely serve as large settling tanks. Effective colour removal occurs here.

(5) A slight further improvement in colour occurs through the "oxidation filter" unit from whose outlet this sample was taken.

(6)& (7) These samples are from the Porsuk River. Sample (6) was taken 50 m. upstream of Mill's effluent discharge point, while sample (7) was taken 50 m downstream (after mixing with river). There is hardly any noticeable difference in colour of the river water before and after discharge of the treated waste.

TABLE 5(a) : Analysis Results of Treated Effluent Samples (November 1988)

(All results except pH in mg/l)

Parameter	Raw Effluent from factory (1)	Outlet of Primary Sedimentation Tank (2)	Outlet of Aeration Tank (3)(4)	Outlet of Oxidation Filter (5)	Porsuk River up-stream of effluent discharge (6)
pH	9.7	9.32	9.46	9.36	8.04
BOD	160	34	60	50.4	9.4
COD	426	224	256	320	64
PO4 - P	13	15	6	4	3.2
NH3 - N	1.8	1.5	3.2	8	0.7
NO3 - N	0.16	0.36	2.8	3.2	0.1
NO2 - N	Nil	Nil	3.4	3.3	Nil
AKM	147	193	232	191	1

3. WASTEWATER DISPOSAL STANDARDS APPLICABLE AND PROPOSED STRATEGY FOR TREATMENT

(a) Various Standards

In order to protect the quality of receiving waters such as rivers, various standards are available. An effort is also underway with UNDP/UNEP assistance to harmonize the Turkish standards with those of ECE countries.

With reference to the Eskisehir Textile Mills, the Consultant was informed that the following standards would have relevance :

1. General Sewer Standards applicable to towns (except Istanbul) where town sewage is finally biologically treated.

2. "Su Urunleri" standards to protect fisheries and other Aquatic Products.

3. Effluent Standards for cotton textiles, under Environmental Protection Law (19880.

The above three standards have been tabulated in Table 5 along with the raw wastewater analysis of the Eskisehir Textile Mills to give a comparative idea of the treatment requirements.

(b) Treatment Strategy Recommended

Although there is talk going on about new sewers being laid in Eskisehir by the Iller Bankasi, there is no clear understanding on the following :

(i) When the new sewer system will be ready to operate? There may be delays due to budgetary reasons.

(ii) Whether full biological treatment will be provided to the Eskisehir town sewage before discharge to the Porsuk River? (Even if a biological treatment plant is proposed to be built, it may take another 3 to 5 years before it is operational).

(iii) Whether the proposed sewer system will impose any additional requirements besides the standards given in Table 5 for general sewer discharge? (There is already talk that the Eskisehir Beledye will impose a colour removal requirement besides the other parameters specified in the Standards).

(iv) What charges will be payable for use of sewers? These charges will also keep increasing from time to time.

A brief meeting were held with the Eskisehir Province Governor, the Eskisehir Belediye, the DSI and other authorities to hear their views. It was evident that, firstly, colour removal was given high priority, and secondly, it appeared that everyone expected Sumerbank to give the lead in proper treatment of the waste before disposal since the Porsuk river passed through the main town just after receiving the textile mill effluent. Even when sewers would come into existence, good treatment would be expected from Sumerbank.

Colour removal is, ofcourse, one aspect of the problem. The other problem is removal of organic matter (BOD, etc.) before discharge. Colour removal can normally be achieved by any one of the following methods :

- Adsorption on a fixed media bed (e.g. activated carbon or coal cinders (CURUF) etc.
- Adsorption on alum floc formed by chemical dosing, mixing and settling.
- Adsorption on biological flocs formed in activated sludge aeration
- Chemical reaction with a bleaching agent like Sodium Hypochlorite or chlorine.

But, all the above methods cannot remove organic and suspended materials. For example, if the raw wastewater is directly passed through a fixed media bed, the organic materials, suspended solids, etc., will foul the bed and stop the adsorption process soon after start. Thus, a method of treatment has to be selected in which both colour and other organic and suspended matter can all be removed. For this purpose, biological treatment is considered desireable to adopt. (Also see Section 4 for a further discussion on the use of "CURUF").

Moreover, the adoption of biological treatment will make it feasible to discharge the treated waste directly to the Porsuk River, and thus avoid payment of high fees for use of town sewers. As stated earlier, it is not clear when town sewers will be ready, nor whether the town will provide treatment of the mixed wastes, nor what charges it will levy. Generally, in the consultant's experience a large industry producing 6000 cu.m./day effluent will find it economical to treat its own waste and discharge independently. Moreover, all the civil structures required for waste treatment already exist. It is now a question of providing the matching equipment to be able to use the plant properly. Thus, biological treatment is recommended as described in the following pages.

4. PROPOSED IMPROVEMENTS TO EFFLUENT TREATMENT PLANT

(a) General

The existing effluent treatment plant inspite of its incomplete nature, has demonstrated its basic ability to treat the wastewater mainly by physically removing solids and colour. It has now to be improved upon so as to give consistently good performance without creating sludge disposal and other problems and be capable of meeting the standards discussed in Section 2.

Firstly, some comments on the original plant design will be useful to make, followed by a re-design of the plant to improve its performance to be able to meet standards for discharge of effluents to rivers.

Finally, the operating costs of the proposed plant are given and a check-list has been given of all the new items of machinery, equipment, piping and electrical work to be done at the plant so as to do a complete job.

(b) Comments on the Original Plant Design

The following comments may be made on the original design of the plant.

1. The design flow is 7000 cu.m./day whereas the present flow of wastewater is only 5600 cu.m./day.

2. The domestic sewage flow is treated separately in a septic tank and discharged to the river. It would br beneficial for the biological treatment section of the plant if domestic sewage flow (estimated to be 400 cu.m./day) is brought to the main plant just before the aeration tanks.

3. The original design is based on very high assumed values of BOD (1945 mg/l). A raw waste BOD value of about 300 mg/l would be more appropriate to use.

4. No equalization tank has been provided to take care of the wide fluctuations in quality (acidity, alkalinity, pH, solids, etc.) likely to come in the raw wastewater.

5. Besides the above aspects, proper plant functioning is severely handicapped by the absence of the following :

   - Chemical dosing/metering pumps
   - Sludge scraping mechanisms
   - Scum removal mechanisms
   - Aeration
   - Biological sludge settling and recycle system
   - Inadequate distribution of flow on the so-called "oxidation filter".

(c) Suggested Improvements

To take care of the short-comings pointed out, the following improvements are suggested :

As shown in Fig. 3 , the raw wastewater will first be brought to an aerated equalization tank created by converting one of the existing aeration tanks. From here, the waste will be neutralised to correct the pH as necessary and dosed with aluminium sulfate before going to the primary sedimentation tanks where mechanical sludge and scum removal scrapers will be provided. The sludge removed will be pumped directly to the sludge drying beds.

After sedimentation, the main flow will go to the three existing aeration tanks as shown for biological treatment (extended aeration) after which, there will be secondary sedimentation with sludge recycle back to the aeration tanks. Any excess sludge will be diverted to the sludge drying beds. Sludge scraper arms and sludge pumps will be provided.

As the "oxidation filter" already exists, its use may be continued if desired. Sodium hypochlorite may be added either just before or just after this filter unit to help bleach any remaining colour before the final effluent goes to the Porsuk River.

Similarly, the sludge drying beds already exist and may be used as far as possible during the relatively dry and sunny seasons. During wet weather when drying is difficult the sludge may have to be carted away off-site by tankers or the sludge may be dewatered in a Solid Bowl Centrifuge (Penwalt-type) and the very small residual volume carted away to use as land fill at approved sites.

(d) Important Specifications of Treatment Units.

The essential design features and important specifications of the various units are given below :

(i) Assumed Flow Rates

The industrial wastewater flow rates are assumed as follows:

Time	Flow, cu.m.
08.00 - 16.00 h.	3,200
16.00 - 24.00 h	1,500
24.00 - 08.00 h	900
	5,600

The domestic wastewater flow = 400 cu.m./day joins the treatment plant after primary sedimentation, namely just before biological treatment.

(ii) Aerated Equalization Tank

Since the incoming industrial flow is variable, an equalization tank will be desireable to have so that the subsequent pumping to various treatment units can be at a constant pumping rate, namely, 5600/24 = 235 cu.m./hr rate. Thus, equalization tank size is computed as follows :

Time	Inflow cu.m.	Pumping Rate	Total Outflow cu.m.	Balance cu.m.
0800-1600h	3200	235 cu.m/h	1800	1320
1600-2400h	1500	235 cu.m/h	1880	940
2400-0800h	900	235 cu.m/h	1880	0
	5,600		5,600	

Hence, maximum balancing capacity required = 1320 cu.m.

However, size of each existing aeration tank compartment

= 25m x 27.5m x 3m liquid depth = 2062 cu.m.

Hence, it will be enough to convert one compartment into an equalization tank. It will provide a maximum detention time

= 2062/5600 = 8.84 hours.

(iii) Pumps

Provide 2 nos. x 235 cu.m./hr capacity (one working and one standby) non-clog pumps, capable of pumping upto 8m head. Suction will be taken directly from the equalization tank. The pumps will be driven by 10 KW motors each (to be checked with suppliers).

(iv) Acid Neutralization System

The acid neutralization tank will enable us to maintain the pH around 9.0 at all times. Thus, sulfuric acid (H_2SO_4) will be added whenever the pH goes above 9.0. This addition can be made from a dosing tank by using a metering pump which will be actuated by a pH meter through a solenoid valve. The neutralization tank (already existing) has a volume of 80 cu.m. namely 23 min. detention time. It has been built in two compartments both of which may be used for acid neutralization with a 4 KW mixer in each compartment.

Alternatively, since the neutralization tank of 80 cu.m. volume is already built in two compartments, the first part may be reserved for neutralization by using flue gases from the boiler house which contain CO_2 gas (as envisaged in the original design) and the second compartment be used for acid neutralization as described above alongwith a 4 Km mixer and a pH sensor in the outlet to facilitate dosing. This will be a more cost-effective arrangement in the long run. The details have already been provided in the original design by ERTOK.

NOTE: A word should be mentioned here about the cloth Kiering, bleaching and mercerising system in use. No caustic recovery is being practised at present for certain practical reasons into which the consultant could not go during his visit. If caustic recovery and recycle is practiced, the wastewater will need much less amount of neutralization by acid which will save considerably in operating costs. This aspect may be considered by the Mill authorities.

(v) Coagulant Dosing and Mixing

The coagulant dosing and mixing tanks have also been provided already in two compartments. In the first compartment Aluminium Sulfate (alum) can be dosed and flash-mixed while in the second compartment it can be slowly stirred to generate alum flocs (flocculation). Since flash mixing requires only one minute reaction time while flocculation needs 20-30 minutes it is suggested that the internal partition in the existing tank be removed. A flash mixing arrangement may be provided only in one corner of the tank, say, 1m x 1m x tank depth, and a 0.5 KW agitator be installed in it. The rest of the tank may be used to install a slow-speed flocculator operating at about 1-2 RPM and driven by a 3 KW motor. See typical drawing.

The provision of a flocculator (which was not included in the original design) will improve the efficiency of alum coagulation. It is also necessary that alum dose is determined from laboratory studies to get optimum results. Alum dose is expected to be between 100-200 mg/l.

(vi) The main flow will now go on to the existing three primary sedimentation tanks.

Each tank dimensions are : 20m x 5m x 2.2m depth or 220 cu.m. volume or total volume 220 x 3 = 660 cu.m. = 2.8 hours detention time at average pumping rate of 235 cu.m./hour. The three tanks are to be operated in parallel from the common feed channel, care being taken to see that the total flow is divided equally between the three tanks. The surface loading will be

$$\frac{Q}{A} = \frac{5600}{3 \times 100} = 18.66 \text{ cu.m./sq.m./day}$$

(acceptable)

Sludge Mechanism

80-90% of the settleable solids are expected to be removed in this tank. However, sludge and scum removal from these tanks will need the use of scrapers driven by a chain-and-sprocket arrangement with 5 KW motor as shown in the typical drawing. This mechanism will need to be installed at the earliest to get a satisfactory sludge withdrawal arrrangement. (Details of the mechanism must be obtained from suppliers on a turnkey basis to fit the existing tanks).

Sludge Pumping

The sludge removed from the primary sedimentation tanks will be approximately 3000 kg/day on an average with a moisture content of 99% . Thus, sludge volume

$$= \frac{3000}{.01} = 300 \text{ cu.m./day}$$

This volume will be flushed periodically to a new sludge holding sump of 30 cu.m. from which two centrifugal, open-impeller type pumps of 50 cu.m./hr. capacity (one working and one standby) will pump the same either to the sludge drying beds or to the chemical conditioning tank prior to dewatering by a SOLID BOWL CENTRIFUGE. The pumping head has not been possible to estimate as the level difference between the proposed sludge sump and the sludge drying beds or the proposed chemical conditioning tank is not known to the consultant. The head loss in the sludge pumping line will also have to be estimated depending on its length. This can be easily done. The dia. of the line will be 150 mm.

(vii) Extended Aeration

Assume the following :

(a) The extended aeration system will be operaed at F/M = 0.1 KG BOD per kg Mixed Liquor Suspended Solids (MLSS)

(b) incoming raw waste BOD from industry = 300 mg/l x 5600 cu.m./day = 1680 kg/day

(c) BOD removed in primary sedimentation = nil (safe assumption)

(d) BOD from domestic sewage = 1229 x 20 g/person + 225 x 50
= 24.5 + 11.25
= 36 kg/day

(e) Final effluent BOD = 30 mg/l
= 180 kg/day

Hence, total BOD going to aeration tank = F = 1680 + 36
= 1716 kg/day
M = F/0.1 = 17,160 kg.

If MLSS = 3000 mg/l = 3 kg/cu.m.

Aeration tank volume required = 17,160/3 = 5,720 cu.m.

Since each aeration tank compartment
= 25m x 27.5m x 3m deep
= 2062 cu.m.

We need to use three compartments only.

Hence total volume under aeration will be = 6,186 cu.m. and MLSS will be 2775 mg/l instead of 3000 mg/l.

Volume of flow going to aeration = 5600 + 400 = 6000 cu.m./day

Hence, detention time = 24.7 hours approximately (acceptable)

Aeration Power

Oxygen required = 1.2 kg O/kg BOD removed
= 1.2 (BOD5 removed)

= (1.2) (1716 - 180) = 1843 kg/day

= 77 kg./hr. at field conditions

Assume aerators give @ 2.0 kg O/KWh at standard conditions namely, 0.6 x 2.0 at field conditions.

$$\text{Power required} = \frac{77}{0.6 \times 2.0} = 64 \text{ KW at shaft}$$

= 91 KW motors

= 120 HP

Thus power level in aeration tanks = 14.5 W per cu.m. tank volume (acceptable).

Hence, provide total of six aerators of 20 HP each i.e. two aerators per compartment. The aerators will be mounted on fixed columns and the submergence of aerator blades will be decided in consultation with the manufacturer/supplier to ensure proper specifications are followed.

Outlet from aeration tanks will be over a weir so that water level in the tanks is always constant.

(vii) Final Settling Tanks

The final sedimentation tanks as existing will be checked for the following parameters :

- Detention time = 2 - 3 hours at average flow
- Overflow rate equal to or less than 17 cu.m./sq.m./day
- Solids flux rate equal to or less than 144 kg/sq.m/day

At average flow rate = 6000 cu.m./day = 250 cu.m./hour
The tank area required = 353 sq.m.

Maximum solids flux including recirculation

= (3000 mg/l) x (60000 cu.m/.day) x (2)
= 36000 kg/day
namely, tank area should not be less than 250 sq.m.

Thus, provide min. 353 sq.m. area totally.
Hence, use 4 nos. existing sedimentation tanks.

These four units should also be provided with chain-and-sprocket type sludge scraping mechanisms similar to those in primary sedimentation tanks (i.e. 5 KW each).
(No scum removal is needed in these tanks).

(viii) Sludge Recycle System (including Excess Sludge Disposal)

In the extended aeration system, effluent recycle from final settling tank back to aeration tank has to be possible @ 100% of the inflow (i.e. 6000 cu.m./day). Hence, the sludge removed from the bottom of the settling tanks will have to be drained to a small sump for recycling as necessary through centrifugal pumps :

1 no., 250 cu.m./hr capacity
2 nos. 125 cu.m./hr capacity

capable of pumping to a total head of 8 m. (i.e. approximately 10 KW and 5 KW each).

Some excess sludge will have to be removed from time to time (so as to keep MLSS in the aeration tank around 3000 mg/l). The same pumps can be used for a few minutes per day to pump the sludge either directly to the sludge drying beds or to the chemical dosing tank prior to dewatering in solid bowl centrifuge.

(ix) Sludge Dewatering

The existing sludge drying beds should be used as far as possible though not much use will be possible to make over the wet-months and snow-bound periods between November and April each year.

After some experience is gained in using these beds, if it is decided to switchover to some mechanical means of dewatering, it is recommended to consider use of SOLID BOWL CENTRIFUGE. A Pennwalt-type "Decanter" unit of about 30 HP will be adequate. The sludge will first be taken to a sludge conditioning tank (stainless steel) with arrangement for adding conditioning chemicals such as polyelectrolytes to properly condition the sludge before dewatering. A 0.33 KW high-speed agitator will be provided in the tank and the sludge fed to the decanter through a 0.5 KW feed pump.

(e) OPERATING COSTS (POWER, CHEMICALS AND STAFF)

(a) Power

The power requirement has been calculated individually for each unit in the treatment plant, based on the number of hours each unit is likely to work in a day. (See Table 6)

The total expected consumption is 4768 Kwh/day.

Assuming power cost @ 100 TL per Kwh, tht total power cost will be 476,800 TL per day.

(b) Chemicals

The chemicals consumption is estimated as follows provided the proposed changes are made in the treatment plant :

CHEM	KG/DAY	TL/DAY	TL/DAY
ACID (50% H_2SO_4)	150	85	12,750
ALUM	500	350	175,000
SODIUM HYPOCHLORITE	180	230	41,400
			229,150 TL/DAY

(c) Staff

	CATEGORY	TOTAL	DAY SHIFT	EVENING SHIFT	NIGHT SHIFT
1.	Foreman (Electrical/ Mechanical)	1	1	-	-
2.	Operators	2	2	-	-
3.	Helpers	4	2	1	1

NOTE: Some additional part-time assistance will have to be given to the plant from the existing factory staff as and when necessary. The factory laboratory will also have to assist in sampling and chemical control.

TABLE 6 COMPUTATION OF POWER CONSUMPTION PER DAY.

		Installed Power (KW)	Opertating Power (KW)	No. of Hours	KWh/day
1. Equalization tank aerators		4 x 11	4 x 11	24	1,056
2. Pumps		2 x 10	1 x 10	24	240
3. Acid neutralization	Metering Pumps	1 x 0.5	1 x 0.5	24	12
	Mixer	1 x 4	1 x 4	24	96
4. Alum Dosing	Metering Pump	1 x 0.5	1 x 0.5	24	12
	Flash Mixer	1 x 3	1 x 3	24	72
5. Primary sedimentation	Scrapers	3 x 5	3 x 5	12	180
6. Primary Sludge Pumps	(Approximately)	2 x 10	1 x 10	12	120
7. Extended Aeration Tanks	Aerators	6 x 15	6 x 15	24	2160
8. Final Sedimentation	Scrapers	4 x 5	4 x 5	24	480
9. Sludge recycle system	Pumps	1 x 10	1 x 10	12	120
					4,608
Add for Solid Bowl Centrifuge		1 x 22	1 x 22	6	132
Conditioning tank		1 x 1	1 x 1	24	24
& Feed Tank		1 x 0.5	1 x 0.5	8	4
					4,768
Cost of Power @ 100 TL per Kwh					
= 4768 x 100 TL = 476,800 TL/day					

CAPITAL COSTS

It is not possible for the Consultant to indicate the likely capital cost of upgrading the existing plant. However, to facilitate estimation the following list of all new items to be provided is given.

(f) CHECK-LIST OF NEW ITEMS TO BE PROVIDED

Equalization Tank

1. Extension of inlet channel to proposed equalization tank.
2. Provision of inlet and outlet arrangements to convert one of the aeration tanks into proposed equalization tank.
3. Provision of aerators/mixers - 4 nos. x 15 HP each together with mounting platforms and access bridges, and electrical cabling work.

Pumps

1. Provision of pump suction arrangements in bottom of equalization tank
2. Erection of 2 nos. x 235 cu.m./hour pumps with 10 KW motors each, together with platforms and cabling.

Acid Neutralization

1. Provision of boiler flue gas arrangement in first compartment as per KRTOK design to neutralize the wastewater partly.
2. Provision of acid dosing tank, metering pump 0 - 100 l/min., and 4 KW mixer in the second compartment to complete the neutralization action. This will also include provision of a pH sensor in the outlet to actuate acid dosing pump through a solenoid valve.

Coagulant Dosing and Flocculation

1. Provision of aluminium sulfate solution preparation tank including its mixing, dose = 100 - 120 mg/l

2. Provision of metering pump, 100 - 1000 l/min. to feed alum solution

3. Dismantling of existing partition in the coagulation tank and provision of a 1m x 1m x tank depth box with inlet at bottom and outlet at top to serve as a flash mixing tank. Provision of 0.5 KW agitator for flash mixing.

4. Provision of flocculation paddles in remaining part of compartment with 3 KW drive motor to stir liquid contents @ 1 - 2 RPM to help build up alum floc.

Primary Sedimentation Tanks

1. Provision of sludge and scum removal mechanism (chain and sprocket type) to fit existing three sedimentation tanks. The drive motor may be 5 KW or as per supplier's design for each unit.

2. Provision of new 30 cu.m. sump to hold sludge for pumping to sludge drying beds. Pumps will be 2 nos. x 50 cu.m./hour capacity capable of pumping to required head.

3. Provision of a sludge delivery line 150 mm dia. from above pump upto the sludge drying beds.

Extended Aeration

1. Provision of 150 mm line to bring domestic sewage from a point prior to septic tank to the aeration tanks.

2. Adjust levels of inlets and outlets from the three compartments proposed to be used for extended aeration, to ensure that all three tanks receive equal flows.

3. Provision of six aerators of 20 HP each, to be installed @ 2 Nos. per compartment, complete with platforms, access bridges and cables, etc.

4. Provision of sludge return line 250 mm dia. from secondary settling tank pumps to the aeration tank to carry upto a maximum of 6000 cu.m./day recycled flow.

Final Settling Tanks

1. Provision of sludge removal mechanism (chain and sprocket type) to fit existing <u>four</u> secondary sedimentation tanks similar to the primary sedimentation tanks except that scum removal is not necessary in the secondary sedimentation tanks.

2. Provision of pump suction arrangement from bottom of four sedimentation tanks to facilitate recycle.

Recycle Pumps

1. Provision of recycle pumps, 1 no. 250 cu.m./hour capacity and 2 nos., 125 cu.m./hour capacity complete with 10 KW and 5 KW motors and 250 mm delivery line upto aeration tanks with a branch line to sludge drying beds to be operated manually by opening sluice valve as necessary.

Mechanically Sludge Dewatering (Optional)

1. Mechanical sludge dewatering is <u>optional</u> and may be considered only after some working experience is gained with the existing open sludge drying beds.

   As and when a mechanical sludge dewatering unit is desired to be installed, M/s. PENWALT, USA, will have to be approached to provide a suitable SOLID BOWL CENTRIFUGE (DECANTER) together with sludge conditioning tank, mixer and feed puump.

Sodium Hypochorite Dosing

1. Provision of arrangement for sodium hypochlorite dosing is to be made either just before the main flow enters the "oxidation filter", or just after this unit, to asist in colour removal if any further colour removal is necessary after biological treatment. It is felt that biological treatment itself will be generally adequate and no further chemical dosing will be required. However, an arrangement should be available for use whenever necessary.

Electrical Control Panels and Cabling

1. For the various items of equipment (pumps, aerators, motors, etc.) electrical connections will have to be provided and preferably centralized control panel also provided to facilitate operation from a central point. Individual switchgear should also be available at each unit to enable operators to isolate the unit if necessary for inspection. Thus, electrical work should be planned and installed alongwith the various items listed above.

5. EXPERIMENTS WITH USE OF CINDERS (CURUF) FOR COLOUR REMOVAL

The factory has demonstrated that ash/cinders (CURUF) from coal-fired boilers can be effectively used for colour removal by creating a bed of "CURUF" about 8m x 4m x 1m deep over which raw wastewater has been spread so as to promote percolation through the bed. The percolated water is seen to be free from colour. The results are very impressive.

But, if this idea is to be pursued further, more scientific data is needed on the loading rate, and the life of the CURUF before its colour adsorption properties are exhausted. Moreover, the raw waste contains suspended solids, organic materials, and some oil and grease, all of which tend to reduce the effectiveness of the CURUF. The extent of CURUF produced in the Mills boilers daily is finite and the quantity produced should suffice to meet the waste treatment needs, as additional CURUF would be too expensive to transport from outside.

Several ways can be suggested to prolong the useful life of the CURUF such as :

(i) Using the CURUF for colour removal <u>after</u> effective primary sedimentation is done (or even after biological treatment is done) so as to remove only the remaining colour and help in "polishing" the final effluent before discharge. (Also see Section 2 of this Report).

(ii) Using the CURUF bed in an <u>upflow</u> mode so as to reduce the choking effect of suspnded solids, etc., coming in the raw waste. This would appear to be the logical manner of using the material to get best results. Each contact bed of about 2.5m x 2.5m x 1m. deep would be fed from the bottom and overflow from the top (See fig. 4)

(iii) Providing a <u>conveyor belt system</u> to load and unload the CURUF from the contact beds, and facilitate handling. A conveyor belt could carry the CURUF from the boiler house to the contact beds and the same conveyor belt could then carry the exhausted CURUF from the beds to a ramp for loading trucks for transporting away the CURUF for disposal, (See Fig. 4). In any event, the CURUF is being carted away at present for disposal.

The initial studies required could be carried out through a university department to obtain data of the type shown graphically in Fig. 5 from which a full-scale unit can be designed.

It may be repeated here that use of CURUF would be advisable after treatment in the proposed treatment plant rather than directly with raw wastewater. Direct use with raw wastewater would lead to rapid exhaustion and choking of the CURUF and while colour may be removed, our objective should also be to remove suspended solids, organic materials (suspended and dissolved) oil and grease, etc.

6. RECOMMENDED STAGEWISE WORK PROGRAMME

(i) The treatment strategy discussed in Section 2 of this Report explains why biological treatment is preferred in the case of Eskisehir.

(ii) All the civil structures for the wastewater treatment plant already exist at Eskisehir. Even without any equipment or machinery, the plant has demonstrated since August 1988 its ability to treat the wastewater with chemicals and sedimentation to give reasonable colour removals and clarify in the effluent, as shown in Section 1. (Fig. 2)

(iii) But such a plant cannot run for long without necessary electrical-mechanical equipment especially for sludge scraping, sludge pumping and for providing extended aeration to the wastewaters. Hence, the first priority is to invite a local equipment supplying/designing company to take up this work in hand.

(iv) The Consultant has given in Section 3 of this Report a complete "check-list" of all the new items of work required to be done. The sizes of units required, power, etc., are also described along with important specifications to enable local contractors to proceed further with the work.

(v) It will be helpful if a local consulting company is retained to assist Sumerbank in the detailing of the new electrical-mechanical work to be done at Eskisehir and in its supervising during implementation as some problems may arise in actually retrofitting the eqipment, machinery and electrification to the existing civil structures.

(vi) Some experiments may be continued with the use of "curuf" for adsorption of colour as explained in Section 5, but completion of the existing treatment plant should not be held up on this account.

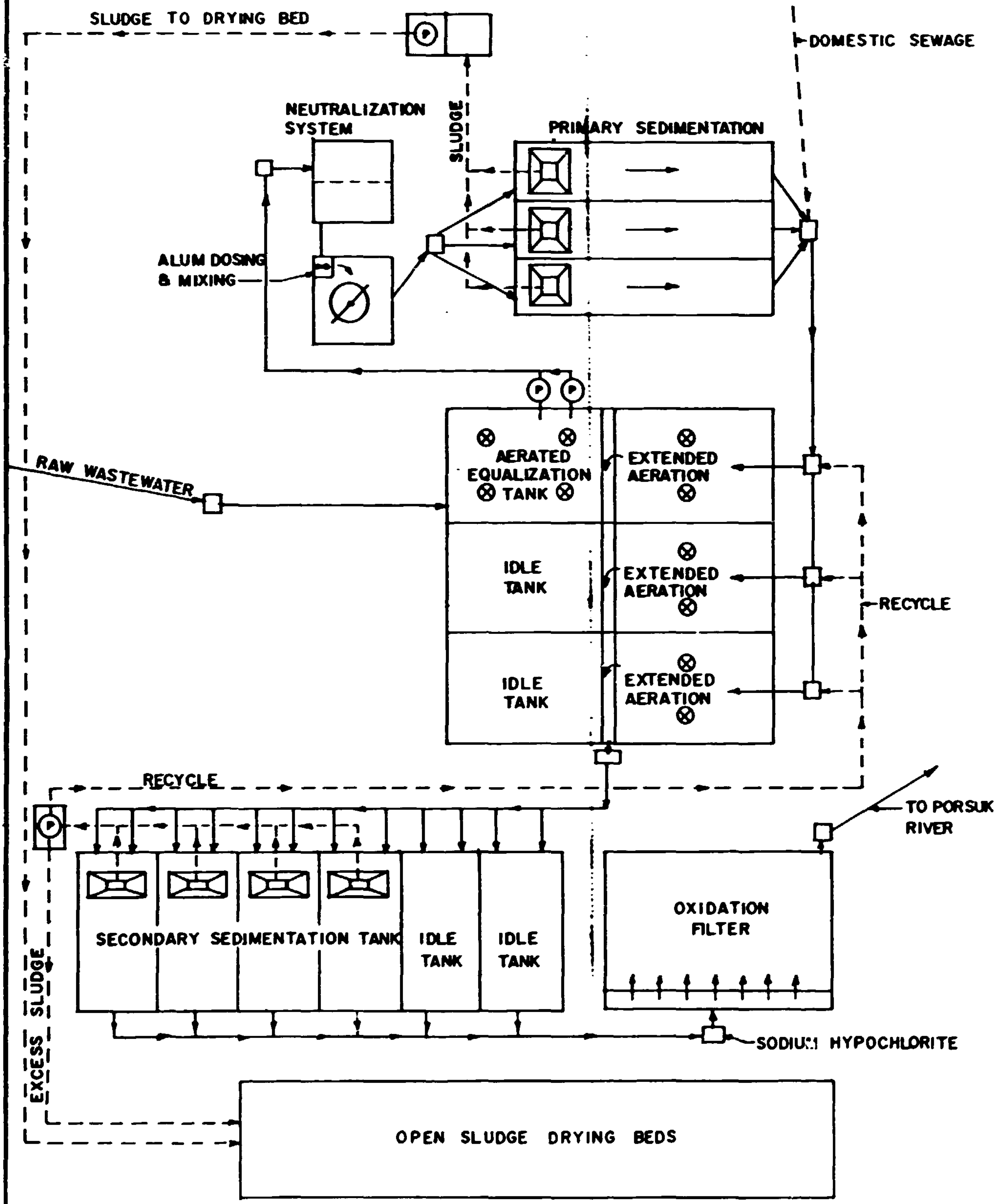


FIG. 3 - SUGGESTED IMPROVEMENTS TO EXISTING WASTEWATER TREATMENT PLANT AT SUMERBANK TEXTILE MILL, ESKISEHIR

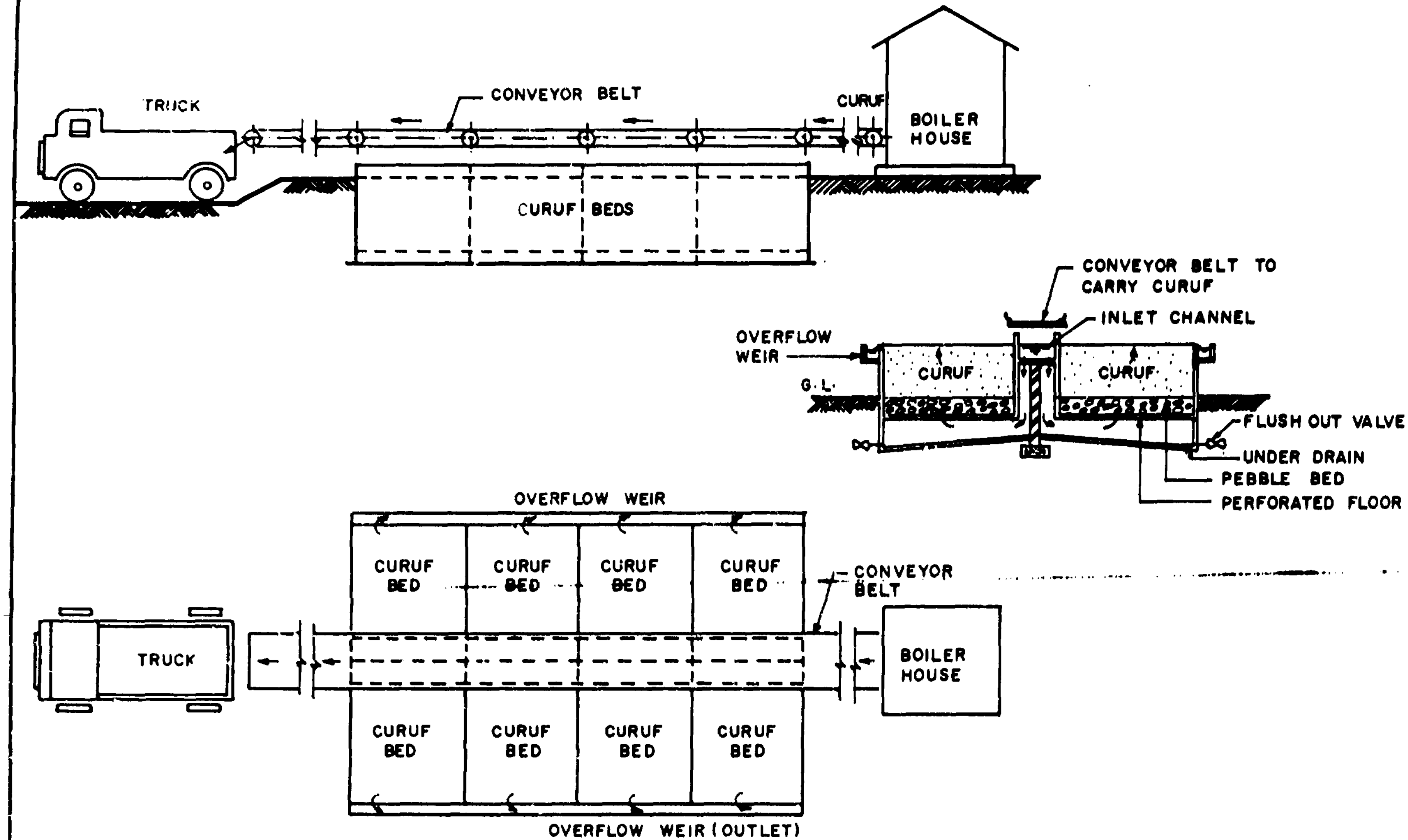


FIG. 4 TYPICAL ARRANGEMENT SHOWING HOW CONVEYOR BELT CAN BE USED TO CARRY FRESH CURUF FROM THE BOILER HOUSE AND DEPOSIT IT INTO THE TREATMENT BEDS. THE EXHAUSTED CURUF CAN SIMILARLY BE PLACED ON CONVEYOR BELT TO CARRY TO A TRUCK FOR DISPOSAL

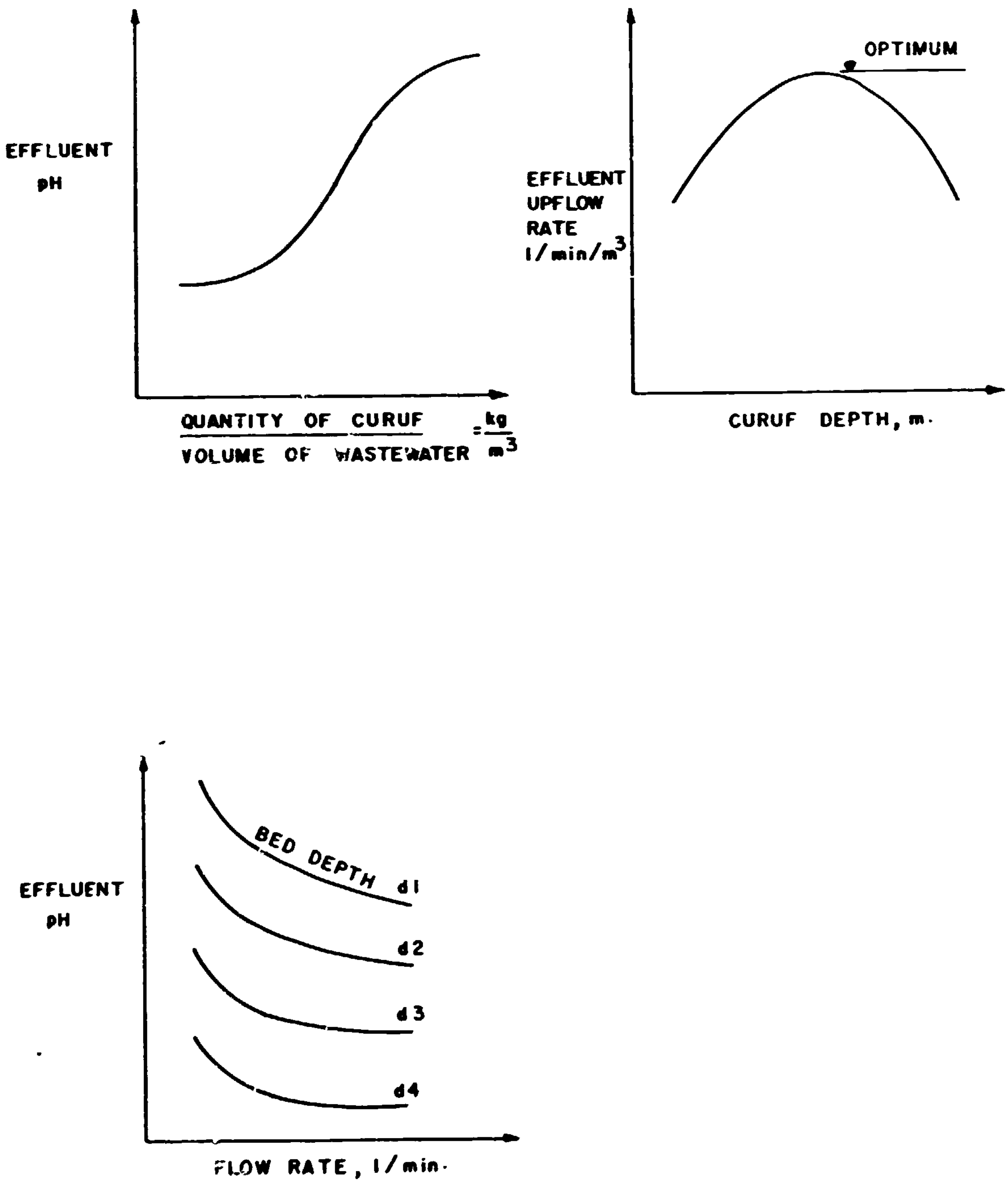
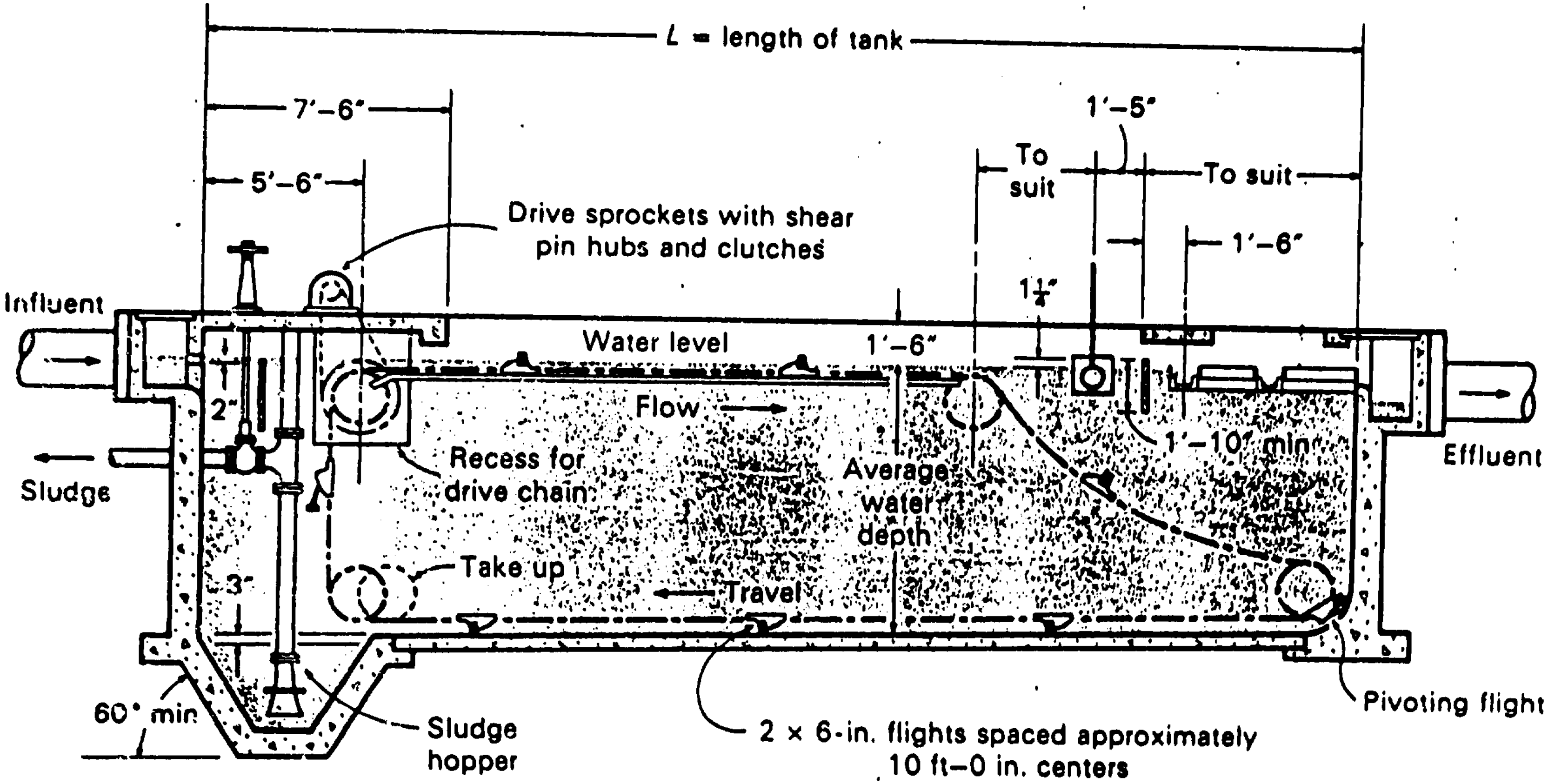


FIG. 5 SUGGESTED EXPERIMENTS WITH "CURUF"



Typical rectangular primary sedimentation tank

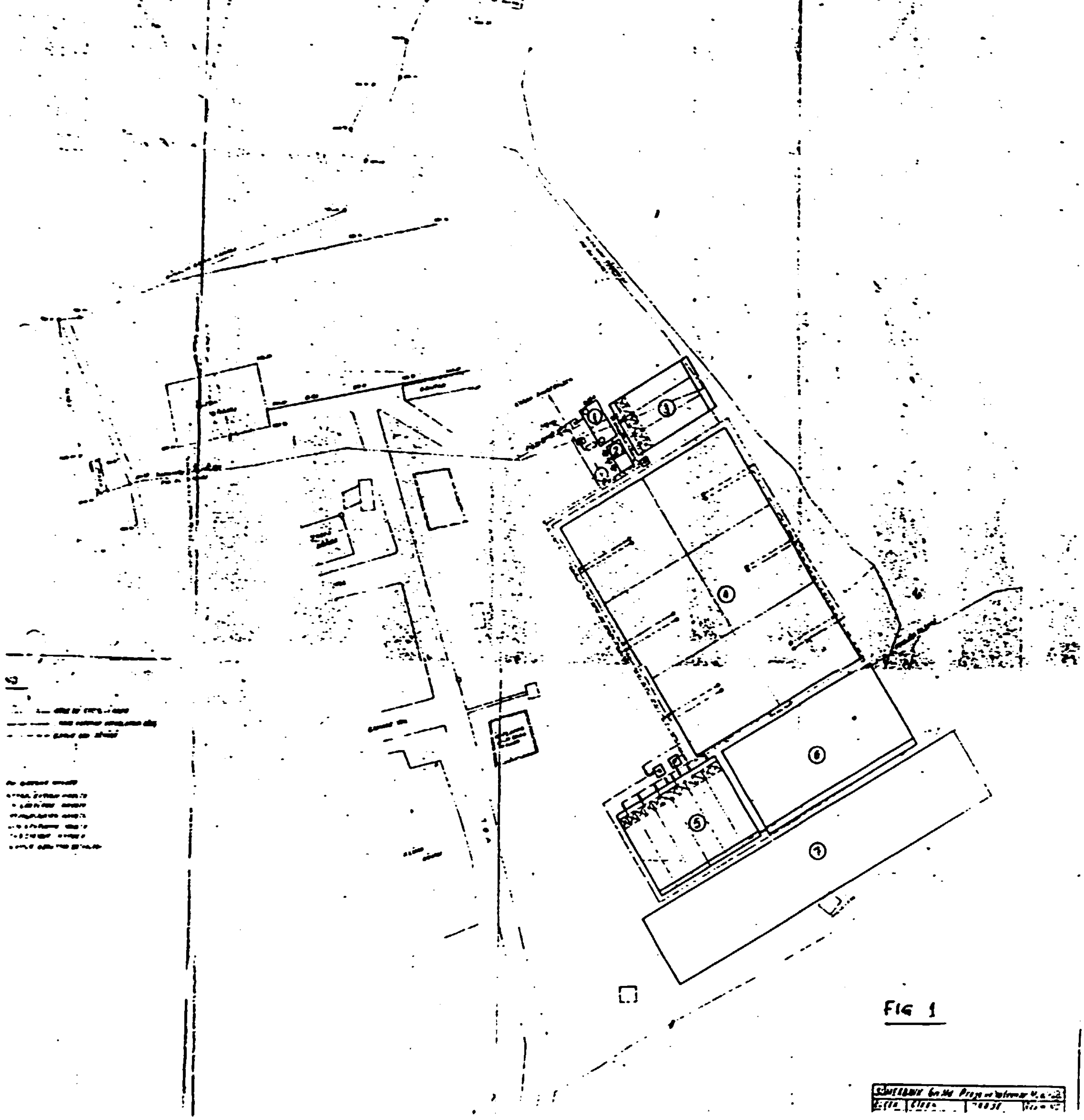
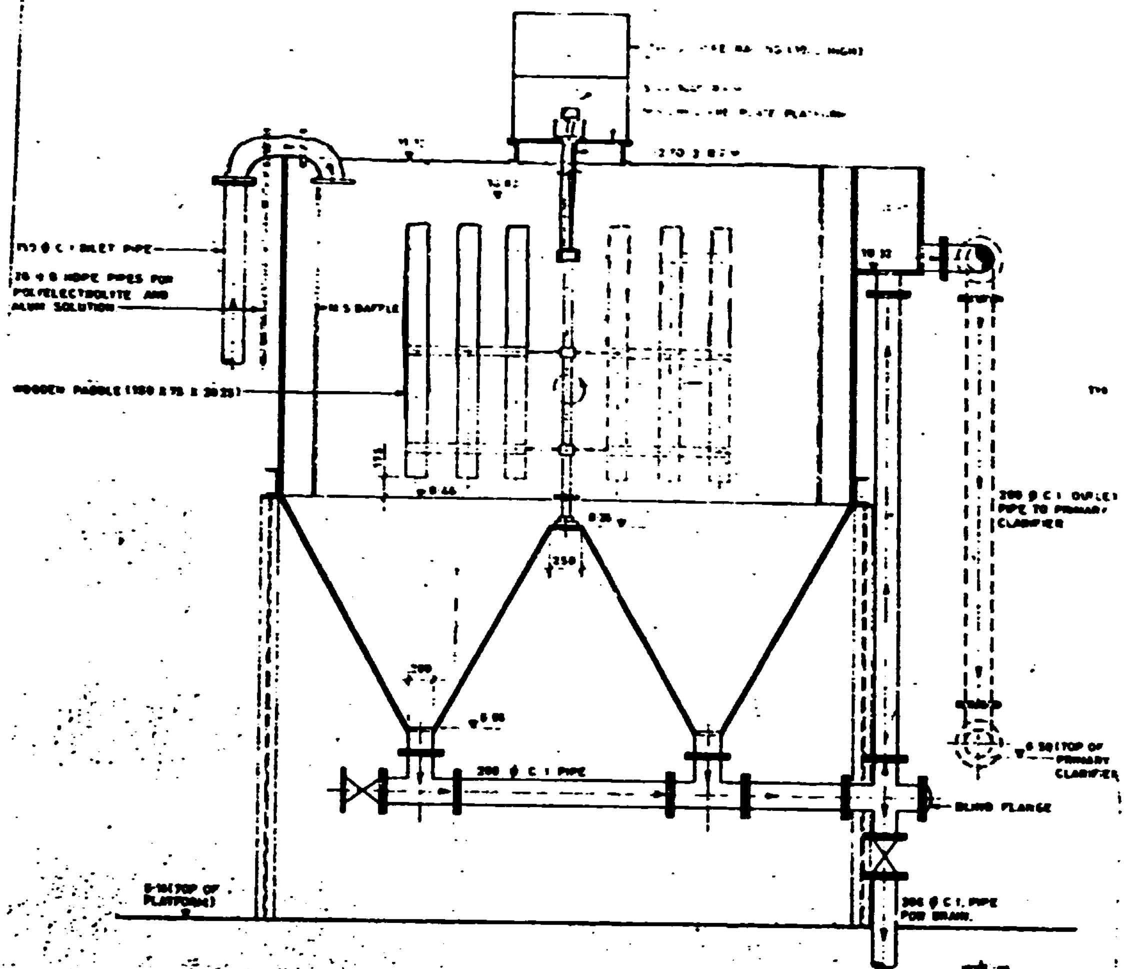
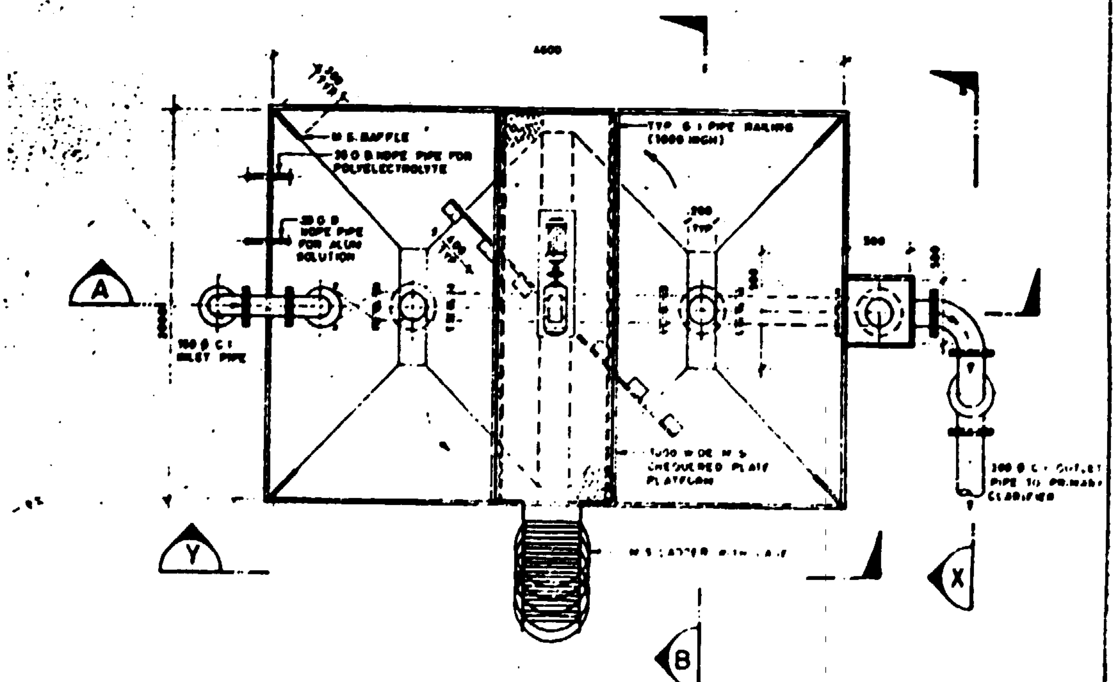


FIG 1

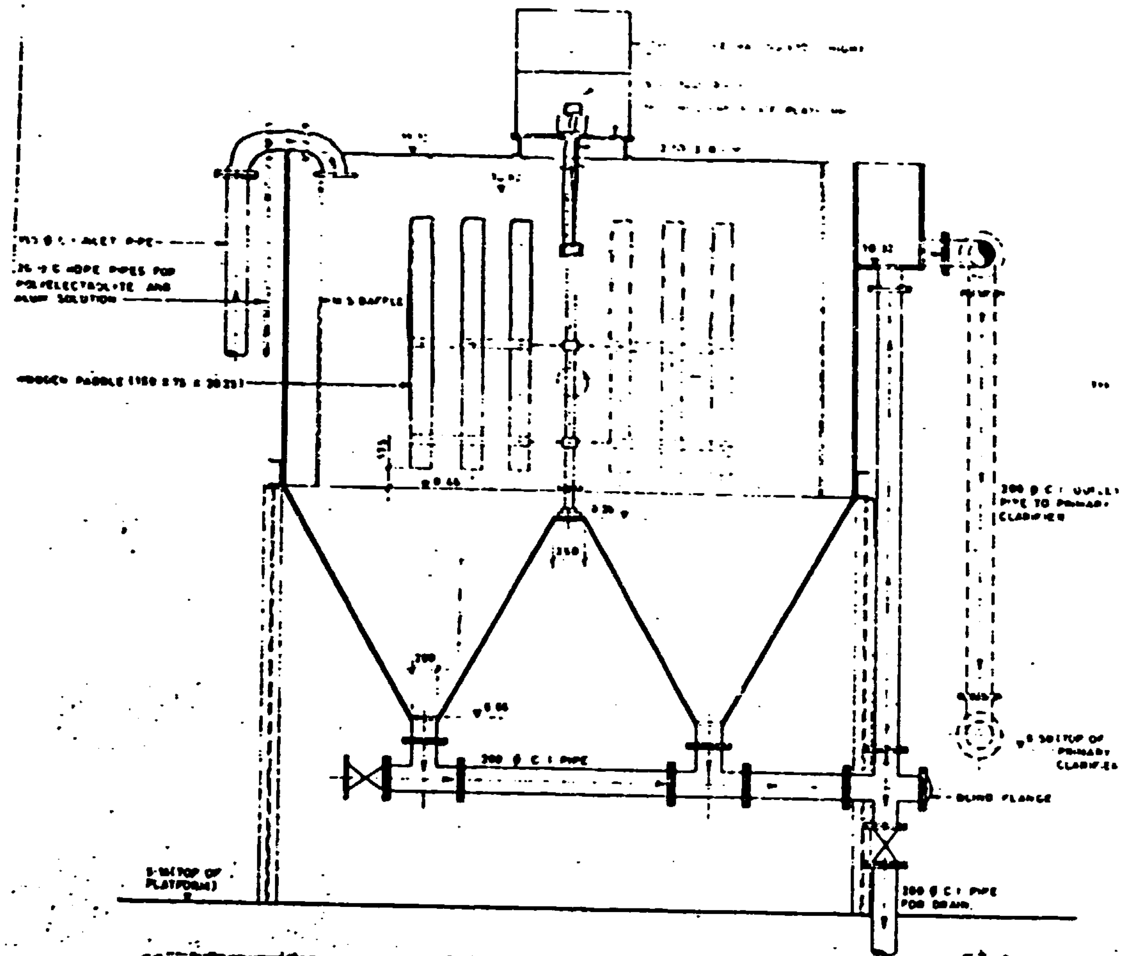


A TYPICAL FLOCCULATOR

(IN STEEL TANK)

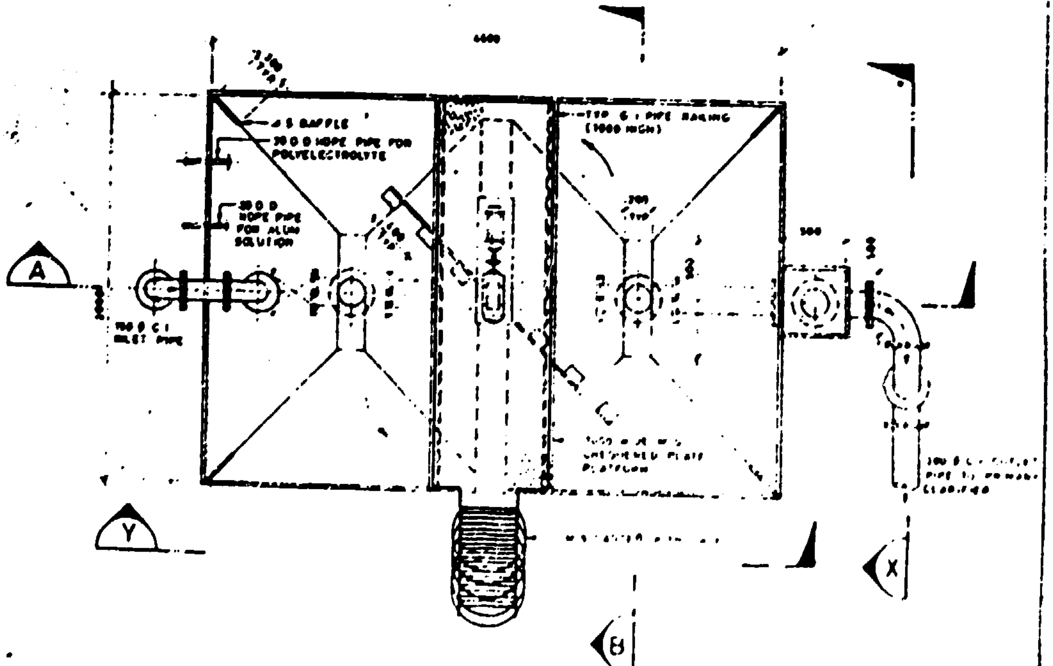


PLAN

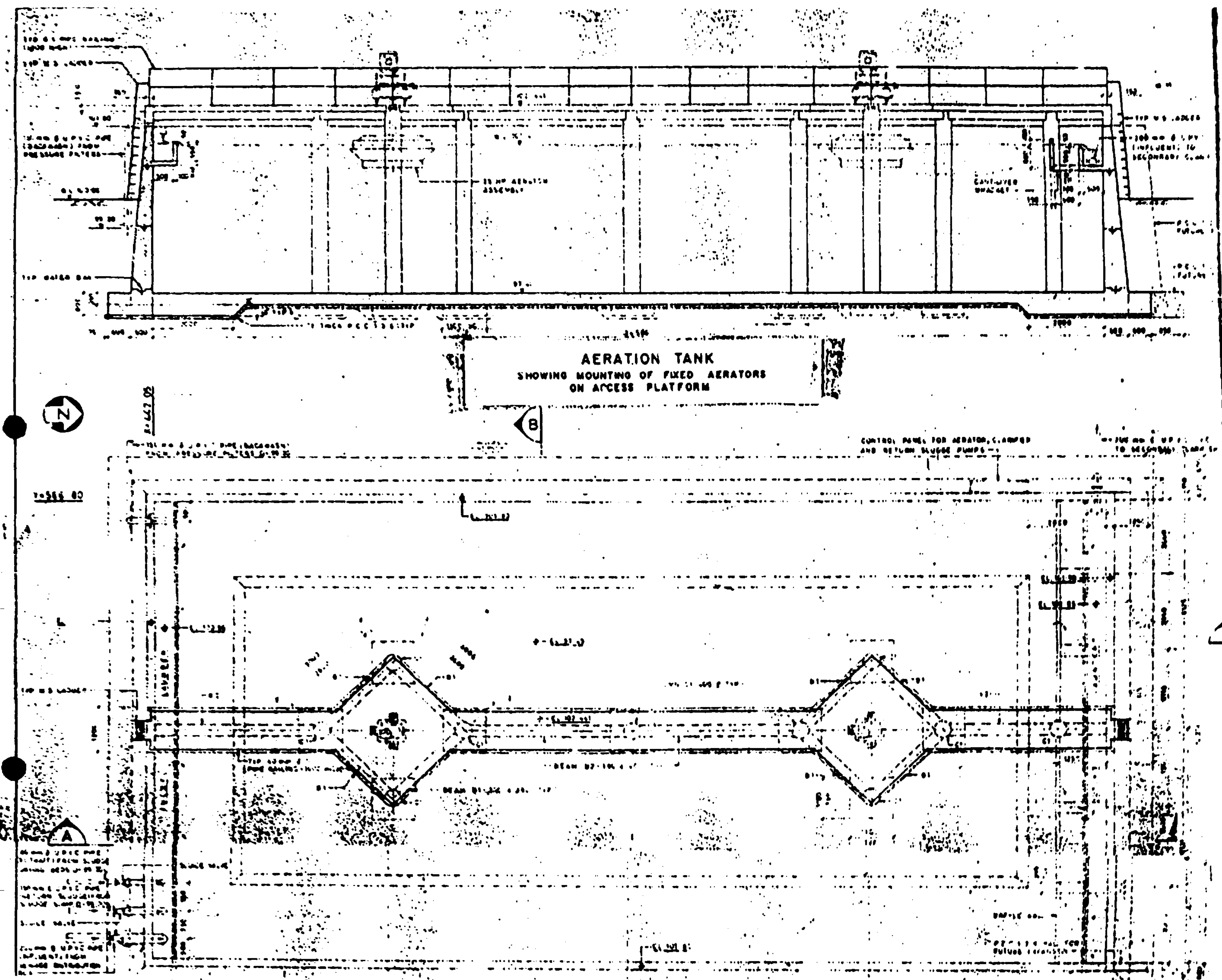


A TYPICAL FLOCCULATOR

(IN STEEL TANK)



PLAN


AERATION TANK
SHOWING MOUNTING OF FIXED AERATORS
ON ACCESS PLATFORM

BAYKOZ LEATHER TANNERY, ISTANBUL,
WASTEWATER TREATMENT AND DISPOSAL

Report based on a visit to Turkey by
UNIDO Consultant, Mr. S.J. Arceivala
from 21-30 November, 1988.

BAYKOZ LEATHER TANNERY WASTEWATER TREATMENT AND DISPOSAL

1. The Existing Situation

(i) General

The Baykoz Leather Tannery established 176 years ago in the Ottoman time, is the oldest of its kind in Turkey. It has five main divisions : Leather tanning, shoe manufacture, synthetic leather, rubber and adhesives. The plant engages 1600 workers and nearly 100 officers. About 34 families live on the factory campus. The plant is occupying a beautiful spot on the Bosphorus facing Tarabya on the Anantolian side, and is discharging its wastewater into the Bosphorus without any pretreatment.

The Government issued instructions for all plants discharging their wastewater into the Bosphorus to move. This could cost Sumerbank about 16-20 billion (about US $ 10 million) besides causing human problems from displacement. Though the site is highly touristic in value, there is a feeling that if the composition of the wastewater could be controlled through treatment to be in line with international standards, the plant may still be able to continue operations from the same site.

(ii) Products and Processes

The factory earlier could handle 30-35 tons/day raw hides but since a fire destroyed a part of the factory only about 21-25 tons/day (6000-7500 tons/year) are being processed. Table 1 gives details of the various types ofproducts made and the raw materials/chemicals consumed per year in 1985 prior to the fire.

The process flowsheet used in production of calfskin and coarse leather is shown in Fig. 1 . The typical steps through which raw hides pass are as follows :

Liming
Beaming
Deliming
Bating, pickling
Vegetable tanning for coarse leathers
Chrome tanning for calfskins
Pressing/splitting/shaving
Neutralizing/tanning/fat liquoring
Finishing (various steps)
Quality control
Weighing and storage.

Artificial coarse leather (leather board) used in the in-soles is made from the waste pieces of coarse and fine leathers after adding chemicals and processing them further as necessary. This is shown in Fig. 2.

TABLE 1. BEYKOZ LEATHER AND SHOE INDUSTRY PLANT

	Production Capacity	Production of 1985
1. PRODUCTS		
- Leather (calfskin, suede, split, etc)	100.000.000 dm2	90.372.300 dm2
- Coarse Leather	750.000 kg	854.200 kg
- Artificial coarse leather	1.200.000 kg	718.000 kg
- Shoes	3.930.000 pairs	1.941.400 pairs

2. RAW MATERIAL CONSUMPTIONS

A) Leather Department

	Consumption of 1985 (in ton)
- Lime	291,9
- Sodium Sulfide	121,1
- Ammonium sulfate	107,6
- Formic acid	2
- Sumac	2,5
- Valex	838,2
- Sodium bisulfite	2,2
- Acids	45,7
- Borax	3
- Oils	275,5
- Synthetic tannins and valex	143
- Sodium bicarbonate	81,5
- Salt	254,3
- Corn starch	37,1
- Sodium Dichromate	174,5
- Molasses	65
- Presar PT	0,2
- Perminol ASB	11,0
- Sulphide acid	314
- Pigment and aniline dyes	51,2
- Binders	72,4

*

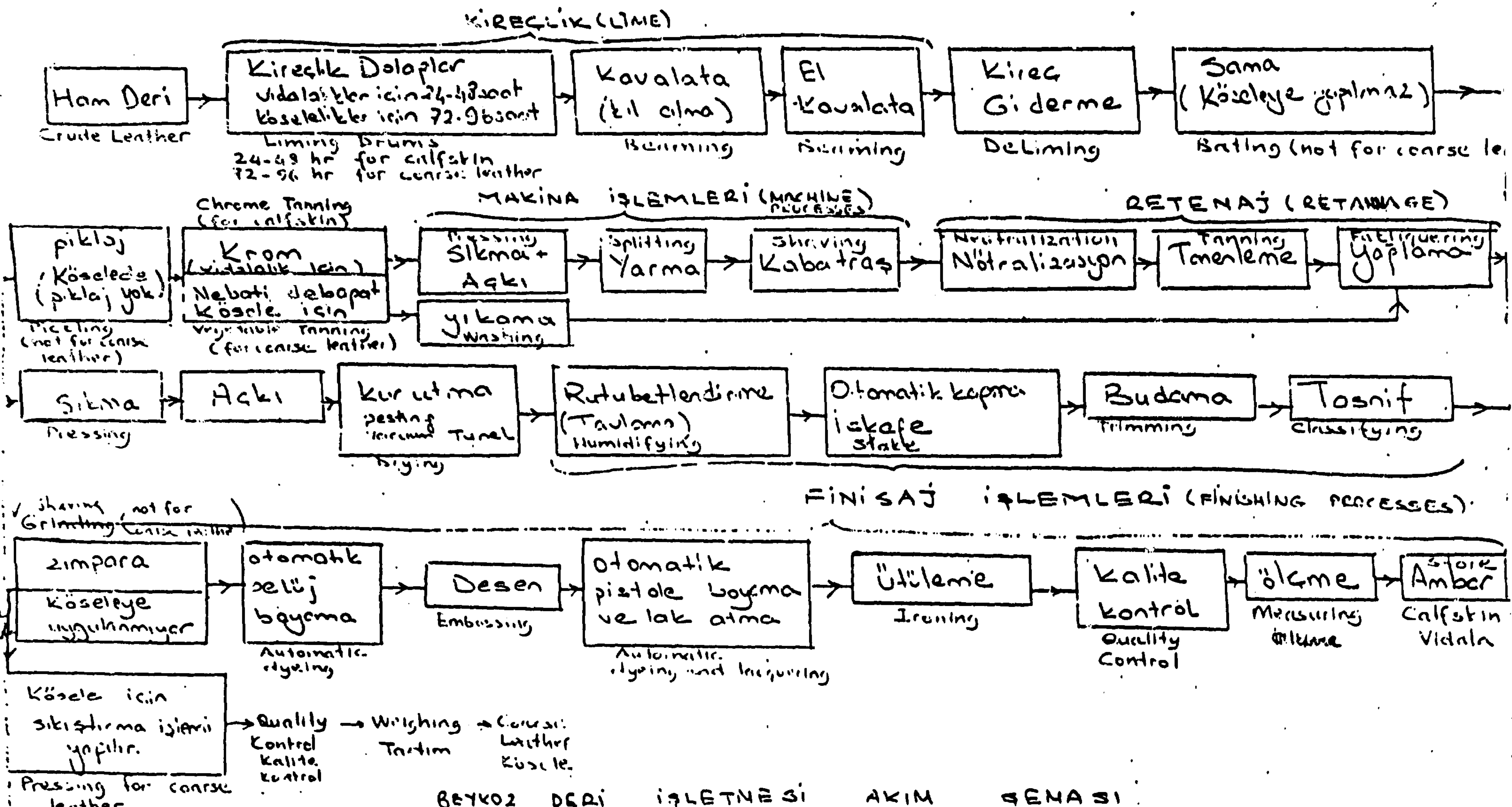
Full Capacity = 30-35 Tons/day of raw hides

Reduced capacity since fire = 21 - 25 Tons/day
= 6000 - 7500 Tons/year

	Consumption of 1983 (in ton)
- Wax emulsion	13,3
- Casein	178
- Laces	75,3
- Magnesium sulfate	29,4
- Oxalic acid	2,4

B) Artificial Coarse Leather Department

- Coarse leather wastes	182,8
- Chromium leather wastes	914,9
- Ammonia	7,9
- Soda	0,5
- Paraffine	3,6
- Stearin	3,1
- Oil	99,9
- Leverten	34,0
- Poly vinyl	11,6
- Hydrochloric acid	1,3
- Dyes	5,9
- Others	509,6



BEYKOZ DERİ İŞLETMESİ AKIM ŞEMASI

4- PROCESS FLOWSHEET OF BEYKOZ LEATHER DEPARTMENT (PRODUCTION OF CALFSKIN AND COARSE LEATHER)

FIG. 1

5- PROCESS FLOW SHEET OF
ARTIFICIAL COARSE LEATHER

SUN-İ KÖSELE İMAL ÂT ŞEMASI

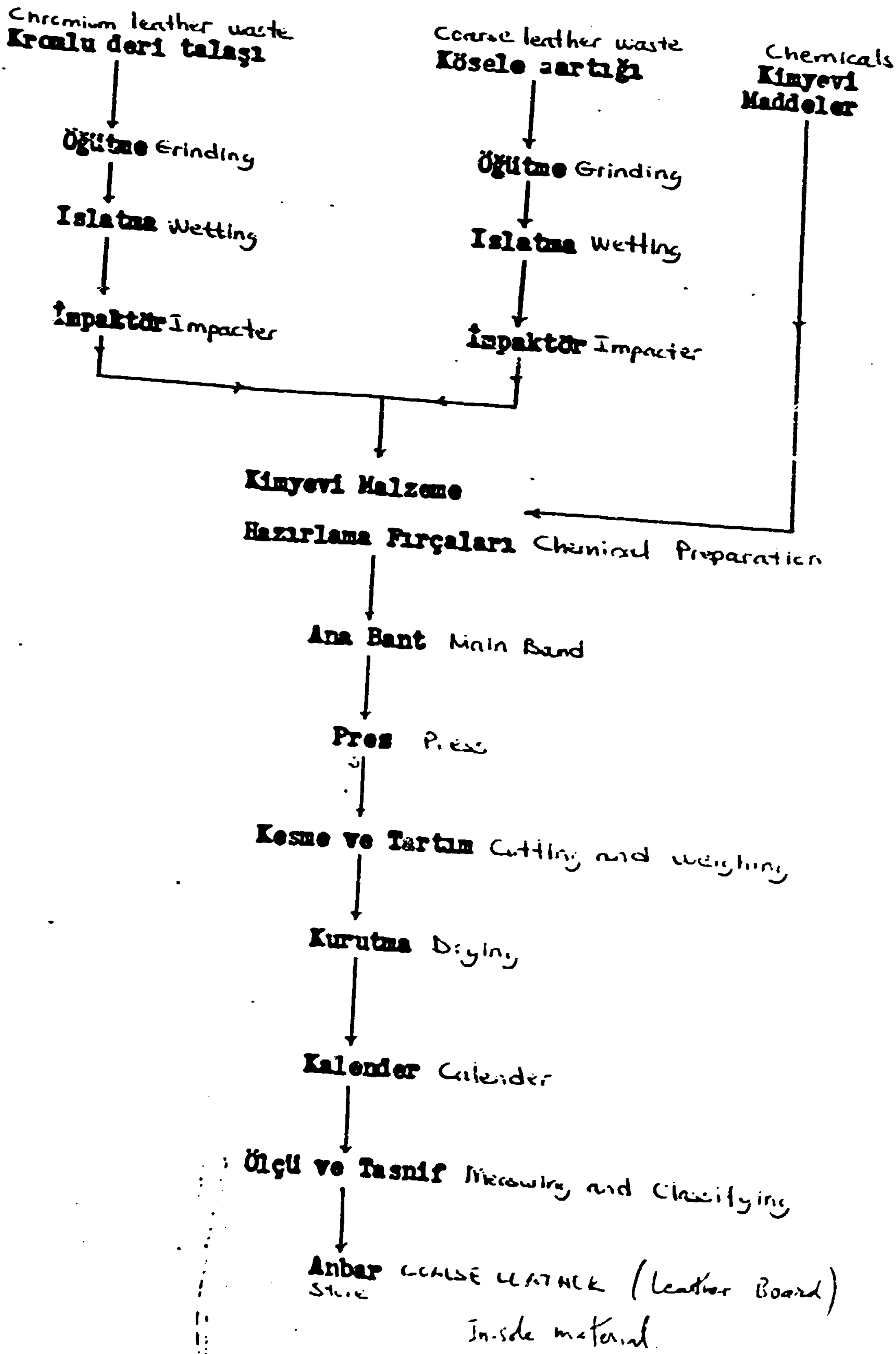


FIG. 2

(iii) Wastewater Quantity and Characteristics

(a) Flows

Fortunately, a very detailed study of the wastewater flows and their chemical and other characteristics had been undertaken in 1981 by a doctoral student, Ali Kalendar, for his Ph.D. thesis. He analysed the wastewater flows from various departments of the factory as well as from the main effluent channel going to the Bosphorus, over a six month period.

Table 2 gives the hourly variations in the flows measured in the maineffluent channel first by Dr. Ali Kalendar in 1981, and thereafter by Sumerbank's own R & D Centre, Bursa, on one day, in January 1988. As far as flows are concerned, there is a wide discrepancy between the 1981 and 1988 results. The method of measurement used in both cases is not known.

Water consumption data, if available, would have been useful evidence but the sources of water are three tube wells, some municipal supply as and when needed and seasonal uptake from an adjoining stream. Sea water is also used in the liming section. Thus, reliable consumption data is not available.

Average flows can also be estimated from production data using appropriate norms. For wastewater treatment purposes, one may assume maximum raw hides handled as 32 tons/day and water usage as 60 l/kg hides. Thus,

processing water in tanning 32 t/d x 60 cu.m./day		= 1920 cu.m./day
Water for leather board and other manufactures		= 800 cu.m./day
Domestic Sewage		
1700 persons x 100 l/day	= 170	
150 residents x 200 l/day	= 30	
Cafeteria	= 100	
	---	300 cu.m./day
	Total	3020 cu.m./day
	(say	3000 cu.m./day)

Hence, the treatment plant would be advisable to construct for 3000 cu.m./day. This figure was also acceptable to the factory authorities during discussions.

Dr. Kalendar's data shows that as much as 2/3 of the daily flow is produced in the day shift alone, the rest of the flow being spread over the remaining two shifts. Assuming that the flow pattern will still be the same (although the total flow will be more) we get :

Average flow rate over 24 hours = 125 cu.m./hr.

High flow rate over 8 hour day shift = 250 cu.m./hr.

Low flow rate over remaining 16 hours = 63 cu.m./hr.

TABLE 2 : EFFLUENT FLOW MEASUREMENTS*

Time	Flows measured in main Effluent Channel, cu.m./hour	
	1981	1988
09	95.76	458.0
10	66.96	381.7
11	120.24	356.2
12	99.00	305.3
13	61.92	229.0
14	137.52	229.0
15	77.04	381.7
16	48.96	305.3
17	24.84	330.8
18	14.40	
19	21.60	
20	18.00	
21	19.08	
22	15.48	
23	15.84	
24	13.68	
01	14.04	
02	23.04	
03	16.92	
04	15.48	
05	14.40	
06	15.12	
07	17.64	
08	56.88	
	1024 cu.m in 24 hours	2646 cu.m. in 8 hours

* Note : (1) 1981 data is part of Dr. Ali Kalendar's Ph.D. thesis. The average and standard deviation values obtained over a six month period were:

8 AM - 4 PM : 85 ± 28 cu.m./hr
5 PM - 7 AM : 17 ± 3 cu.m./hr

(2) The 1988 data covering only the day shift on 21-1-1988 was obtained by Sumerbank's R & D Centre, Bursa. In both cases, the method of measurement used is not known.

(b) Wastewater Characteristics

The wastewater analysis for various chemical and other parameters were also carried out by Dr. Ali Kalendar in 1981 and the Sumerbank R & D Centre in 1988. The results are given in Table 3(a).

The wastewaters are typical of any tannery, namely, the wastes contain grease, total solids, BOD, COD, sulfides and chromium. As biological treatment would be dependent on BOD values, a closer look at the BOD values would be desireable.

BOD Values

The analysis values of Dr. Kalendar given in Table 3(a) show BOD ranging from 600-1600 mg/l while Sumerbank's value is only 700 mg/l. Using some typical BOD load norms and assuming production levels of 32 tons/day of raw hides 80% of which are chrome tanned, we get :

As per UNIDO report IB/WG 411/10 :

BOD from chrome = 26 T/day x 60 kg/T = 1560 kg/d
BOD from Veg. tan. = 6 T/day x 85 kg/T = 510 kg/d

2070 kg/d
= 690 mg/l in flow of 3000 cu.m./day

As per Dr. Ali Kalendar's study :

BOD = 70 to 90 kg/ton hides x 32 T/d = 2240 to 2880 kg/d
= 750 to 960 mg/l

Thus, for design purposes, assume BOD = 900 mg/l.

Sulfides

Sulfides values range from 100-300 mg/l and treatment will have to take this into account as sulfides would exert an oxygen demand and would be objectionable in the final effluent. (See Section 5)

Chromium

Chromium values range from 20-90 mg/l and also need removal as any chromium discharged to the Bosphorus would be picked up by algae, protozoons, etc. and, through the food chain, it would pass to the fish and finally to human beings. Thus, chromium accumulation gives toxicity and must be controlled.

Any attempt to remove it in a treatment plant will only transfer the Chromium from the liquid effluent to the sludge phase and careless disposal of sludge would bring it back into the environment. Thus, it is better to handle chromium right at the source by recycling it as far as as possible rather than wasting it in the effluent. Chromium recycle possibilities have been discussed in a Section 5 of this report.

pH

pH ranges from 7.0 to 11.0 generally though peak values may range from 5.0 to 12.0. The provision of a suitable sized equalization tank would keep the pH flucutations within a narrower range and also permit some self-neutralization to occur in the tank, thus reducing chemical dosing requirement for pH adjustment.

Oil and Grease

Oil and grease removal can be ensured during treatment.

(iv) Present Disposal Arrangements

The present disposal arrangements at the factory merely comprise conveying the wastewaters from the various departments through sewers to the main effluent channel which discharges into the Bosphorus at surface level. No outfalls exist.

At the discharge point some solids, oil and grease (scum) float up and make unsightly conditions. Scavenging birds are also attracted to the site. Eventually, the rapid currents of the Bosphorus carry away all the material towards the Marmara Sea.

TABLE 3 (a)
BAYKOZ TANNERY WASTEWATER ANALYSIS

(All results except pH and temperature are given as mg/l)

Table 3 (b)
SOME WASTEWATER DISCHARGE STANDARDS OF RELEVANCE TO BAYKOZ TANNERY SITUATION

Parameter	Dr. Ali Kalendar (1981)	Sumerbank R & D Centre 20.1.1988	ISKI SEWER STD.	Su URUNLERI (FISHERIES)	DERIN DENIZ (DEEP SEA)	Effluent Standards FOR TANNERIES (ENV. PROT. LAW)
Temperature ^{o}C	22 - 35 ^{o}C	-	40 ^{o}C		35 ^{o}C	
pH	7 - 11	8.3	5.5 - 10	5 - 9	6 - 9	6 - 9
BOD	600 - 1600	700	250	50	250	100
COD	1500 - 4500	13200	800	70	400	200
Suspended Solids (TSS)	650 - 1000	6122	350	200	350	150
Settleable Solids	1500 - 2500	-	-	-	-	-
Oil & Grease (Hexane Extract)	-	142	50	30	10	20
Detergents	-	0.25	5			
Total N			30		40	
Total P		0.14	8		10	
Arsenic (As)		1.49	3	0.5		
Boron (B)		0.08	5			
Cadmium (Cd)		0.048	5			
Total Chromium (Cr)	20 - 80	90	5	0.5		2.0 *
Copper (Cu)		3.25	10	0.5		
Lead (Pb)		0.55	3	0.5		
Nickle (Ni)		2.08	10	0.5		
Phenol		3.6	10	5.0		
Mercury (Hg)		Traces	1	.01		
Sulfide (S)	100 - 300	127.8	2			1.0
Sulfite (SO3)		179				
Sulfate (SO4)		1637	1000			
Cyanide (CN)			10	.2		
Silver (Ag)			5			
Zn				2.0		
Fish Bioassay (Toxicity Dil. Factor)						4.0

* Cr^{6} = 0.3

2. WASTEWATER DISPOSAL STANDARDS APPLICABLE

(a) Various Standards

The Government has recently promulgated various standards for discharge of industrial wastewaters and for the protection of the quality of receiving waters such as rivers, lakes, coastal and deep sea waters. An effort is also under way to harmonize the Turkish Standards withthose of the ECE countries (with UNDP/UNEP assistance).

With reference to Baykoz Leather Tannery effluent, the Consultant was informed that the following standards would have relevance:

1. ISKI (Istanbul Water and Sewerage Organization) Standards for discharge to public Sewers.
2. "SU URUNLERI" standards to protect fisheries and other aquatic products.
3. DEEP SEA discharge (Derin Deniz) standards
4. EFFLUENT STANDARDS for tannery wastes, under Environmental Protection Law (1988)

Thus, all the above standards have been tabulated in Table 3 (b) alongside the effluentanalysis results of Baykoz Tannery in Table 3 (a) to give a comparative idea of the treatment requirements.

(b) Comments on the Standards

(i) It is not quite clear from reading the Turkish text of the standards for tannery waste waters promulgated under the Environmental Protection Law (1988) whether these standards apply to all tannery effluents regardless of the point of discharge. For example, is the BOD value (given as 100 mg/l in the standards) applicable to all rivers, lakes, sea waters, regardless of the actual dilution at site? Is the value applicable to sewer discharges also? These questions are not clear. Under what conditions are the values given in the Environmental Protection Law applicable? Also, do they supersede the corresponding values given under "Su Urunleri" and "Derin Deniz" discharge regulations? We can bring down the BOD to 250 mg/l but it will be very expensive to bring it down to 100 mg/l.

(ii) The BOD and COD values required in the various standards are <u>not</u> compatible with each other. For example :

In ISKI Std.,	BOD = 250,	COD = 800,	or	ratio COD/BOD	= 3.2
In SU URUNLERI,	" 50,	" 70	or	"	= 1.4
In DERIN DENIZ,	" 250,	" 400	or	"	= 1.6
In ENV PROT LAW (1988)	" 100,	" 200	or	"	= 2.0

Thus, the COD/BOD raios range from 1.4 to 3.2. It is well known that for tannery wastes, the ratio will generally never beless than 3.2 after treatment. In such a case will the BOD limit be insisted upon or both the BOD and COD limits? If COD limit is insisted upon we will have to "over-treat" the waste which will be very expensive. It will be possible to meet the BOD limit of 250 mg/l only.

(iii) The Su Urunleri standards are applicable for a dilution of 1:10 in the receiving water body (river, lake, estuary or coastal water). In the case of Baykoz Tannery discharge to the Bosphorus, the actual dilution will be about 1:345,600 which is so much higher than obtainable anywhere that the authorities should be willing to relax the standards, atleast for the bio-degradable items such as BOD upto 250 mg/l.

3. TREATMENT STRATEGY RECOMMENDED

Although at first review of Table 3(b) it may look difficult to decide which of the four different sets of standards are truly applicable to the Baykoz situation, it may be possible to draw some conclusions from the following discussion and arrive at a strategy for treatment.

(A) ISKI Sewer Standards are the most relaxed and relatively easiest to comply with. But, as yet, no sewers are available in Baykoz town area and none are expected to be laid and be ready for use (along with common treatment/disposal facility) for atleast another 3-5 years. Even without sewers, ISKI is presently collecting about 1.2 million TL per day from the Baykoz Leather Tannery (on the basis of min. flow 1200 cu.m./day and sewer charge of 1080 TL/cu.m. for a pollution level assumed at Code 2).

After pretreatment to meet ISKI standards, the tannery wastewater will be acceptable provided the factory pays 550 million TL as their share in the capital cost of laying the sewer system, and an operating cost of 540 TL/cu./m. A few points emerge from this :

- The costs indicated at present by ISKI are not firm and may escalate substantially in the future. Moreover, they have been calculated on the basis of 1200 cu.m./day and will increase 2.5 times when the real flow of 3000 cu.m./day is taken into account.

- The whole effluent presently draining towards the sea wuld need to be pumped away from the sea to go to the ISKI sewers in Baykoz town. This would imply additional pumping costs.

- Even for meeting ISKI sewer standards, biological treatment, would be needed besides physico-chemical.

Thus, it would appear desireable to consider full biological treatment and discharge directly to the Bosphorus through a deep outfall, and thus remain independent of ISKI. This suggestion is examined further below and a two-step approach is recommended.

(B) (i) In the <u>first stage</u>, it should be our aim to meet the DERIN DENIZ DISCHARGE standards which will also help us to meet the ISKI Sewer Standards at the same time. The various metals listed in the ISKI standards are not a problem with tannery wastes, except Chromium, for which a separate recycling arrangement is recommended in Section 5 of this report. Thus, all parameters will be taken care of and the final treated effluent will meet :

Temp.	35^{0} C. or less
pH	6 - 9 range
BOD	250 mg/l or less
COD	400 - 800 mg/l range
Suspended Solids	350 mg/l or less
Oil and Grease	10 mg/l or less
Total Nitrogen	40 mg/l or less
Total Phosphorus	10 mg/l or less
Chromium	0.5 mg/l or less
Sulfides ($S^{=}$)	1.0 mg/l or less

(ii) The treatment plant to meet above stated requirements will take about two years from now to be ready. Initially the plant will discharge the treated effluent at the surface of the Bosphorus through the existing channel, but the present unsightly conditions will <u>not</u> occur, organic pollution will greatly reduce and chromium toxicity removed. Thus, all the important problems will be solved in the first stage itself.

(iii) Thereafter, in the <u>second stage</u> a decision will be taken whether to provide a deep discharge outfall in the Bosphorus <u>or</u> to pump the effluent to the ISKI Sewer system for Baykoz town. This decision will have to be based on the follwing information.

- A feasibility study (by ITU or Bogazici Univ.) to determine techno-economic feasibility of a deep discharge outfall at Baykoz Tannery. This will involve a hydro-geological investigation.

- ISKI's charges, capital and operating, for use of sewers as applicable at the time. The present charges may be substantially increased in the near future.

If this two-stage approach is followed, it should be possible to continue tanning operations at Baykoz for a long time to come.

4. PROPOSED EFFLUENT TREATMENT PLANT

The proposed effluent treatment plant will be provided for treating 3000 cu.m./day wastewater to meet the standards referred to earlier in Sections 2 and 3. The essential steps in treatment will be both physico-chemical and biological. The initial BOD of 900 mg/l is expected to be brought down to 250 mg/l after treatment so as to make the wastewater fit for discharge as per "ISKI" and "DERIN Discharge" standards.

4.1 General Description of the Plant

The raw wastewater will be picked up from the existing main effluent channel. It will first pass through a mechanically cleaned bar screen,then pumped up to pass through a revolving drum screen, and enter a flow-equalization tank where it will be held for 4 hours. Subsequently, the equalized and self-neutralized flow will be further adjusted for pH as necessary and dosed with alum and polyelectrolyte followed by good flocculation to promote proper settling in a combined flocculator-clarifier unit. The settled waste will then be sent for biological aeration, settling and recirculation to bring down the BOD to 250 mg/l or less.

The sludge from the plant will be chemically conditioned for vacuum filtration and dry disposal of the sludge cake will be made by transporting it to selected sites.

A typical schematic and hydraulic flowsheet of the proposed treatment plant is shown in Fig. 3

Some seggregation of wastes will be necessary from certain departments such as Chrome tanning, as explained in Section 5 of this report.

The various treatment units proposed have been listed below:

A. PHYSICO-CHEMICAL SECTION

i) Mechanically cleaned bar screen

ii) Raw waste inlet sump and pump house

iii) Revolving drum screen

iv) Flow-equalization and self-neutralization tank

v) Intermediate Pumping Station

vi) pH correction tank wtih acid/alkali dosing

vii) Alum dosing and flash mixing tank

viii) Polyelectrolyte dosing unit

ix) Combined flocculation-clarification (settling) tank

x) Sludge conditioning tank

xi) Vacuum filtration.

B. BIOLOGICAL SECTION

xii) Aeration tanks

xiii) Sludge recycle system (including excess sludge disposal)

xiv) Final settling tank.

4.2 PLANT LAYOUT AND LAND REQUIREMENT

The Consultant has ben just able to fit in the treatment plant in the available area as suggested by the Tannery authorities.

The proposed layout is given in Fig. 4 . The non-availability of additional land places a constraint on the degree of treatment that can be given at the Tannery site.

The possibility of building tanks, etc. in two levels, one above the other (i.e. two-storeyed tanks) was considered but the sub-soil condition was found to be relatively soft and ground water was visible at about 1.5m below the surface owing to the nearness of the sea. Accordingly, it was concluded that proper site investigation would be necessary before the use of two-stioreyed tanks could be considered. Presently, the proposed plant layout shown in Fig. 4 could be followed without much difficulty.

Owing to the high ground water situation, the structures would have to be designed carefully against "uplift".

DESIGN FLOWS

For design purposes, the following flow rates have been assumed :

Flow rate of 8 hours day shift	= 250 cu.m./hr
Average flow rate over 24 hours	= 125 cu.m/hr
Low flow rate over 16 hrs. (Night shifts)	= 63 cu.m./hr

4.3 IMPORTANT SPECIFICATIONS OF EACH UNIT

(i) Mechanically-Cleaned Bar Screens

The total raw waste flow of 3000 cu.m./day = 250 cu.m/hr = 0.069 cu.m./sec will be taken from the existing effluent channel and first passed through mechanically cleaned bar screens. The bars will be 10 mm thick and clear spacing will be not more than 20 mm and the cleaning rake motor (1.5 HP) and mechanism will be actuated by a head differential between upstream and downstream side of the bars. Alternatively a time-switch actuated arrangement will also be acceptable.

The rakings will be lifted to ground level and placed on a drip platform for carting away from time to time or reused in manufacture of leather board.

To keep velocity in approach channel at 0.9 m/sec., the area of cross-section of channel = 0.069/0.9 = 0.77 sq.m. Allowing additional area to account for loss of area in bars, area of channel = 0.77 x 2 (say) 1.6 sq.m.

(ii) Raw Waste Inlet Sump and Pumphouse

After screening, the raw wastewater will arrive at a sump from where it will be pumped upto enable gravity flow through the Revolving Drum Screen and the equlization tank. Four pumps will be provided:

2 nos. 125 cu.m./h capacity and 2 nos. 63 cu.m./hr capacity, driven by 7 Kw and 5 Kw motors respectively. The total pumping head will be 8 m. Either Archemedian screw type pumps will be used or centrigugal, non-clog pumps with horizontal or vertical mounting will be used.

(iii) Revolving Drum Screen

A revolving type drum screen with 5-6 mm openings will be provided to help in further removal of pieces of fleshings, leathers, etc., before the flow goes to the next unit. The screen will be continually backwashed as it revolves so as to keep it clean. The screenings, along with the screenings from the mechanically raked bar screen, will be either carted away or reused in manufacture of leather board.

(iv) Flow Equalization and Self-Neutralization Tanks

Two tanks of fill-and-draw type will be provided for alternate use. Each tank will be 38 m x 8m x 3.5 m liquid depth (1000 cu.m. volume) to provide four hours detention time during the dayshiftwhen flow rate is 250 cu.m./h.

To keep the tank contents stirred and aerated (@ 1 cu.m./min. per sq.m. tank area) to prevent septic conditions in the tank, two air blowers (one operating and one standby) each of 15 HP capacity will be installed per tank with 110 mm OD HDPE pipe manifold and 63 mm OD HDPE drop pipes to release air (coarse bubble aeration) below minimum water level.

As large solids, leather pieces, fleshings, etc. are liekly to settle in such tanks, a sludge cleaning mechanism (5 Kw) mounted on a chain and sprocket drive will be provided. The drive motor, reduction gear and all bearings will be dry mounted to facilitate inspection and repairs. The cleaning mechanism will push the sludge towards a hopper/channel from which it can be taken by gravity to sludge conditioning tank prior to vaccum filtration.

The tank contents will be emptied from the bottom of the tank by pumping as described below:

(v) Intermediate Pumping Station

Intermediate pumps are necessary as the flow taken from the bottom of the equalization tanks has to be lifted up to flow by gravity ghrough the rest of the treatment plant.

The pumps will be : 2 nos. 125 cu.m./h and 2 nos. 63 cum/h centrifugal, non-clog type, driven by 5 Kw and 7 Kw motors.

(vi) pH Correction Tank

The next step in treatment is pH correction through the addition of acid or alkali, as necessary, to the equalized flow. The chemicals proposed to be used are sulfuric acid (H_2SO_4) and soda ash (Na_2CO_3) which will be dosed through a pH actuated mechanism. Detention time of 15 minutes at peak flow will be provided in the mixing tank. Hence, tank volume = 62.5 cu.m. = 6m x 3m x 3.4m water depth. Two mechanical agitators of 3 Kw each will be adequate. The tanks will have to be suitably lined to resist corrosion. Inlet pipe will be 200 mm diameter and the outlet pipe 350 mm diameter.

(vii) Alum Dosing and Flash Mixing Tank

Assuming a reaction time = 1 minute
Tank volume = 4.16 cu.m. = 1.6m x 1.6m x 1.6m
Agitator = 0.5 Kw
Inlet pipe = 350 mm diameter
Outlet pipe = 350 mm diameter
Alum dose assured = 100-250 mg/l (exact dose will be fixed after performing "jar tests" on the wastewater during operation of the plant). If average dose is 150 mg/l daily consumption of alum = 0.150 x 3000 = 450 kg/d
Volume of 10% solution = 4500 l/d. Solution agitator = 0.25 Kw.

Provide two tanks eachof 2.5 cu.m. capacity (say 1.3 x 1.3 x 1.5m) and provide metering pumps of 100 l/h to 1000 l/h capacity)

(viii) Polyelectrolyte Dosing Unit

A Polyelectrolyte dosing unit consisting of a stainless steel tank with a high speed mixer will be provided to facilitate dosing 1.0 - 3.0 mg/l of polyelectrolyte to assist floculation and settling, namely max. 9 kg/d in the form of 1% solution. Tank size = 1m dia x 1m water depth. Provide metering pump of 20 l/h to 200 l/h capacity.

(ix) Combined Flocculation and Settling Tank

(a) Assume flocculation time = 20 minutes
Volume = (250/60)(20) = 83.33 cu.m.
Depth = 2.5m
Area = (83.33/2.5) = 33.33 sq.m. Provide rotating flocculator arms operated by 3 Kw motor

(b) Assume settling tank detention time = 2 hours
Volume = (250 m/h) (2) = 500 cu.m.
Let overflow rate = 1.25 m/h
Hence, area = (250/1.25) = 200 sq.m.
Total area = 200 + 33.333 = 233.33 sq.m.
= 17.23 m diameter x 2.5m water depth

The settling compartment will have sludge-scraping arms which will scrape the sludge to a central pocket from where it will be flushed out and sent to vacuum filter.

(x) Sludge Conditioning Tank

Total quantity of sludge will be as follows :

- Sludge from plain settling in equalization tank = 3000 kg/d
- Sludge from alum (as $Al(OH)_2$) = 100 kg/d
- Biological sludge (0.25 kg per BOD removed = 150 kg/d

4150 kg/d

say 4,500 kg/d with average moisture content of about 97% (i.e. 150 cu.m./day)

Conditioning chemicals like lime or fullers earth or bentonite will have to be used to get a minimum consistency of 4% solids (i.e. 96% moisture content) to be applied to the vacuum filter. Thus, about 2.250 kg/day of conditioning chemicals will be required to be added.

(xi) Vacuum Filtration

If one vacuum filter of 2m dia and 3m length is provided, the area available for filtration will be 18.84 sq.m. which will give an yield rate of

$$\frac{6750 \text{ kg/d}}{18.84 \text{ sq.m.}} = 358 \text{ kg/sq.m.-day}$$

This rate being less than 400 kg/sq.m.-day will be acceptable. Hence, provide 2 units of above size (one working and one standby)

Power required will be 25 HP per unit.

(Neither land nor climate is adequate for providing an open sludge drying bed).

(xii) Aeration Tank

The main flow from the physico-chemical treatment section will now go to the biological treatment Section where further treatment will take place.

Assume BOD removal in physico-chemical treatment = 50%
Hence BOD going to aeration = (900 mg/l)(0.5) = 450 mg/l
= (0.450)(3000) = 1350 kg/d
Assume F/M ratio = 0.15 and MLSS = 3000 mg/l = 3 kg/1000 cu.m.
Hence, M = 1350/0.15 = 9000 kg = 9000/3 = 3000 cu.m.
Final BOD = 250 mg/l = 750 kg/d

Oxygen required = 1.2 kgO/kg BOD removed
= 1.2 (1350 - 750) = 720 kg/day at standard conditions
= 720/0.6 = 1200 kg/d at field conditions
Aerator capacity assumed @ 2.0 kgO/KWh
Hence, power required = $\frac{1200}{2.0 \times 24}$ = 25 Kw at shaft
= 36 Kw motor
= 50 HP motor

From mixing considerations (@ 15 w/cu.m.), power required
= 15 x 3000 = 45 Kw at shaft
= 64 Kw motor (86 HP motor)
Provide 3 nos. x 10 HP in each tank, i.e. total 90 HP.

(xiii) Sludge Recycle System (including Excess Sludge Disposal)

Effluent recycle capacity from final settling tank back to aeration tank should be upto max. 100% of inflow, (i.e. 3000 cu.m.,/day)
Hence, provide 4 nos. centrifugal pumps (2 nos. 125 cu.m./h and 2 nos. 63 cu.m/hr) for recycle.

Excess sludge for disposal may either be pumped to the combined flocculator-settling tank to mix with other sludge before going to vacuum filter, or alternatively, the excess sludge may be sent directly to the Chemical conditioning tank before vacuum filtration.

(xiv) Final Settling Tank

Let detention time = 2-3 hours approximately.
Overflow rate not to exceed 0.7 cu.m./sq.m.-hr
Solids flux ratenot to exceed 6 kg/sq.m.-hour

At 250 cu.m./h (max. rate during day time) the tank area required = 357 sq.m.

Maximum solids flux including recirculation = 3000 mg/l x (3000 cu.m./d x 2)
= 18000 kg/d = 750 kg/h

Hence, tank area required = 125 sq.m.

Provide 357 sq.m. area, namely, 21.3 dia. tank with 2.2 m water depth with sludge withdrawal arrangement from the bottom. Motor = 2 Kw.

4.4 OPERATING COSTS : (POWER, CHEMICALS AND STAFF REQUIREMENTS)

(a) Power

The power requirement has been calculated individually for each unit in the treatment plant based on the number of hours each unit is likely to work in a day. (See Table). The expected consumption is 3475 Kwh per day.

Assuming the cost of power as 100 TL per Kwh, the power cost will be 347,500 TL per day.

(b) Chemicals

The chemicals consumption is not possible to estimate accurately. But, it is estimated roughly to be of the following order :

CHEMICAL	Kg/d	TL /kg	TL /day
ALUM	450	350	157,500
POLYELECTROLYTE	9	3000 *	27,000
BENTONITE CLAY	2250	50 *	112,500
ACID	1200	100	120,0000
			417,000

(* denotes assumed prices)

(c) Staff

Category	Total	Day Shift	Evening Shift	Night Shift
Foreman (eletric-mechanic)	1	1	-	-
Operators	2	1	1	-
Helpers	4	2	1	1

Some additional part time assistance will have to be obtained from the factory staff as and when necessary. The factory laboratory will also assist in sampling and chemical contol.

TABLE CONSUMPTION OF POWER CONSUMPTION PER DAY

	Unit		Installed power (KW)	Operating power (KW)	No. of hours	Kwh per day
1.	Mechanical raked bar screen		1. 5	1. 5	4	6.0
2.	Inlet Pumps	a.	2 x 5	5	16	80
		b.	2 x 7	14	8	112
3.	Revolving Drum Screen		1	1	24	24
4.	Equalization Tank (Blowers)		4 x 12	2 x 12	20	480
	Equalization Tank Cleaning Mechanism		2 x 5	5	4	20
5.	Intermediate Pumps	a.	2 x 5	5	16	80
		b.	2 x 7	14	8	112
6.	pH Correction Tank		2 x 3	2 x 3	24	144
7.	Alum Flash Mixing		0. 5	0. 5	24	12.0
8.	Alum Metering Pump		0. 5	0. 5	24	12.0
9.	Poly Electrolyte Metering Pump		0.25	0.25	24	6.0
10.	Alum Solution Preparation Agitator		2 x0.25	0.25	24	6.0
11.	Poly Solution Preparation Agitator		1 x0.25	0.25	24	6.0
12.	Combined Flocculator and Settling		3	3.0	24	72.0
13.	Aeration Tank		9 x7.46	9 x 7.46	24	1611.0
14.	Final Settling Tank		2	2.0	24	48.0
15.	Vaccum Filter		2 x 19	1 x 19	24	456.0
16.	Sludge Recirculation Pump		2 x 7	1 x 7	24	168.0
17.	Sludge conditioning Tank Agitator		1 x0.33	1 x 0.33	24	8
18.	Filter Feed Pump		0.5	0.5	24	12.0
						3475

Cost of Power @ TL 100/- per KWH

3475 x 100 TL = 3,47,500/- TL per day.

CAPITAL COSTS

It is not possible for the consultant to indicate the likely capital cost of this plant as he is not familiar with Turkish prices, nor is it clear at this stage which items will be of foreign import and which ones will be locally fabricated.

(As a very rough indication of the capital cost a figure of 3-4 billion TL (US$ 1.8 - 2.4 million) may be kept in view but should be verified locally before using it.)

5. SEGGREGATION OF CERTAIN WASTES

In order to facilitate proper treatment, it will be desirable to seggregate the following three components of wastewaters at their sources for pre-treatment

- Chrome bearing wastes (Cr)
- Sulfide containing wastes from alkali liming liquors
- Others where sea waters are used (high TDS)

(i) CHROME BEARING WASTES

A typical arrangement for recycling chromium is shown in Fig. 5

The spent waste from chrome tanning contains basic chromium sulfate (Cr OH SO4) which can be recovered as follows : The waste is first screened as shown in the figure and collected in a sump from which it is pumped to Reaction Tank No. 1 where MgO is added to give MgSO4 and Cr(OH)3 precipitate. The MgSO4 remains in solution and can be drained to the sewers. The Cr(OH)3 precipitate can be transferred each day to Reaction Tank No. 2 where it accumulates and is treated with H2SO4 to restore the basic chromium sulfate (Cr OH SO4) which is recycled back to the chrome tanning drum for use.

It is hoped that the chromium waste can be controlled at source and recycled as shown rather than discharged to the general wastewater treatment plant. In the treatment plant chromium can ofcourse be precipitated out to a considerable extent (though not fully) but the precipitate would only enter the sludge phase and from the sludge the chromium may be leached back to the environment. Chromium is a toxic substance which accumulates in fish, algae and other biota. Thus, it is best controlled at source.

(ii) Sulfide containing Wastes

Sulfides will be present in the alkali liming liquors which could be seggregated for separate treatment by aeration in the presence of Manganese Sulfate ($MnSO_4$) as a catalyst. (See Fig. 6). If separate treatment is not feasible, the same can be achieved in the main treatment plant by the same method, though separate treatment should be preferred.

(iii) Other Wastes Needing Seggregation

Among the other wastes which may adversely affect treatment if not seggregated are those which involve use of sea water for certain factory operations.

In the future, it will be desireable to use the treated effluent from the waste treatment plant rather than sea water for those purposes. This possibility may be kept in view for the future.

6. RECOMMENDED STAGEWISE WORK PROGRAMME

Reference is invited to the Treatment Strategy discussed in Section 3 of this Report. The stepwise recommended work programme is as follows :

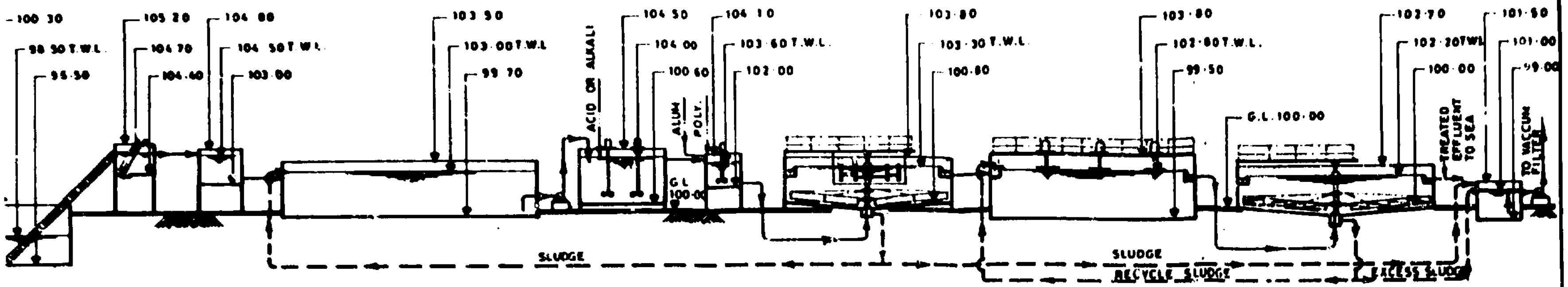
(i) The treatment plant design provided by the UNIDO Consultant in this Report will be capable of meeting the ISKI and DERIN DENIZ DISCHARJ Standards. The design is given in sufficient detail with essential specifications to enable contractors to understand the basic requirements. The available land is just sufficient to provide the required treatment units.

(ii) Invite tenders/offers from only a few reputed and experienced contractors (a selected short list of turnkey contractors) for construction of the treatment plant, provision of all the necessary electrical and mechanical equipment and responsibility for start-up and operation of the treatment plant to meet the desired standards for three months before handing over to factory authorities.

(iii) All items of work (civil, structural, mechanical, electrical and interconnecting piping and other related work) would be awarded to the <u>same</u> contractor to ensure that responsibility is not divided. This is very important in view of the specialized nature of work involved. It will also be advantageous to involve an experienced (local) consulting Company to assist Sumerbank in preparing tender papers and in supervising the actual implementation later on.

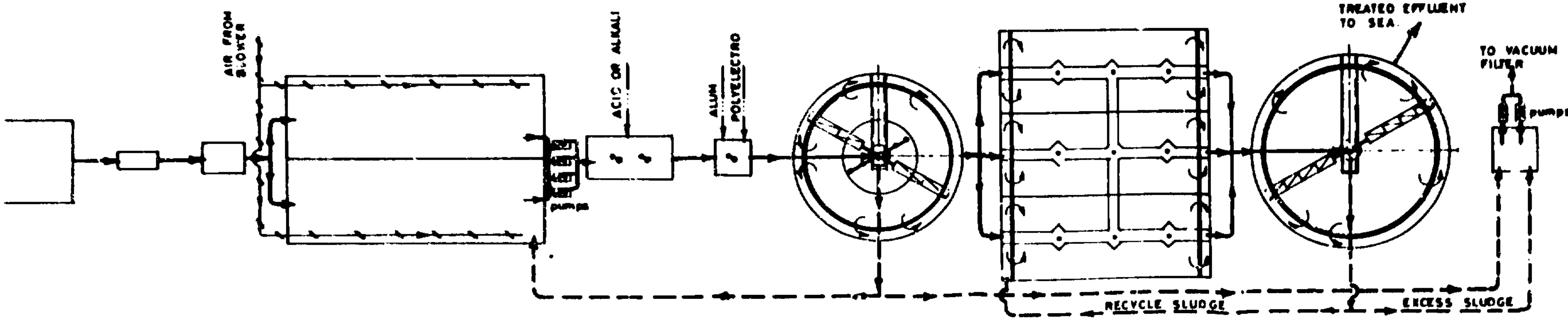
(iv) Initially, the treated effluent may be discharged at the sea surface with special permission, until the new ISKI sewerage project for Baykoz is completed <u>or</u> a deep sea outfall is provided to discharge the treated effluent to the Bosphorus at desired depth. This will need a prior feasibility study of the outfall site conditions as stated in Section 3 of the Report. Discharge to the sea by an outfall may prove cheaper in the long run, as ISKI's charges are already quite high.

(v) With the above proposed arrangements, tanning operations can be carried out at the present site for several years to come.



HYDRAULIC FLOW DIAGRAM

...W ...FLUENT ...MP / ...MP	BAR SCREEN CHANNEL	DRUM SCREEN	EQUALIZATION CUM PLAIN SETTLING TANK	pH ADJUSTMENT TANK	ALUM DOSING TANK	COMBINED FLOCCULATION AND SETTLING TANK	AERATION TANK	FINAL SETTLING TANK	SLUDGE CONDITIONAL SUMP / PUMP
30M X 30M X 00 M.L.D	2.0M X 0.50M X 3.0MLD	3.00M X 2.00M X 1.50MLD	2 NOS. X 38.00 M. X 8.00 M. X 3.30 M.L.D.	6.00 M. X 3.00 M. X 3.40 M.L.D.	1.60M X 1.60M X 1.60M.L.D.	17.25 M.ϕ X 2.50 M.S.W.D.	32.00 M. X 8.00 M. X 3.30 M.L.D.	21.30 M ϕ X 2.30 M.S.W.D.	1.50M X 1.80M X 2.0MLD

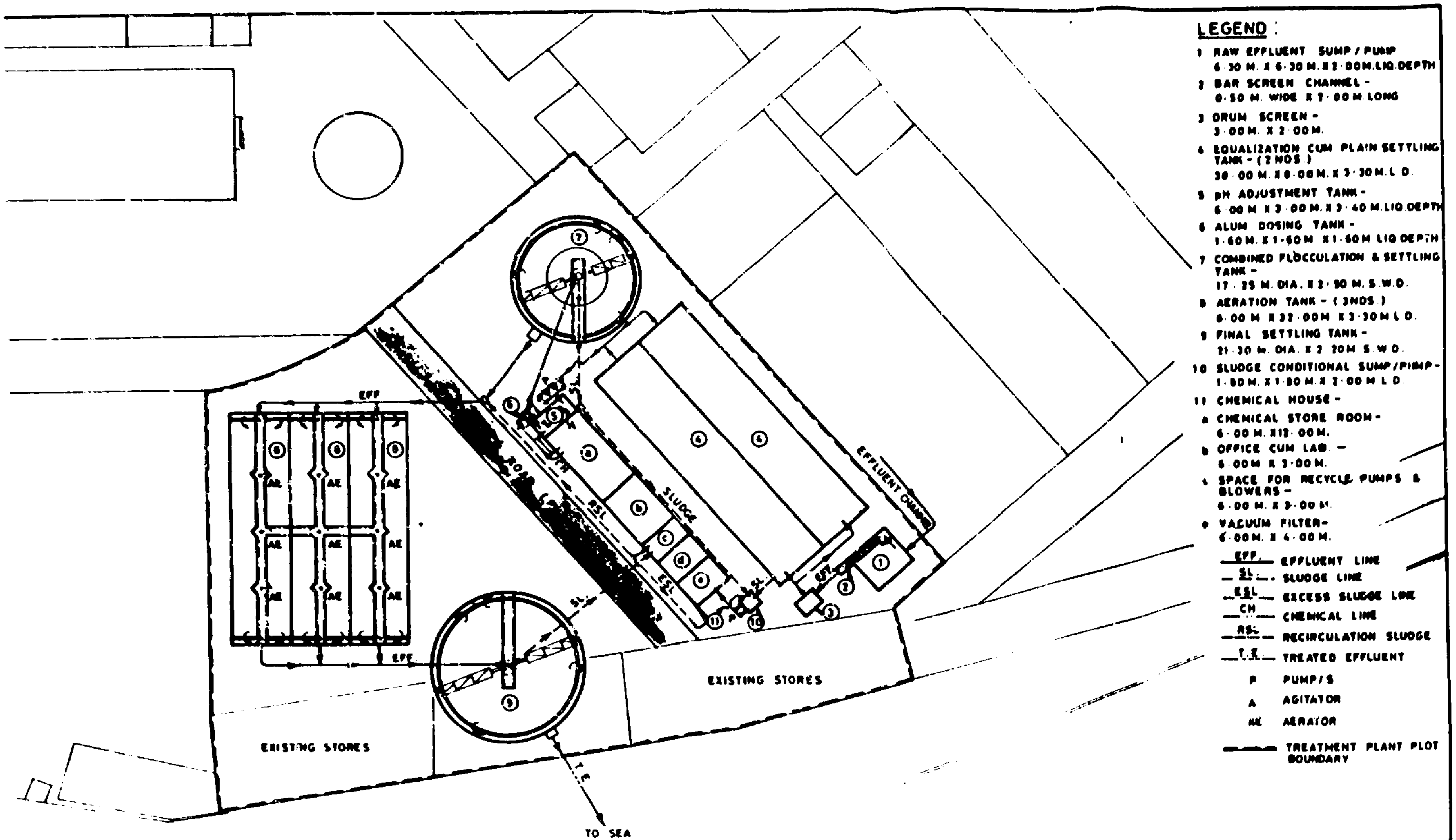


SCHEMATIC FLOW DIAGRAM

...OZ LEATHER TANNERY, ISTANBUL

...RAULIC AND SCHEMATIC FLOW DIAGRAM (FOR 3000 m^3/day FLOW)

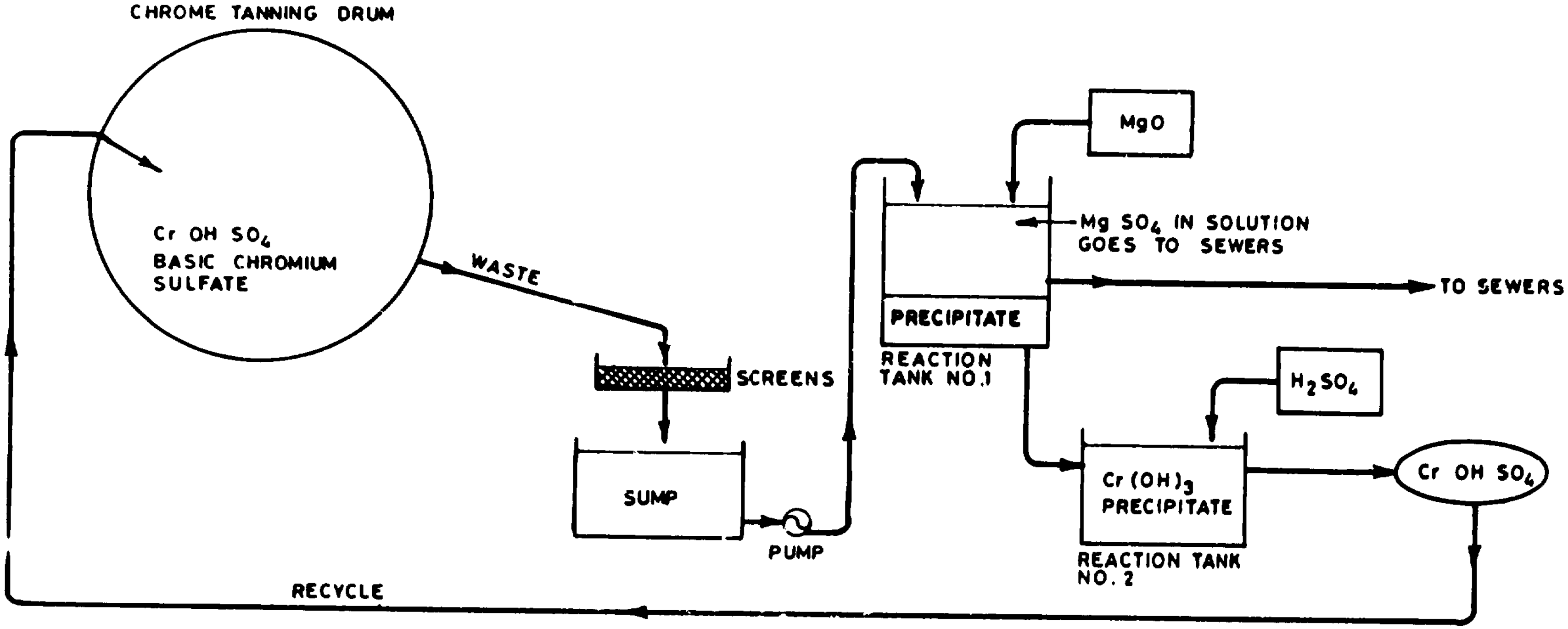
SCALE	N.T.S
DRN BY	R.D.M
DATE	15-12-88
CHD BY	
FIG NO	3



BAYKOZ LEATHER TANNERY, ISTANBUL.

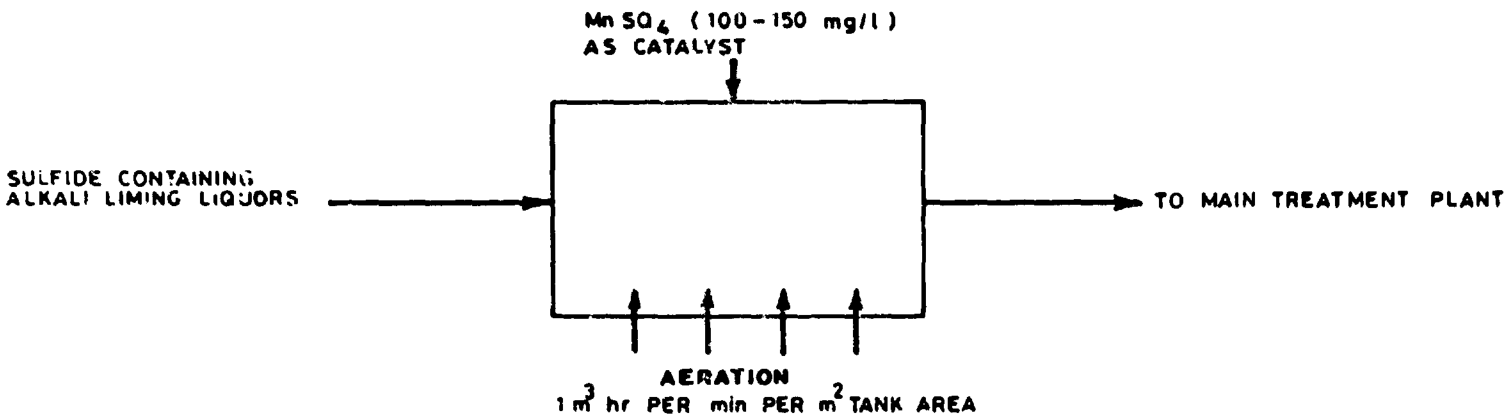
PROPOSED LAYOUT OF WASTE-WATER TREATMENT PLAN FOR 3000 m^3/ day FLOW.

SCALE	1 : 500
DRN BY	R D M
DATE	14 - 12 - 88
CHD BY	
FIG NO	4



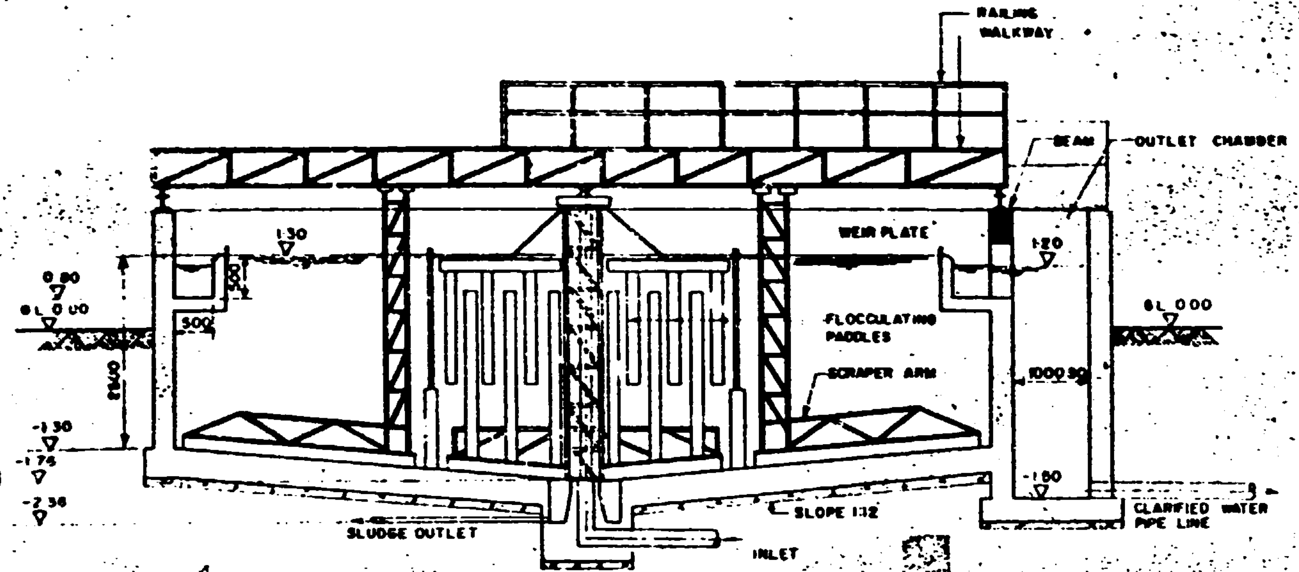
TYPICAL ARRANGEMENT FOR RECYCLING CHROMIUM.

SCALE	N.T.S.
DRN.BY	R. D. M.
DATE	14-12-88
CHD.BY	
FIG. NO.	5

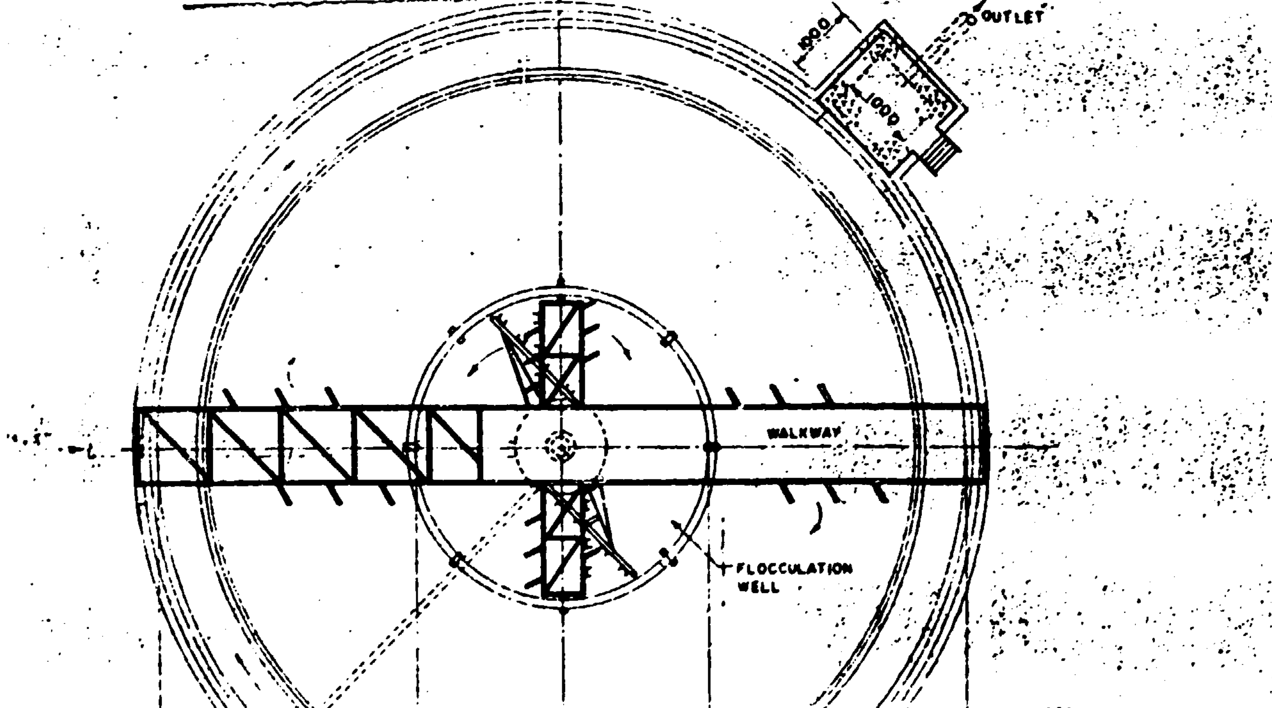


PRE - TREATMENT OF SULFIDE CONTAINING WASTES FROM ALKALI LIMING LIQUORS

SCALE	N.T.S.
DRN. BY	R. D. M.
DATE	15 - 12 - 88
CHD. BY	
FIG. NO.	6



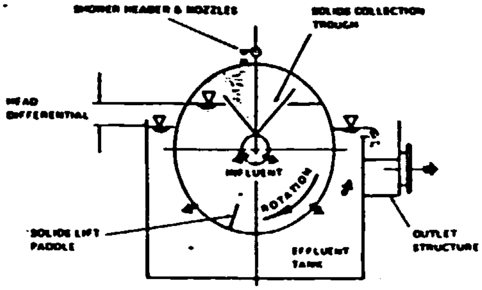
A COMBINED CLARIFIER - FLOCCULATOR UNIT

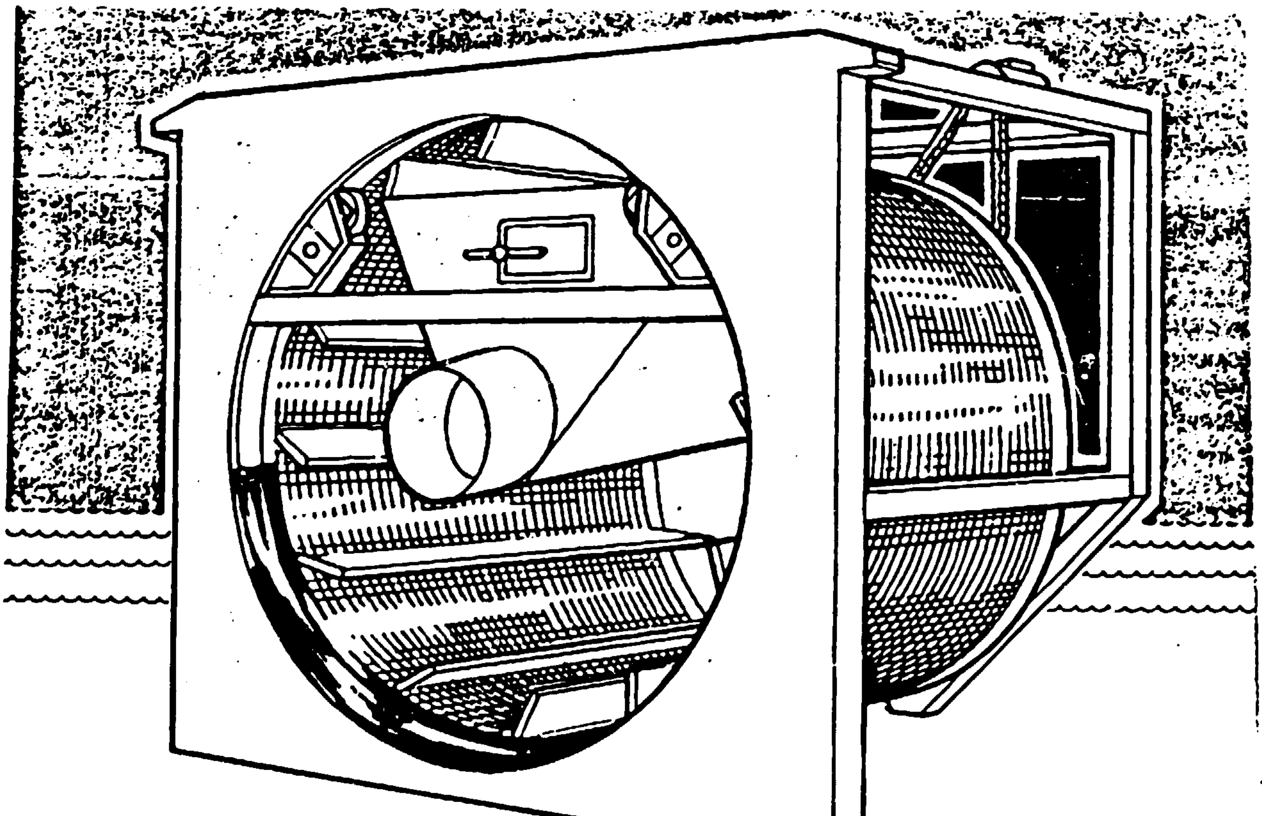


PLAN

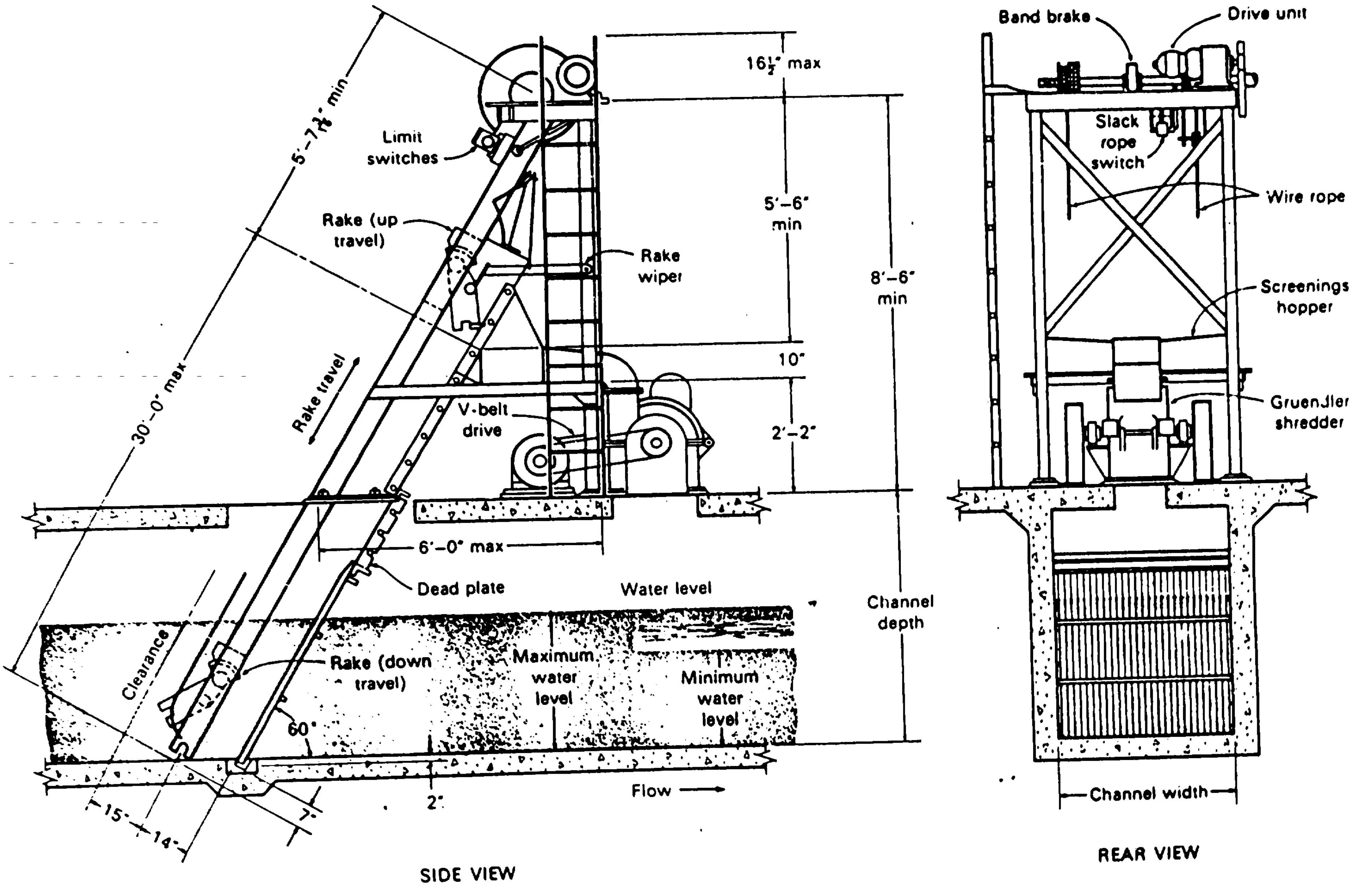
1) IT MIGHT BE NECESSARY TO INCORPORATE SLIGHT MODIFICATIONS TO THE STRUCTURES TO SUIT AVAILABLE MECHANICAL EQUIPMENT
2) ALL DIMENSIONS ARE IN MM.
3) ALL LEVELS ARE IN M. WITH RESPECT TO THE REFERENCE LEVEL

COARSE AND FINE SCREENING

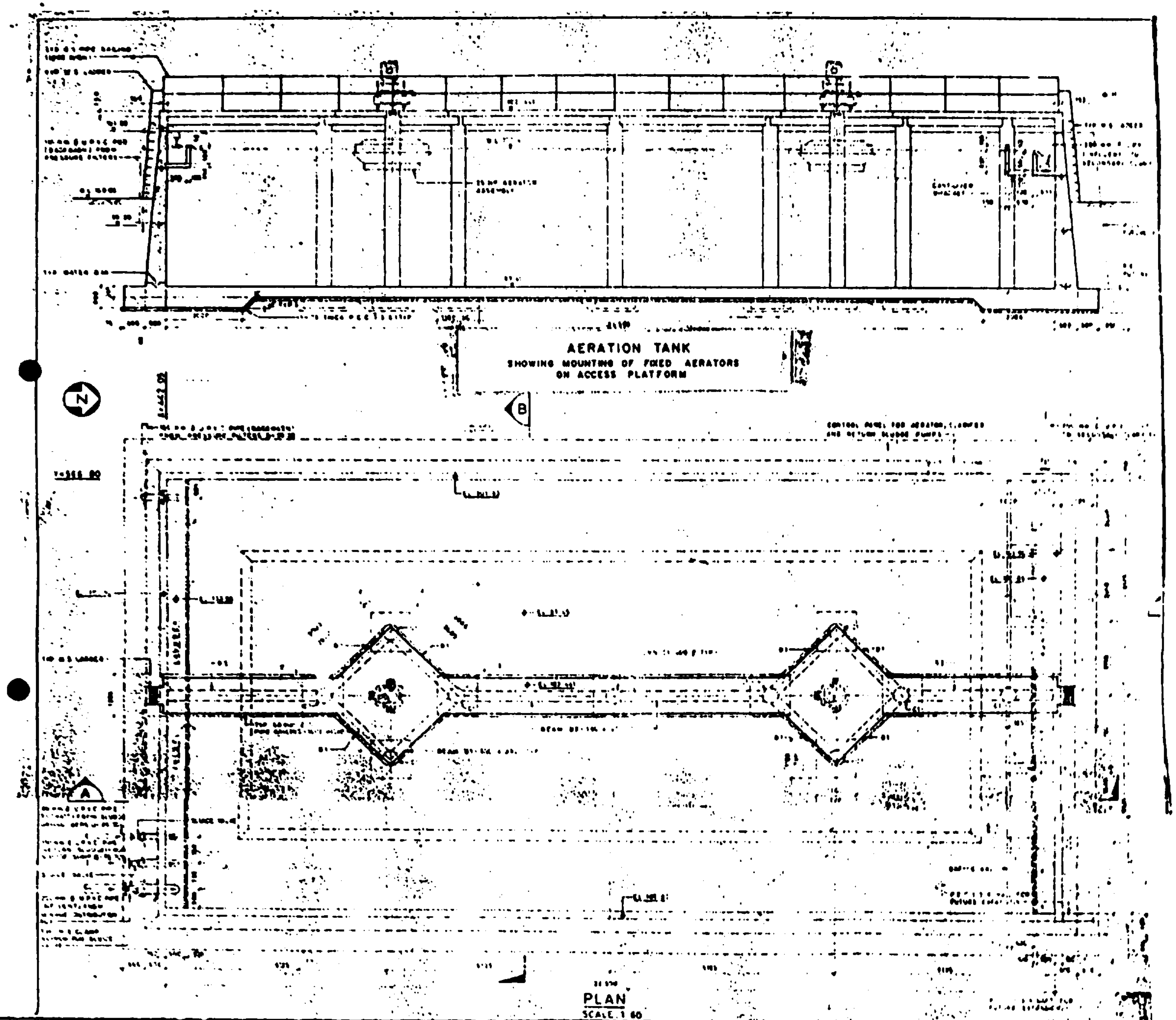


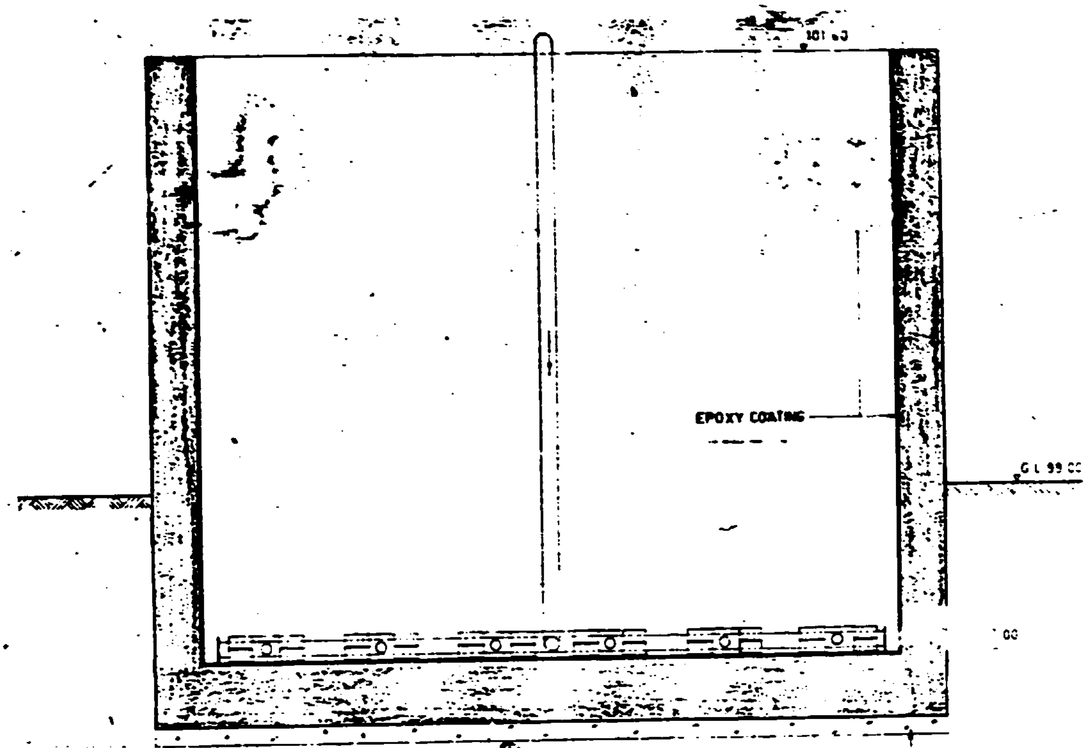


REVOLVING DRUM SCREEN

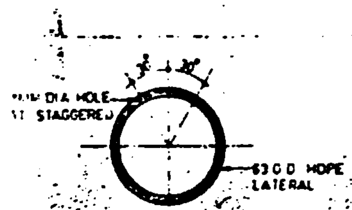


Cross section and end views of a mechanically cleaned bar rack


AERATION TANK
SHOWING MOUNTING OF FIXED AERATORS
ON ACCESS PLATFORM
B
N
A
PLAN
SCALE 1:60



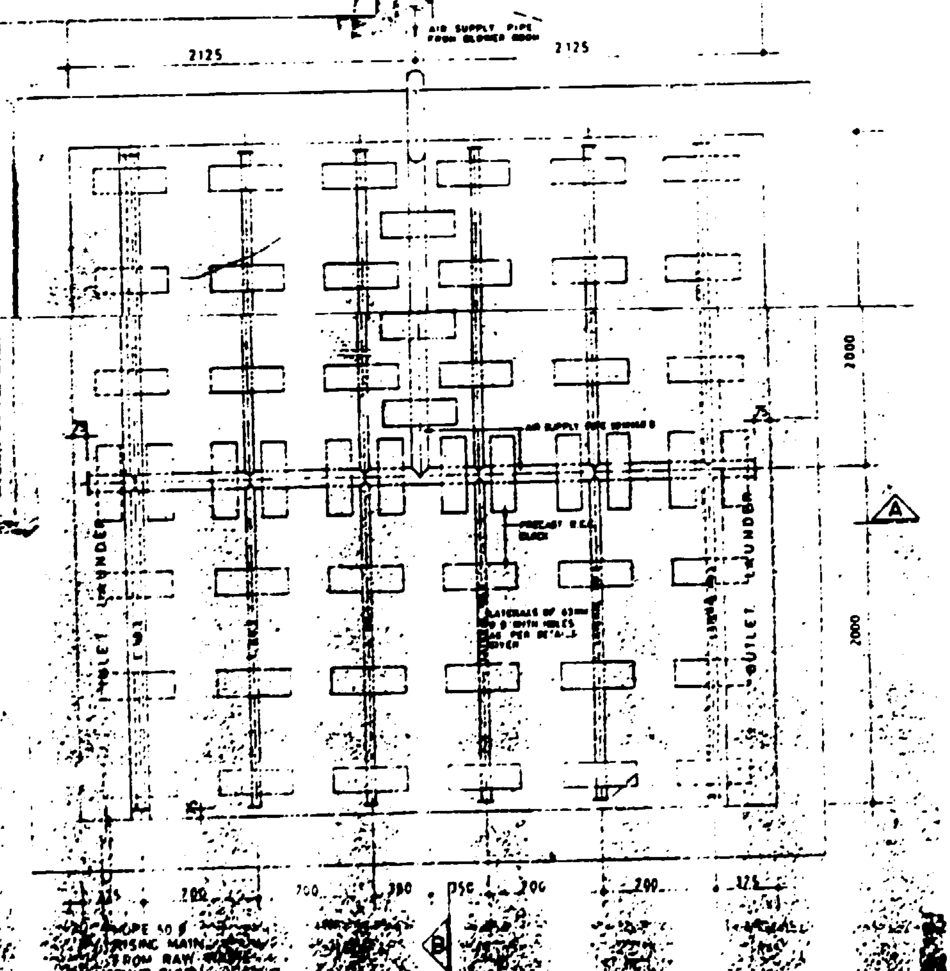
AERATED EQUALIZATION TANK
(INLET & OUTLET NOT SHOWN)



TYP. SECTION OF LATERAL
(NOT TO SCALE)

TABLE FOR HOLES ON LATERALS

LATERAL NO	HOLES AT STAGGERED DISTANCE
1	150 MM
2	125 MM
3	100 MM



PLAN