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PREPARATORY ASSISTANCE IN THE TREATMENT OF TANNERY WASTES IN KASUR, THE ISLAMIC REPUBLIC OF PAKISTAN

DP/PAK/89/205

FINAL REPORT ON

ADDITIONAL SERVICES UNDER THE EARLIER CONTRACT No. 91/106

PART I

COMMENTS ON THE JOINT FORMULATION MISSION REPORT

PART II

DESCRIPTION AND CALCULATIONS OF THE NEW ALTERNATIVES WITH SOLID WASTE DISPOSAL IN THE EXTENSION OF THE CETP

BASED ON THE WORK OF:

TEH – PROJEKT "HIDRO" TEAM

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Agro-Based Industries Branch

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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TABLE OF CONTENTS

0. GENERAL INTRODUCTION AND SUMMARY

After a detailed study of various possibilities for the Kasur tannery effluent drainage and pretreatment as well as the solid waste treatment and disposal, the system consisting of the entireties recapitulated in Annex 16 of the "Techno-Economic Study" (TES) has been recommended as optimum for the first phase of the integral Kasur pollution control system. The whole concept was preconditioned by the specific situation with land availability in the Kasur area. The local government suggested useing the area along the abandoned railway tracks which are in government property;

- the track to the south of the town for the CETP (width 80 m and length 1000 m) and
- the track near Indian border (to the east of the town) for the solid waste disposal.

Naturally the site limitations had considerable repercussions on the system design and the maximum effluent treatment effect to be achieved with the simple cost effective physical treatment and lagooning is not sufficient to completely satisfy the Pakistani standards for effluent discharge in the first phase of implementation (without the common municipal plant for final effluent treatment).
To study this technological problems and to draft the plans for the project implementation the JOINT FORMULATION MISSION (JFM) was fielded to Kasur between Jan.26th and Feb.15th 1993. The Subcontractor was recruited by UNIDO to send the Team Leader as the JFM resource person and to assist in designing of some new ideas concerning the final discharge of the effluents, if necessary.

Comments on the JFM Report excerpts received from the BSO, Mr.J.Buljan on 27/04/1993, regarding technical data and cost estimations, are presented in the PART I of this Report. Technically, no big differences exist but regarding the cost estimation of the civil works we do not see justification to plan with more than 25% buffer inspite all the inflation problems anticipated in Pakistan.

Since no other assistance was demanded, only the recommendations and calculations of the new solid waste disposal site (requested by UNIDO on 04/05/1993 are summarized here and have been elaborated in details in the PART II of this Report.
During the JFM, the local government changed their suggestion regarding the solid waste disposal because of the military base vicinity and suggested that the abandoned railway track in the extension of the CETP should be taken into account instead.
UNIDO has requested TEH-PROJEKT "HIDRO" to study the consequences of such a change on the system in the whole and to estimate the investment and running costs for it.
The following two alternatives of "CETP/solid waste treatment and

disposal system" have been studied and compared with the one recommended earlier in Annexes 13 & 16 of the "Techno-Economic Study" in PART II of this Report:

Alternative 1.

Sludge thickening/drying in lagoons to be constructed on the abandoned railway track in the extension of the CETP and then the evacuation and separate disposal of the dry sludge on the abandoned railway track in the extension of the lagoons.

Alternative 2.

Simultaneous sludge thickening/drying and permanent disposal on the abandoned railway track in the extension of the CETP.

Alternative 2 (specifically its sub-alternative 2a) has been recommended as optimum, since it does not demand higher investment than the system recommended earlier and in the same time it is possible to achieve an even better effluent treatment.

RECAPITULATION OF THE COST ESTIMATION FOR THE WHOLE KASUR TANNERY EFFLUENT DRAINAGE/TREATMENT AND SOLID WASTE DISPOSAL SYSTEM ACCORDING TO THE SUB-ALTERNATIVE 2a

* x 1000 US$
** x 1000 US$/10 years

	INVESTMENT COSTS* equipment	INVESTMENT COSTS* civil works	RUNNING COSTS**
1. DRAINAGE AND PUMPING	158	1.324	787
2. TANNERY EFFLUENT TREATMENT			
2.1. IN-HOUSE ARRANGEMENTS	32	74	49
2.2. CETP & SOLID WASTE HANDLING & DISPOSAL	1.832	2.295	8.300
2.3. ANALYTICAL LABORATORY	60		51
2.4. Cr-RECOVERY PILOT PLANT	75	25	80
3. UNFORSEEN COSTS	630		
GRAND TOTAL COSTS:	2.787	3.718	9.267
	(6.505)		

PART I

COMMENTS ON THE JOINT FORMULATION MISSION PROPOSALS

COMMENTS ON THE JOINT FORMULATION MISSION REPORT

1. EXCERPTS OF THE JFM REPORT RECEIVED

Title page,

Annex 4 Technical Project Data and Costs

Annex 4.a. Technical project data
Pages: a15 - a18

Annex 4.b. Details of civil works and equipment costs
Pages: a21, a22, a24

2. COMMENTS ON THE ANNEX 4.a.(Technical data)

Ad 1. Drainage

Ad 1.1. Dingarh Collector

JFM proposal to construct an open channel cannot be accepted since it would intercept storm water which should be drained freely into the R.Nullah.

Ad 1.2. Dingarh Pump Station

Manually cleaned screens proposed by JFM can be introduced in the first phase to save some money but the space for later automatic screens installation should be prepared.

Ad 1.3. Pressure Pipeline

PVC material can be used (instead of cast iron) but availability in Pakistan as well as problems with valves and fittings should be taken in consideration.

Ad 1.4. Prolongation of the Pucca Drain

No proposals have been made.

Ad 1.5. Y.Nagar Drainage

No proposals have been made.

Ad 1.6. Y.Nagar Pumping Station

Same as Ad 1.2.

Ad 1.7 Final Outfall

The Subcontractor recommended three smaller diameter pipes for crossing the R.Nullah (rather than two bigger) to prevent blocking of the river flow.

Ad 2. **Treatment Plant**

- We consider flow measuring and recording necessary to collect the data about the flow distribution during the day, (season etc.), the treatment cost per m^3 as well as to determine other parameters for research and development of effluent treatment system(s).
- Simple and cost effective sludge drying lagoons cleaned with drag-line crane were recommended earlier and not sludge drying beds mentioned by JFM. The beds were considered too expensive, and difficult to maintain for such a big system.
- TEH-PROJEKT was of the opinion (just like the UNIDO consultant Mr.Aloy) that 1,8 m deep artificially aerated lagoons could give optimum effect but this was considered too expensive in investment and running costs (at least in the first phase). For naturally aerated lagoons (like those recommended) max. depth allowed is 1,5 m.
- There are no technical problems to add the second floor on the Administration/Control Building recommended.

Ad 3. **Solid Waste (Vehicles)**

- We are of the opinion that one 4-wheel pick-up combined with 5 seat cabin is sufficient and that separate vehicle proposed by JFM is not necessary.
- We agree that only 5 tractors and 10 trailers can be purchased in the first phase and the others can be added later according to the needs for solid waste handling.
- We consider 3-vacuum tankers necessary to clean the in-house grit/grease chambers and to transport Cr-tanning (and other) liquors to the recovery plant (JFM omitted them from proposal).
- For the new concept recommended in Part II of this report, a sludge drag-line crane and dump-trucks would not be necessary at all.

3. COMMENTS ON THE ANNEX 4.b. (Cost estimation)

1) There are great discrepancies between the civil works costs estimated by TEH-PROJECT and JFM. JFM costs are 66% bigger for drainage and 30% bigger for CETP.

2) Only the access road to the solid waste disposal is estimated cheaper by JFM than by TEH (23.000/200.000$). This can be realistic only if JFM took into consideration the waste disposal at (or near) the CETP location, but it is not clearly stated and in our opinion should be elaborated in more details (see Part II of this report).

3) It is not clear what the reason/interest of JFM was to estimate the civil works so much higher then TEH since TEH's team has checked and rechecked the prices of standardized civil works several times with the local consultants and compared them with other similar projects in the area.
The following official documents were used:

"Composite schedule of rates for Punjab/Pakistan"

"PC-I and project estimate of re-sectioning R.Nullah at Kasur city, Feb.1991"

"Revised costs estimate for urban sewerage scheme at Kasur, PHED, 1983"

Respecting all the price enhancing expected to be caused by inflation during the project implementation it does not seem realistic to estimate the cost increase at more than 25%. If this is taken into account (+ 25%) it is obvious that the project costs estimations made by TEH are practically the same as those made by JFM (see the comparative table, Annex 4.b. below).

4) JFM estimations do not seem always in conformity with their proposals. E.g. manually cleaned screens were proposed but prices for the automatic ones are included in the cost estimation; on the other hand the costs for the vehicles and the laboratory were significantly reduced and for Cr-recovery significantly increased, (in comparison with the TEH's estimations) without an accurate explanation.

5) We feel obliged to stress, as many times before, that cost estimations were prepared (as the most probable approximation) to enable the comparison of the

alternatives elaborated in the "Techno-Economic Study". Based on this, an optimum system has been recommended and confirmed on various levels (local, UNIDO/UNDP, donors) and Tender Documents for its implementation prepared. Naturally, only the tendering procedure once completed can precisely answer all the technical and economical dilemmas.

5) RECOMMENDATION:

The costs estimated by TEH and JFM should serve only to plan the general financing of the project and precise costs could be determined only after the tendering procedures for particular parts and stages of system recommended.

NOTE: The changes in the solid waste disposal concept proposed recently and elaborated in details in Part II of this report should be taken into consideration during the project implementation planning and tendering procedure (Tenders No.5 & 8 should be adequately adopted).

TABLE

ANNEX 4b: DETAIL OF CIVIL WORKS AND EQUIPMENT COSTS (US$)

1. DRAINAGE	J F M		TEH (Study) (+25%)	
1. Dingarh Collector	CV	27.000.-	CV	8.000.-
2. F.S. Dingarh	CV	65.000.-	CV	64.000.-
	E	131.000.-	F	105.000.-
3. Pipeline D-F.D.	CV	134.000.-	CV	50.000.-
4. Prolongation F.D.	CV	161.000.-	CV	40.000.-
5. Y.Nagar Drainage	CV	28.000.-	CV	25.000.-
6. P.S.Y. Nagar	CV	53.000.-	CV	37.000.-
	E	66.000.-	E	53.000.-
7. Final Outfall	CV	1.734.000.-	CV	1.100.000.-
T O T A L 1:				**1.485.000.-**
		2.399.000.-	**+25%=**	**1.856.000.-**

2. TREATMENT PLANT	J F M	TEH
1. Structures	CV 1.454.000.- E 1.500.000.-	CV 1.870.000.- E 1.285.000.-
2. Lagoons	CV 1.008.000.- E 104.000.-	
3. Laboratory	19.000.-	60.000.-
T O T A L 2:	4.085.000.-	3.215.000.- +25%= 4.018.000.-

3. SOLID WASTE MANAGMENT	J F M	TEH
1. Vehicles and E	448.000.-	980.000.-
2. Road	23.000.-	200.000.-
3. Site Preparation	200.000.-	160.000.-
T O T A L 3:	671.000.-	1.340.000.- +25% = 1.675.000.-
2 + 3	4.[illegible]6.000.-	4.555.000.- +25% = 5.693.000.-

4. IN-HOUSE ARRAGEMENT	J F M	TEH
1. Clear Technology	E 71.000.-	Nema u zadatku
2. Pretreatment	CV 90.000.- E 39.000.- 129.000.-	CV 74.000.- E 32.000.- 106.000.-
3. Cr-Recovery	CV 138.000.- E 171.000.- 309.000.-	CV 25.000.- E 75.000.- 100.000.-
T O T A L 4:	509.000.-	206.000.- +25%= 257.000.-
GRAND TOTAL	5.115 000.- 2.549.000.- 7.664.000.-	6.242.000.- +25%= 7.802.500.-

PART II

DESCRIPTION AND CALCULATIONS OF THE NEW ALTERNATIVES WITH SOLID WASTE DISPOSAL IN THE EXTENSION OF THE CETP

1. INTRODUCTION

After a detailed study of the various possibilities for the Kasur tannery effluent drainage and pretreatment as well as the solid waste treatment and disposal, the system consisting of the e'.ireties recapitulated in Annex 16 of the "Techno-Economic Study" (TES) has been recommended as optimum for the first phase of the integral Kasur pollution control system. The whole concept was preconditioned by the specific situation with land availability in the Kasur area, so the local government suggested using the area along the abandoned railway tracks which are in the government property;

- the track to the south of the town for the CETP (width 80 m and length 1000 m) and
- the track near the Indian border (to the east of the town) for the solid waste disposal.

Later on during the JOINT FORMULATION MISSION, the local government changed their suggestion regarding the solid waste disposal because of the military base vicinity and suggested using the abandoned railway track in the extension of the CETP and across the existing "stagnant pool 4" instead.
UNIDO requested TEH-PROJEKT "HIDRO" (on 04/05/1993) to study the consequences of such a change on the system in the whole and to estimate the investment and running costs.
The two additional alternatives of the "CETP/solid waste treatment and disposal system" have been studied and compared with the one recommended earlier in Annexes 13 & 16 of the "Techno-Economic Study":

Alternative 1.

Sludge thickening/drying in lagoons to be constructed on the abandoned railway track in the extension of the CETP and then the evacuation and separate disposal of the dry sludge on the abandoned railway track in the extension of the lagoons.

Alternative 2.

Simultaneous sludge thickening/drying and permanent disposal on the abandoned railway track in the extension of the CETP.

Previously 4-6 of the 18 lagoons within the CETP were planned to serve for sludge thickening/drying so if sludge drying is to occur in the extension of the CETP it would be only logical to use all the CETP lagoons as facultative lagoons for effluent treatment since anyhow the area limitation caused rather poor possibilities for biological treatment. With the increase in the capacity the overall treatment effect could be increased as well (elaborated under the sub-alternatives 1a & 2a). Additionally, just to enable a logical comparison of the new alternatives with the one recommended earlier in the ANNEX 16 , two more

sub-alternatives with only 12 facultative lagoons within the CETP boundaries were elaborated under 1b & 2b.
The newly recommended concept of solid waste disposal near the CETP will have repercussions only on the CETP. The rest of the system e.g., in-house arrangements, Cr-recovery, laboratory and drainage will remain as recommended in the "Techno-Economic Study". This is the reason why only the CETP and sludge treatment and disposal are described below in details (chapter 2).
The tabular comparison of investment and running costs between the Kasur tannery effluent treatment and solid waste disposal systems recommended earlier (TES, annex 16) and after the JFM (chapter 2) is presented at the end.

2. DESCRIPTIONS AND CALCULATIONS OF THE NEW CETP/SLUDGE DISPOSAL CONCEPT

2.1. BASIC DATA

EFFLUENT CHARACTERISTICS:

Volume	(m3/day):	12700
SS	(mg/l):	2700-3000
BOD5	" :	1200-1350
COD	" :	3500-4000
S-2	" :	70-80
Cr+3	" :	20-30
SO4-2	" :	800-1000
Cl-	" :	3000-3200
pH	:	7-9

NOTE: Since the site for the effluent treatment plant, due to legal/proprietary reasons in Kasur, is limited to the abandoned railway route near SP2, the following calculations will be based on the space available.

2.2. DESCRIPTION OF THE CONCEPT

The major part of the processes is identical for all the sub-alternatives of the concept, which is going to be described below (see drawings 17 - 17/4.
This concept enable easy experimenting with other possible physical, chemical and biological (anaerobic, and aerobic) processes which can be proved feasible in a future design of the Kasur integral environmental project (after the development of technology and local financial abilities).

2.2.1. EFFLUENT TREATMENT

After screening the effluent will enter the homogenization tanks (20-A-02) mixed with surface aerators. The homogenized effluent will be uniformly pumped, during the day, (20-A-03, 30-P-01) into the settling tanks (30-A-02) equipped with sludge & scum scrapers (30-Z-01).
The settled sludge will be discharged into the pumping tank (30-A-03), and from there pumped occasionally (30-P-02) into one of the six sludge thickening/drying lagoons (Alternative 1) or into one of the two pits for permanent solid waste disposal (Alternative 2).

The clarified effluent will overflow through the flow, pH and temperature control pit (40-A-01, FIRQ 1, AIRA pH 2, TIR 3) into two series of facultative lagoons (21-L-02). After zig-zagging through the lagoons the purified effluent will be discharged into the Pandoki Outfall via Final Outfall (8400m), and further on (10-12 km) into the Sutlej river.

NOTE: Since according to this new concept, sludge drying is going to occur at the location behind the CETP (in extension), all the 18 lagoons previously designed (6 for sludge drying and 12 for facultative effluent treatment) can be now used as facultative lagoons for effluent treatment. This would be logical and useful since the space available was not sufficient for adequate biological treatment and we strongly recommend it to be implemented (sub-alternatives 1a & 2a).
To enable a logical comparison of the old (dislocated CETP and solid waste disposal sites) and the new concept (CETP and solid waste disposal at the same site) we have supplementarily presented sub-alternatives 1b & 2b in which these additional facultative lagoons (6 pcs) are not taken into account.

2.2.2. SLUDGE HANDLING

Lime milk prepared in the mixed concrete tanks (50-A-01, 50-M-01) will be occasionally added, into the tank (30-A-03) for the sludge stabilization, by pumps (50-P-01) preventing sludge anaerobic decomposition and the emission of noxious gases.

ALTERNATIVE 1

When filled with sludge the particular sludge drying lagoon will be blocked off from the system and left for some time, so that sludge can be thickened. After that, separated/drained water will be collected into the pumping pit (21-A-02) and pumped back to the equalization tanks by the pump (21-P-01).
Simultaneously the sludge will be dried due to high evaporation.
Once sufficiently dry, the sludge will be excavated by a dragline crane, loaded onto trucks and transported to the solid waste disposal site constructed on the abandoned railway tracks in the extension of the CETP and sludge drying lagoons.

ALTERNATIVE 2

The sludge from the clarifiers will be pumped into the deep pits constructed on the abandoned railway tracks in the extension of the CETP where it would be gradually thickened, dried, compacted and permanently disposed off. To enhance sludge drying, the two pits will be filled alternately and supernatant from them will be drained off into the pumping pit (21-A-02) and pumped (21-P-01) back into the equalization tanks. Once the pits have been completely filled with compacted and stabilized sludge (after several years), they can be covered by humus and cultivated by adequate vegetation (timbre and fire woods for example).

2.2.3. UTILITIES

The water necessary for the process (lime milk preparation, equipment and floor washing etc.) will be supplied from the well (70-BU-01) equipped with a submerged pump (70-P-01).
Potable water will be supplied from the municipal network.
A separate high-voltage network (11 kV) should be constructed from the central transformer station (110/11 kV), as well as the local transformer 11/04 kV. Apart from this, one stand by power generator should be installed in a separate building (80-PO-01).
Indoor and outdoor illumination should be installed and all the equipment should be grounded according to the standards.
A telephone should be connected to the Kasur network.
Fine screens and power generators should be placed in the closed object.
The main control monitoring, and regulation equipment should be installed inside the building (80-UP-01) comprising; control room, laboratory, office, rest room, lavatories, work-shop and storage.
Access and internal communication roads should be constructed and the whole plant area protected by a fence.

2.3. MAIN TECHNOLOGICAL CALCULATIONS

2.3.1. GENERAL REMARK

All the materials applied in the plant construction should be resistant to the aggressive influence of the tannery effluents and the surrounding atmosphere.

2.3.2. SCREENING

1) Manually cleaned coarse screen

Max.flow:	980 m3/h
Openings:	50 mm
Gradient:	70 o
Width:	1.200 mm
Perforated drainage	platform

2) Automatically cleaned fine screens & compactors

Max.flow:	980 m3/h
Openings:	6 mm
Gradient:	60 o
Width:	1.200 mm
Length:	3.550 mm
Screen power:	0,18 kW
Compactor power:	3,6 kW

2 sets

The building for the fine screens and the power generators:

Area:	12 x 5 m
Height:	3,5 m

2.3.3. HOMOGENIZATION IN CONCRETE TANK

Effluent volume:	12.700 m3/day
Sulfide quantity:	80 mg/l, 1000 kg/day

1) Tanks

Width:	32,5 m
Length:	65,0 m
Water depth:	3,0 m
Volume:	6.375,5 m

2 tanks

Total volume:	12.675 m3
Detention time:	ca 1 day

2) Floating aerators

Power: 30 kW
Oxygen transfer: 1,8 kg O2/kWh

16 pcs

Overall mixing power:
38 W/m3

Overall oxygen transfer:
864 kg O2/h ---> 20.736 kg o2/day
Oxygen necessary for sulfide oxidation:
0,75 kg O2/kg S2- ---> 750 kg O2/day

3) Pumps for flow equalization

Average flow: 530 m3/h

Q = 300 m3/h
H = 12 m
N = 18,5 kW

2+1 pcs

2.3.4. SLUDGE SETTLING AND STABILIZATION

Q = 530 m3/h

1) Settling tanks

Diameter: 18 m
Depth: 2,4 m
Volume: 611 m3

2 pcs

Superficial load: 1 m3/m2 x h
Detention time: 2,5 h

From all the measurements carried out on the effluent homogenized and aerated during the 24 hours, the elimination rates after the primary settling were as follows:

SS	60-80%	Cr+3	90-95%
BOD5	40%	SO4-2	/
COD	40%	Cl-	/
S-2	50-70%		

2) Sludge pumping (same for all alternatives)

Sludge volume:

SS (raw effluent): 2850 mg/l

SS (clarified effluent):
1000 mg/l (65% expected removal)
SS (expected in sludge):
30-40 kg/m3
Dry solids expected to be separated:
20000-25000 kgDS/day
Sludge volume expected after settling:
650-700 m3/day

Lime for sludge stabilization

Quantity needed: ca 10% CaO on the dry solids in sludge.
2000-2500 kg CaO/day or
2640-3300 kg Ca(OH)2/day
ca 30 m3/day lime milk

Pumping pit

Area: 2 x 2 m
Depth: 2,5 m
Volume: 10 m3

Sludge pumps

Sludge + lime volume:
max.730 m3/day
Qav. = 30 m3/h

Q = 60 m3/h
H = 45 m
N = 18,5 kW
1+1 pcs

Pressure pipeline

Sludge transport pipeline is longer than in the alternative recommended earlier (TES, Annex 16) since sludge drying is dislocated from the CETP.

Pipe diameter: 125 mm

Additional length: 1.000 m

Sludge distribution pipeline is the same as described in the TES, Annex 16.

3) Lime milk preparation (same for all alternatives)

Concrete tanks

Width:	3 m	
Length:	4 m	
Depth:	2,5/3,1 m	
		2 pcs
Active volume:	30 m3	

Electric mixers

N = 9 kW

2 pcs

Recirculation/dosing pumps

Q = 10 m3/h
H = 10 m
N = 1,5 kW

1+1 pcs

2.3.5. FACULTATIVE LAGOONS

According to the new concept of a dislocated CETP and sludge treatment/disposal, there is a possibility to use all the space available within the CETP for effluent treatment in facultative lagoons (18 pcs altogether) and to increase the treatment effect (sub-alternatives 1a & 2a). In the sub-alternatives 1b & 2b the concept with the same number of sludge drying lagoons and facultative lagoons as in the alternative recommended earlier (TES, Annex 16) are presented mostly to enable a logical comparison between the old and new recommendations (side by side CETP/sludge disposal : dislocated CETP and sludge disposal).
Naturally, longer overall effluent detention time in the treatment system can be expected to occur according to the new concept presented in the alternatives 1a & 2a, then these calculated for the old concept (TES, Annex 16) and for the alternatives 1b & 2b.
Logically, a higher treatment effect, proportional to detention time can be expected as well (see calculations in Annex 16).

2.3.5.1. Excess sludge after biological treatment in the lagoons

Sludge production: 0,3-0,4 kg per 1 kg of the BOD5 removed.

0,35 x 12700 x (600-300)max:1000 = 1333 kg/day

Taking into consideration the low concentration of biological sludge (0,5-1,5% of dry solids), the lagoons should be blocked off from the rest of the system one by one, and the sludge should be dried and evacuated approx. once in 1-2 years.

2.3.6. SLUDGE THICKENING/DRYING AND DISPOSAL

2.3.6.1. Alternative 1

Six lagoons, of the same dimensions as described in the TES, Annex 16, are going to be constructed at the abandoned railway track in the extension of the CETP.

1) Lagoons

Width:	30 m
Length:	100 m
Water depth:	1,5 m
Active volume:	3790 m3

Sludge + lime quantity:

max. 30.000 kgDS/day or,
max. 730 m3/day (40-50 kg/m3)

Expected sludge concentration after the combination of the supernatant drainage & draw off and evaporation during the lagoon filling (ca 80-90% of water content removal):

200-300 kgDS/m3
(specific gravity ca 2 kg/l)

or:

20-25% DS

Volume of the thickened sludge:

max 100-150 m3/day

Estimated lagoon filling time:

3790/150 to 3790/100 = 25-38 days

Planned additional sludge stabilization and drying time (after the filling is stopped):

30 days

Estimated sludge dryness:

30-40% DS

Estimated sludge volume:

60-100 m3/day ; 3000 m3/lagoon

Estimated sludge evacuation time:

30 days/lagoon

The whole cycle (thickening/drying/evacuation) would last approximately 3 months/lagoon so, if two lagoons operate simultaneously it would be necessary to plan 4 (2 x 2) sludge drying lagoons to cover whole year cycle.
For the safety reasons we recommend the construction of 6 (2x3) lagoons!

2) Supernatant Drainage

Since now the drying lagoons are too far from the equalization tanks, it is not possible to drain/return supernatant simply by transportable pumps but a special drainage system of so called "fish bone" should be applied. Using this system the supernatant will be decanted, collected in the pumping pit and pumped back to the equalization tank.

Pumping pit

Area:	2 x 2 m
Depth:	2,5 m
Volume:	10 m3

Pumps

Qav. = 30 m3/h

Q = 60 m3/h
H = 45 m
N = 18,5 kW

1+1 pcs

"Fish bone" and Collection Pipeline

Pipe diameter : 125 mm

Length : 300 m

Pressure pipeline

Identical as the sludge transport pipeline.

Pipe diameter: 125 mm

Length : 1.000 m

3) Disposal of the dry sludge

The site arrangements will be the same as described in the TES, (Annex 13) and recommended in Annex 16 with the exception of the site location which will be just near the sludge drying lagoons, so the access road will be significantly shorter.

2.3.6.2. Alternative 2

1) Sludge Disposal Pits

In this alternative the construction of pits for simultaneous sludge thickening, drying, compacting and permanent disposal are recommended. For this purpose deep pits are more economical than relatively shallow lagoons (bigger volume and higher compacting). Contrary to drying lagoons, the shape of the pit is not relevant to the final effect, but as stated before in our case the location is limited and the shape determined by the available area (with 80m).
Such disposal pits are usually constructed for a longer use which apart of being more economical is favorable for better natural drying and compacting of the sludge.
In the first phase we recommend a construction for 5 year operation divided into two parts, which are going to be used alternately to improve supernatant decanting as well as sludge drying and compacting.
In this first phase it would be necessary to use a stretch approximately 500 m long (width 80m).

Pit dimensions:

Width :	59 m
Length:	238 m
Depth :	4,5/5 m
Volume:	52443 m^3
	2 pcs

The operation of these pits for the calculated sludge quantity will be possible in a period of:

$$\frac{2 \times 52443 m3}{(60-100\ m3/day) \times 365} = \text{approx. } 3 - 6 \text{ years}$$

Valuable experiences could be collected during the operation of this system and there would be no problem to design probably even more appropriate system in the future.

2) Supernatant Drainage

The supernatant drainage system will be in principle similar to the one in the Alternative 1, but the dimensions and details are dictated by the local conditions. The system will consist of the following:

Pumping pit

Area:	2 x 2 m
Depth:	2,5 m
Volume:	10 m3

Pumps

Qav. = 30 m3/h

Q = 60 m3/h
H = 45 m
N = 18,5 kW

1+1 pcs

"Fish bone" and Collection Pipeline

Pipe diameter : 125 mm

Length : 150 m

Pressure pipeline

Identical as the sludge transport pipeline.

Pipe diameter: 125 mm

Length : 1.000 m

2.3.7. EFFLUENT TREATMENT EFFICIENCY

OVERALL EFFLUENT DETENTION TIME

For earlier recommendation (Annex 16) and sub-alternatives 1b & 2b:

(12.700 + 1.220 + 14 x 3790) : 12.700 = 5 days

For the sub-alternatives 1a & 2a:

(12.700 + 1.220 + 18 x 3790) : 12.700 = 6.5 days

EXPECTED TREATMENT EFFECT

For earlier recommendation (Annex 16) and sub-alternatives 1b & 2b:

SS = 95-98 %	pH = 7-8
BOD5 = 60-70 %	COD = 50-70 %
S-2 = 95-98 %	Cr+3 = 90-98 %
SO_4-2 = 0 %	Cl-1 = 0 %

For the sub-alternatives 1a & 2a:

	Raw effluent	treated effluent/ min.overall effect
SS (mg/l)	2700	< 150 (95%)
BOD5 "	1200	< 400 (67%)
COD "	3100	<1200 (60%)
S-2 "	70	< 1,5 (98%)
Cr+3 "	25	< 0,5 (98%)
TDS "	6500	6400 (0%)
SO4-2 "	1000	1000 (0%)
Cl-1 "	3200	3200 (0%)
pH	8-10	7-8 -

2.4. SPECIFICATIONS AND INVESTMENT COSTS

2.4.1. CIVIL WORKS

(Earth works, concrete works and masonry)

1. Physical Treatment & Equalization

20-A-01	Supply channel,	
20-PD-01	Building for screens & power generators 12 x 5 x 3,5 m	
20-A-03	Equalization tank 2 x (32.5 x 65 x 3) = 12.675 m3	
30-A-02	Settling tanks diameter:18 m H = 2,4 m 2 pcs	
30-A-03	Sludge pumping station V = 10 m3	
40-A-01	Venturi channel	
50-A-01	Lime preparation tanks 3 x 4 x 2,5 m 2 pcs	
80-UP-01	Control building 24 x 10 x 3,5 m	
80-PG-01	Power generator building 7 x 12 x 3,5 m	
	TOTAL 1.:	620.000 US$

2. Biological Treatment

2a. Facultative Lagoons (sub-alternatives a)

21-1-02	Construction of the lagoons with inlet and outlet arrangements. L = 100 m W = 30 m H = 1,5 m 18 pcs	975.000 US$

2b. Facultative Lagoons (sub-alternatives b)

21-1-02	Construction of the lagoons with inlet and outlet arrangements. L = 100 m W = 30 m H = 1,5 m 12 pcs	650.000 US$
	TOTAL 2.: Alternatives 1a & 1b :	975.000 US$
	Alternatives 2a & 2b :	650.000 US$

3. Sludge Treatment and Handling

3.1.1. Sludge Drying Lagoons (alternative 1)

21-L-01	Construction of the lagoons L = 100 m W = 30 m H = 1,5 m 6 pcs	300.000 US$

3.1.2. Solid Waste Disposal (alternative 1)

Access road: width: 4,5 m length: 1100 m	100.000 US$
Site preparation and drainage: 80 x 1000 m	160.000 US$

3.2. Sludge Disposal Pits (alternative 2)

21-L-01	Construction of the pits L = 238 m W = 59 m H = 4,5 m 2 pcs	500.000 US$

TOTAL 3.:	Alternatives 1a & 1b:	560.000 US$
	Alternatives 1a & 1b:	560.000 US$

4. Utilities

4.1. Concrete Outflow Channel

RCC dia.: 530-840 mm L = 1.200 m	95.000 US$

4.2. Water Supply

70-BU-01 water well D = 400 mm H = 15 m 1 pc	12.000 US$
- process water pipeline	3.000 "
- potable water pipeline	15.000 "
TOTAL 4.2.:	30.000 US$

4.3. CETP Access & communication roads

W = 3,5 m L = 2.200 m	75.000 US$

TOTAL 4.:	200.000 US$

TOTAL CIVIL WORKS

Alternative 1a:	2.355.000 US$
Alternative 1b:	2.030.000 US$
Alternative 2a:	2.295.000 US$
Alternative 2b:	1.970.000 US$

2.4.2. EQUIPMENT

(Electro-mechanical equipment and all the accessories, pipes, valves and local electrical commands & controls are included in the costs)

1. Physical Treatment & Equalization

-	Sluices (9pcs) & penstocks (2 pcs), 1500x1200 mm	20.000 US$
20-RS-01	Bar screen openings: 50 mm 1 pc	500 "
20-RS-02	Automatic screen with compactor openings: 6 mm W = 1200 mm Nc = 3,6 kW Ns = 0,18 kW 2 sets	238.000 "
20-K-01	Containers V = 1000 l 5 pcs	600 "
20-AP-01	Floating mixers/aerators N = 30 kW 16 pcs	352.000 "
20-P-01/1/2	Equalized effluent pumps Q = 300 m3/h, H = 12 m, N = 18,5 kW 2 + 1 pc	25.000 "
30-Z-01/1/2	Sludge/scum scraper diameter: 18 m N = 1,1 kW 2 pcs	80.000 "
30-P-02	Sludge pumps Q = 60 m3/h H = 15 m N = 6,5 kW 2+1 pcs	12.000 "
50-M-01	Lime mixer N = 9 kW 2 pc	20.000 "
50-P-01	Lime transport pumps Q = 10 m3/h, H = 10 m,N = 1,5 kW 2 pcs	2.500 "
	TOTAL 1.:	750.600 US$

2. Biological Treatment

-	No equipment for facultative lagoons!	0 US$

3. Sludge Treatment and Handling

21-P-01	Diesel-motor pump for periodic sludge supernatant draw off from facultative lagoons Q = 200 m3/h H = 5 m N = 5 kW 2 pcs	25.000 "
-	Mobile sludge loader/dragline crane (alternative 1)	80.000 "
-	Sludge bulldozer/compactor (alternative 1)	80.000 "
-	Sludge transport trucks (5 t) 2 pcs	120.000 "
	TOTAL 2.(alternative 1):	305.000 US$
	TOTAL 2.(alternative 2):	25.000 US$

4. Utilities

4.1. Water Supply

70-P-01	Well pump Q = 30 m3/h P = 6 bars N = 5,8 kW 1 pc	6.000 US$
-	process water distribution system ca 200 m. D=80 mm	4.000 "
-	potable water distribution system ca 1800 m, 1.5".	10.000 "
	TOTAL 4.1.:	20.000 "

4.2. Diesel Power Generator

-	630 kVA generator with automatic connection to the electric network in the case of electric power brake down. Daily fuel tank included. 1 set	160.000 US$

4.3. Vehicles

–	Pick-up (Comby)	
	1 pc	30.000 US$
–	General purpose truck (5 t)	
	1 pc	53.000 "
–	Solid waste handling:	
	18 tractors	
	30 trailers	
	3 vacuum tanks	600.000 US$
	TOTAL 4.3. :	**683.000 US$**

5. Measurements and Regulations

FIRG 1	Flowmeter with transmitter, display, counter and register	
	1 set	6.000 US$
AIRA 2	pH measurement with transmitter, display, register and alarm	
	1 set	6.000 US$
	TOTAL 5.:	**12.000 US$**

6. Electricity Supply & Equipment

- Electricity supply, 11 kV	26.200 US$
- Transformer, 11/0,4 kV, 630 kVa	
2 set	30.800 "
- Compensator	
1 set	17.500 "
- Control-boards	
1 set	42.000 "
- Local commands	
1 set	9.000 "
- Cables	
1 set	21.000 "
- Indoor & outdoor illumination	26.000 "
- Service voltage	7.000 "
- Telephone connection	1.500 "
TOTAL 6.:	**181.000 US$**

TOTAL EQUIPMENT

Alternative 1a:	2.111.600 US$
Alternative 1b:	2.111.600 US$
Alternative 2a:	1.831.600 US$
Alternative 2b:	1.831.600 US$

2.5. RECAPITULATION AND COMPARISON OF THE INVESTMENT COSTS

	THE NEW SUB-ALTERNATIVES (US$)			
	1a	1b	2a	2b
Civil works:	2.355.000	2.030.000	2.295.000	1.970.000
Equipment :	2.111.600	2.111.600	1.831.600	1.831.600
TOTAL :	4.466.600	4.141.600	4.126.600	3.801.600

2.6. RUNNING COSTS

Running costs are presented through:

- Material consumption and costs.
- Maintenance costs.
- Energy consumption and costs.
- Sludge transport costs.
- Labor consumption and costs.
- Depreciation of the civil works and equipment.

2.6.1. Material Consumption and Costs

Ca 10% of lime should be added on dry matter of the sludge for its stabilization.

600 t/year x 53 US$/t = 32.000 US$/year

2.6.2. Maintenance Costs

Maintenance costs for such a plant can be estimated at 1,5 % of the mechanical and electrical equipment value per a year.

	THE NEW SUB-ALTERNATIVES			
	1a	1b	2a	2b
Equipment(US$):	2.111.600	2.111.600	1.831.600	1.831.600
Maintenance($/y):	31.600	31.600	28.000	28.000

2.6.3. Energy Consumption and Costs

Taking into account the compensation for the engaged power, the costs per kwh will vary depending of the max. load, but we can estimate that it would be an average of ca 71 US$/MWh.

Power consumption :

- Floating aerators:	
16 pcs x 30 kW x 24 h/d x 300 d/year	= 3.456.000 kWh/y
- Effluent pumps:	
12700 m3/d : 300 m3/h x 18,5 kW x 300 d/y	= 238.000 kWh/y
- Sludge pumps:	
1300 m3/d : 60 m3/h x 18,5 kW x 300 d/y	= 120.000 kWh/y
- Sludge scrapers:	
2 pcs x 1,1 kW x 24 h/d x 300 d/y	= 16.000 kWh/y
- Lime mixer + pump:	
(9 + 1,5) kW x 8 h/d x 300 d/y	= 30.000 kWh/y
- Screens, illumination etc:	
ca 20 kW	ca 50.000 kWh/y
TOTAL	= 4.050.000 kWh/y

Energy costs : 4.050 MWh/y x 71 $/MWh = 288.000 US$/y

2.6.4. Sludge Transport Costs (Alternative 1)

Dewatered sludge volume: 60-70 m3/day, 19500 m3/year
Working with 5 t-trucks one can assume that 19.500 : 5 = 3.900 rounds will be necessary per year.
Taking into account ca 2 km per round, fuel consumption of 0,2 l/km and the fuel price of 0,25 US$/l the sludge transport costs can be calculated as follows:

3900 x 2 x 0,2 x 0,25 = 390 US$/y

NOTES: * Only the fuel is calculated since labor, maintenance and depreciation costs are presented under other items!

** In the alternative 2 sludge is transported hydraulically!

2.6.5. Labor Costs

Necessary labor, qualification and costs can be estimated as follows:

Qualification	Workers no.	Salaries (gross) $/w/year	Yearly Costs US$/year
Process engineer	1	2.250	2.250
Technician	1	1.100	1.100
Qualified workers	18	850	15.300
Non-qualified workers	3	550	1.650
TOTAL :	23		20.000

2.6.6. Civil Works and Equipment Depreciation

Yearly depreciation rates are estimated at:

- civil works for lagoons: 10,0 %
- concrete works & roads : 2,0 %
- sludge disposal sites : 20,0 %
- electro-mechanical equipment: 7,0 %
- vehicles and compactor : 20,0 %
- solid waste handling equipment (sludge trucks, tractors & trailers): 8,5 %

Alternative 1a

- Lagoons: 1.275.000 x 10%	= 127.000 $/y
- Sludge disposal sites: 160.000 x 20%	= 32.000 $/y
- Concrete works & roads: (2.355.000 - 160.000 - 1.275.000) x 2%	= 18.000 $/y
- Vehicles & compactor: (83.000 + 80.000) x 20%	= 33.000 $/y
- Solid waste handling equipment: (120.000 + 600.000) x 8,5%	= 61.000 $/y
- Electro-mechanical equipment: (2.111.600-720.000-163.000) x 7%	= 86.000 $/y
TOTAL:	357.000 $/y

Alternative 1b

- Lagoons: 950.000 x 10%	= 95.000 $/y
- Sludge disposal sites: 160.000 x 20%	= 32.000 $/y
- Concrete works & roads: (2.030.000 - 160.000 - 950.000) x 2%	= 18.000 $/y
- Vehicles & compactor: (83.000 + 80.000) x 20%	= 33.000 $/y
- Solid waste handling equipment: (120.000 + 600.000) x 8,5%	= 61.000 $/y
- Electro-mechanical equipment: (2.111.600-720.000-163.000) x 7%	= 86.000 $/y
TOTAL:	325.000 $/y

Alternative 2a

- Lagoons: 975.000 x 10%	= 98.000 $/y
- Sludge disposal sites: 500.000 x 20%	= 100.000 $/y
- Concrete works & roads: (2.295.000 - 500.000 - 975.000) x 2%	= 16.000 $/y
- Vehicles: 83.000 x 20%	= 17.000 $/y
- Solid waste handling equipment: 600.000 x 8,5%	= 51.000 $/y
- Electro-mechanical equipment: (1.831.600 - 600.000 - 83.000) x 7%	= 80.000 $/y
TOTAL:	362.000 $/y

Alternative 2b

- Lagoons: 650.000 x 10%	= 65.000 $/y
- Sludge disposal sites: 500.000 x 20%	= 100.000 $/y
- Concrete works & roads: (1.975.000 - 500.000 - 650.000) x 2%	= 16.000 $/y
- Vehicles: 83.000 x 20%	= 17.000 $/y
- Solid waste handling equipment: 600.000 x 8,5%	= 51.000 $/y
- Electro-mechanical equipment: (1.831.600 - 600.000 - 83.000) x 7%	= 80.000 $/y
TOTAL:	329.000 $/y

2.6.7. Miscellaneous

ca 15% addition to the all running costs: 85.000 $/y

2.7. RECAPITULATION OF THE RUNNING COSTS

	THE NEW SUB-ALTERNATIVES (US$/y)			
	1a	1b	2a	2b
Material :	32.000	32.000	32.000	32.000
Maintenance :	31.600	31.600	28.000	28.000
Energy :	288.000	288.000	288.000	288.000
Sludge transport:	400	400	0	0
Labor :	20.000	20.000	20.000	20.000
Depreciation:	357.000	325.000	362.000	329.000
Miscellaneous:	100.000	100.000	100.000	100.000
TOTAL :	829.000	797.000	830.000	797.000

3. COMPARISON OF THE NEW CONCEPT WITH THE ONE RECOMMENDED EARLIER IN THE "TECHNO-ECONOMIC STUDY"

3.1. ECONOMIC COMPARISON

		THE NEW SUB-ALTERNATIVES			
	TES	1a	1b	2a	2b
1. INVESTMENT (x US$ 1000)					
Civil works:	2.230	2.355	2.030	2.295	1.970
Equipment :	2.292	2.111	2.111	1.831	1.831
TOTAL 1. :	4.522	4.466	4.141	4.126	3.801
2. RUNNING (x 1000 $/10Y)					
	8.030	8.290	7.970	8.300	7.970
TOTAL 1+2 :	12.552	12.756	12.111	12.426	11.771

3.2. OVERALL TREATMENT EFFECT

		Raw effluent	TES / 1b & 2b treated effluent/ min.overall effect	1a & 2a treated effluent/ min.overall effect
SS	(mg/l)	2700	< 150 (95%)	< 150 (95%)
BOD5	"	1200	< 450 (65%)	< 400 (67%)
COD	"	3100	<1600 (55%)	<1200 (60%)
S-2	"	70	< 2 (98%)	< 1,5 (99%)
Cr+3	"	25	< 1 (96%)	< 0,5 (98%)
TDS	"	6500	<6400 (0%)	<6400 (0%)
SO4-2	"	1000	<1000 (0%)	<1000 (0%)
Cl-1	"	3200	<3200 (0%)	<3200 (0%)
pH		8-10	7-8	-

3.3. FINAL CONCLUSIONS AND RECOMMENDATIONS

1) It would be cheaper to construct the CETP and solid waste disposal facilities at same location than apart (like it was recommended earlier).
Savings which can be achieved for the system of the same performance characteristics (alternative 1b)can be:

- in investment: US$ 381.000
- in running : US$/y 60.000

2) If hydraulic sludge transport directly to permanent disposal is applied (which is now possible because of the site close to the CETP) even higher savings can be achieved (alternative 2b):

- in investment: US$ 721.000
- in running : US$/y 78.000

3) Since there would be enough space at the CETP site now, we suggest that the previously recommended sludge drying lagoons should be used for facultative effluent biological treatment, increasing the overall system efficiency.
Apart from efficiency benefits this system recommended under the sub-alternative 2a could eventually be more economical than the system recommended earlier in the TES (Annex 16).
In spite of a little bit higher running costs, lower investment (US$ 396.000) could result in some savings taking into account the total 10 year costs (US$/10y 96.000).
The financial construction of the whole recommended Kasur tannery effluent drainage/treatment and solid waste disposal system is presented in the table 3.4.below.

4) It is necessary to bear in mind that all the costs presented are estimated on the basis of the Subcontractor experiences and the data collected from the local consultants and running projects during the field missions.
Firm, absolute costs could be known only after the bidding procedure which should be performed using the "Tender Documents" elaborated earlier. Naturally, the parts of the documents concerning the CETP and solid waste disposal (Nos.5 & 8) should be adopted in accordance with the recommendations made above.

3.4. COST ANALYZE OF THE RECOMMENDED SYSTEM

* x 1000 US$
** x 1000 US$/10 years

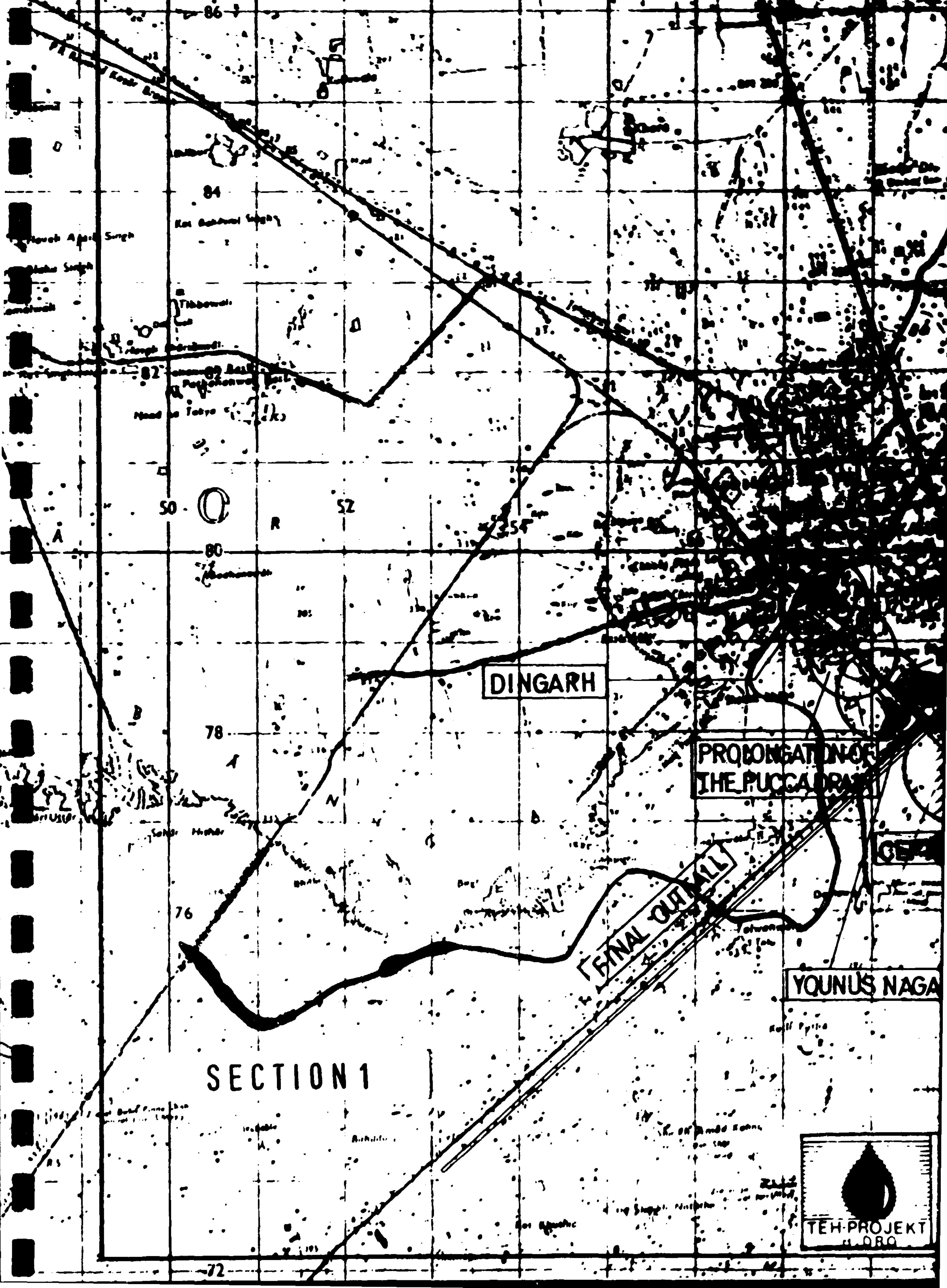
	INVESTMENT COSTS*		RUNNING
	equipment	civil works	COSTS**
1. DRAINAGE			
1.1. DINGARH COLLECTOR			
D=0,76 m, L=480 m	0	8	30
1.2. DINGARH PUMP STATION			
Q=100 l/s			
H= 14 m			
N= 25 kW			
2 pumps & 2 screens	105	64	155
1.3. PIPELINE DINGARH-"PUCCA DRAIN"			
D=300 mm, L=450 m	0	50	15
1.4. PROLONGATION & RECONSTRUCTION OF THE "PUCCA DRAIN"			
0,90x1,25 m, L=590 m	0	40	120
1.5. Y.NAGAR DRAINAGE			
0,60mx0,60m; L=500m		25	80
1.6. Y.NAGAR PUMP STATION			
Q= 171/s			
H= 10m			
N= 4,5kWh			
screen & 2 pumps	53	37	57
1.7. FINAL OUTFALL			
L= 8.400 m	0	1.100	330
TOTAL DRAINAGE (1.1-1.7):	158	1.324	787
	(1.482)		

Continued -/-

	INVESTMENT COSTS* equipment	civil works	RUNNING COSTS**
2. TANNERY EFFLUENT TREATMENT			
2.1. IN-HOUSE ARRANGEMENTS 190 flowmeters 190xscreen + grit/grease chambers	32	74	49
2.2. CETP & SOLID WASTE HANDLING & DISPOSAL Q= 12.700 m3/day N= 600 kW, 13500 kWh/day area: 80x1700m = 13,6 ha Treated effluent characteristics: SS (mg/l): < 150 BOD5 " : < 400 COD " : <1.200 S-2 " : < 1,5 Cr+3 " : < 0,5 SO4-2 " : <1.000 Cl- " : <3.200 Solid waste quantities: - from the production processes: 42 t/d - from the effluent treatment: 60-70 t/d	1.832	2.295	8.300
2.3. ANALYTICAL LABORATORY	60		51
2.4. Cr-RECOVERY PILOT PLANT	75	25	80
TOTAL EFFLUENT TREATMENT & SLUDGE DISPOSAL (2+3):	1.999	2.394	8.480
	(4.393)		
UNFORSEEN COSTS	630		
GRAND TOTAL COSTS:	2.787	3.718	9.267
	(6.505)		

4. DRAWINGS

original contains
color illustrations



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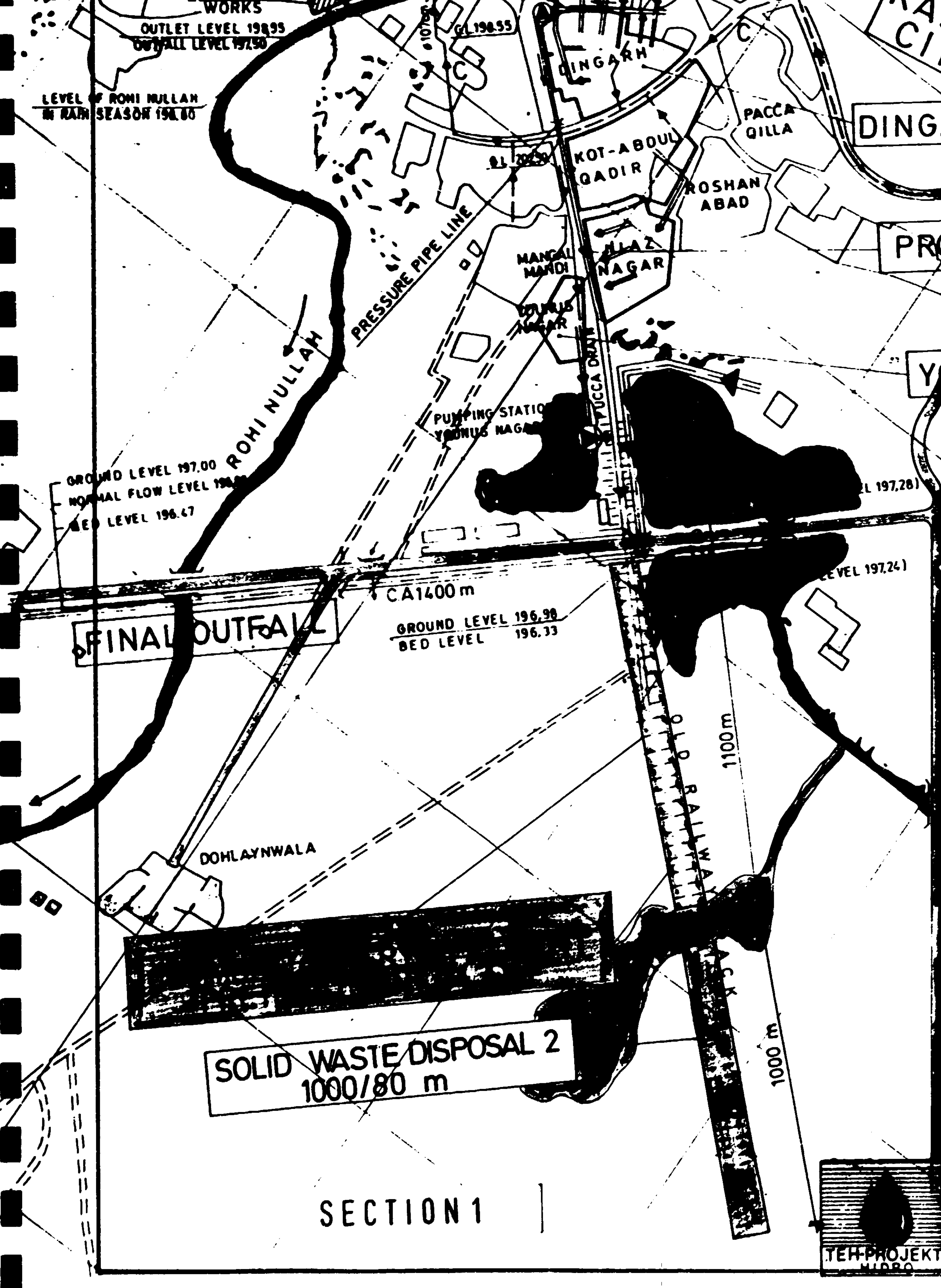
	DATE	MAP NO
	MAY 1993	17a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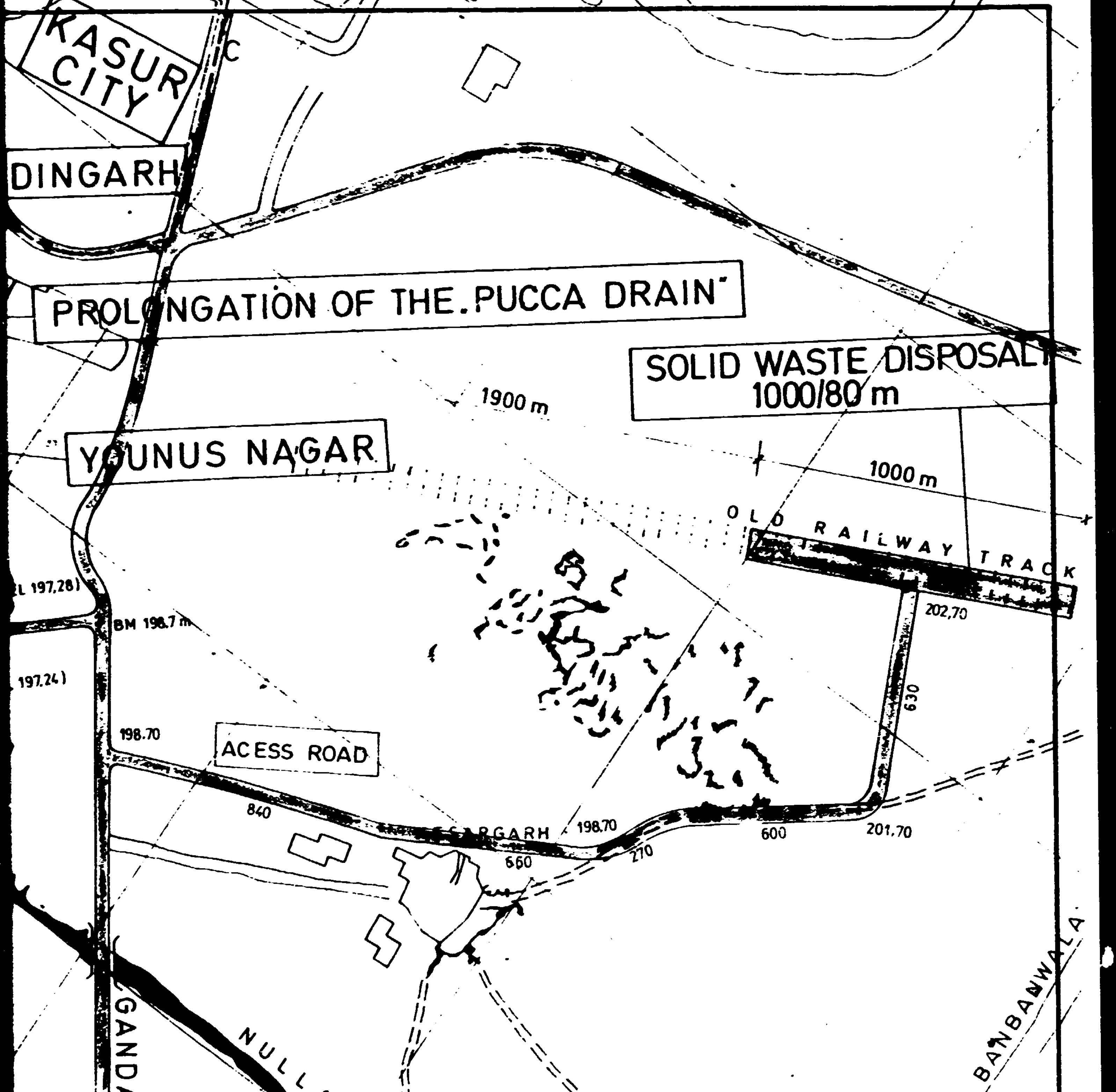
OUTFALL LEVEL 197.50
LEVEL OF ROHI NULLAH IN RAIN SEASON 196.80
GL 198.55
C
DINGARH
PACCA QILLA
DING
GL 201.50
KOT-ABDUL QADIR
ROSHAN ABAD
PR
PRESSURE PIPE LINE
MANGAL MANDI
NAGAR
YOUNUS NAGAR
PUCCA DRAIN
PUMPING STATION YOUNUS NAGAR
ROHI NULLAH
GROUND LEVEL 197.00
NORMAL FLOW LEVEL
BED LEVEL 196.47
L 197.28)
LEVEL 197.24)
CA 1400 m
FINAL OUTFALL
GROUND LEVEL 196.98
BED LEVEL 196.33
OLD RAILWAY TRACK
1100 m
DOHLAYNWALA
SOLID WASTE DISPOSAL 2
1000/80 m
1000 m
SECTION 1
TEH-PROJEKT HIDRO



MAP NAME		PROJECT NO:	SCALE:
GENERAL LAY-OUT 17b	UNIDO	DP/PAK/89/025	1:15.000
		DATE	MAP NO:
		MAY 1993	17b

PROCESS DIAGRAM
of the C E P T P WITH PHYSICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS

20 PHYSICAL TREATMENT & EQUALIZATION

20-A -01 SUPPLY CHANNEL
20-SS-01 MANUALLY CLEANED SCREEN
20-SS-02 AUTOMATIC FINE SCREEN (WITH COMPACTOR)
20-[illegible] -01 SOLID WASTE CONTAINER
20-[illegible] -02 EQUALIZATION TANKS (CONCRETE TANKS)
20-AR-01 SURFACE AERATORS (IN EQUALIZATION TANKS)
20-A -03 EFFLUENT PUMPING STATION

30 SEDIMENTATION

30-A -01 DISTRIBUTION & DELIVERY TANK
30-P -01 EQUALIZED EFFLUENT PUMPS
30-A -02 SETTLING TANKS
30-7 -01 SLUDGE SCRAPERS
30-A -03 SLUDGE PUMPING STATION
30-P -02 SLUDGE PUMPS

40 MEASUREMENT, EFFLUENT DISPOSAL

40-A -01 FLOW MEASUREMENT CHANNEL

50 SLUDGE STABILIZATION

50-A -01 LIME PREPARING & SLAKING TANK
50-M -01 LIME SLAKING MIXER
50-P -01 LIME MILK DOSING PUMP

21 EFFLUENT TREATMENT IN LAGOONS

21-L -01 SLUDGE DRYING LAGOONS
21-L -02 EFFLUENT TREATMENT LAGOONS
21-A -01 OVERFLOW IN THE LAST LAGOONS
21-A -02 SLUDGE SUPERNATANT PUMPING STATION
21-P -01 SLUDGE SUPERNATANT PUMP

70 WATER SUPPLY SYSTEM

70-[illegible] [illegible] WATER [illegible]
70-P [illegible] [illegible] PUMP

80 BUILDINGS

80-[illegible] ADMINISTRATION & CONTROL [illegible]
80-SS-01 GENERATOR STATION
80-[illegible] TRANSFORMER STATION

SECTION 1

SECTION 2

TEAM LEADER

UNITED NATIONS DEVELOPMENT ORGANIZATION

THE ISLAMIC REPUBLIC OF PAKISTAN

TEH PROJEKT
HIDRO RIJEKA

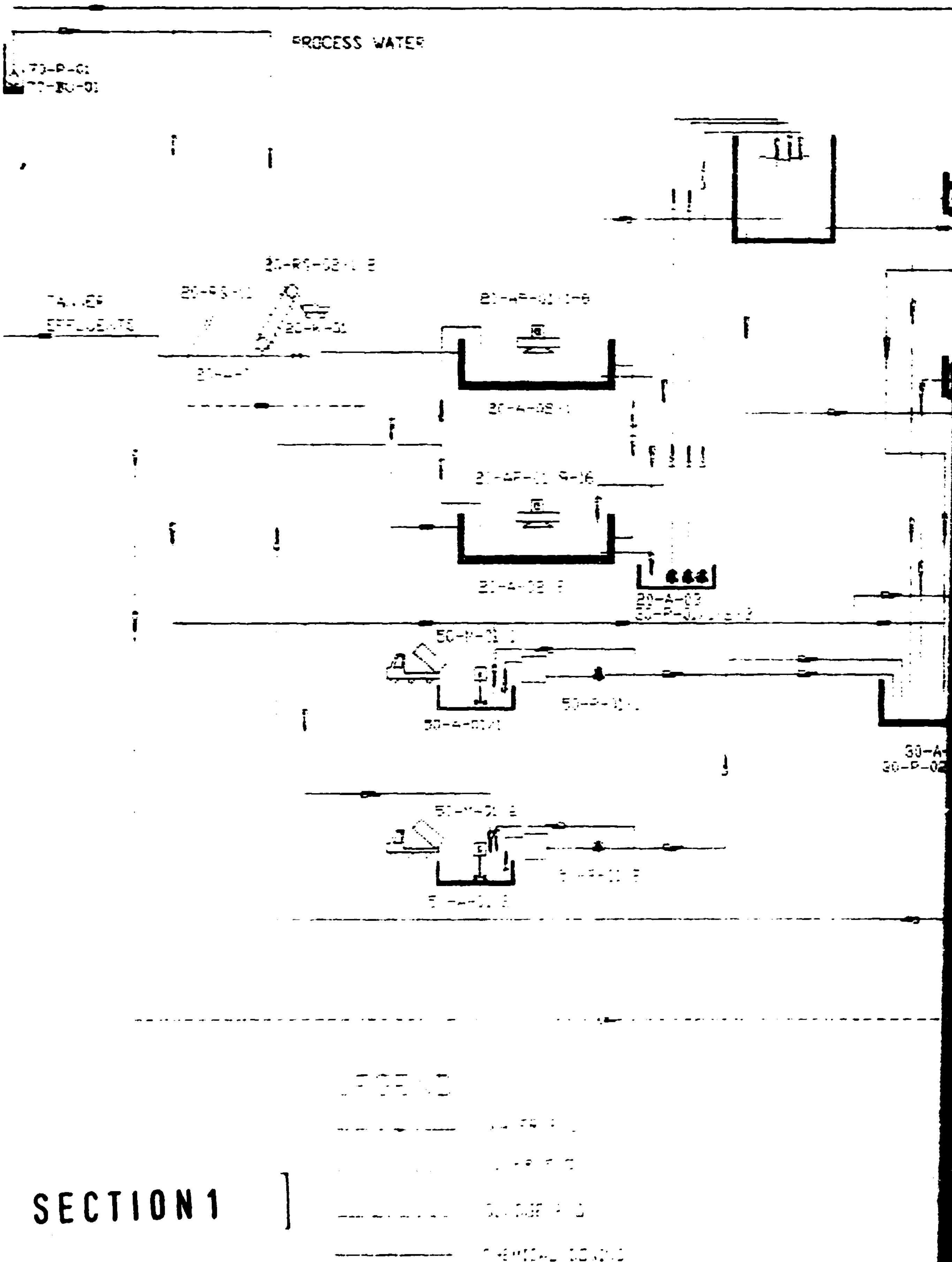
PROJECT NO | DATE

MAP NAME

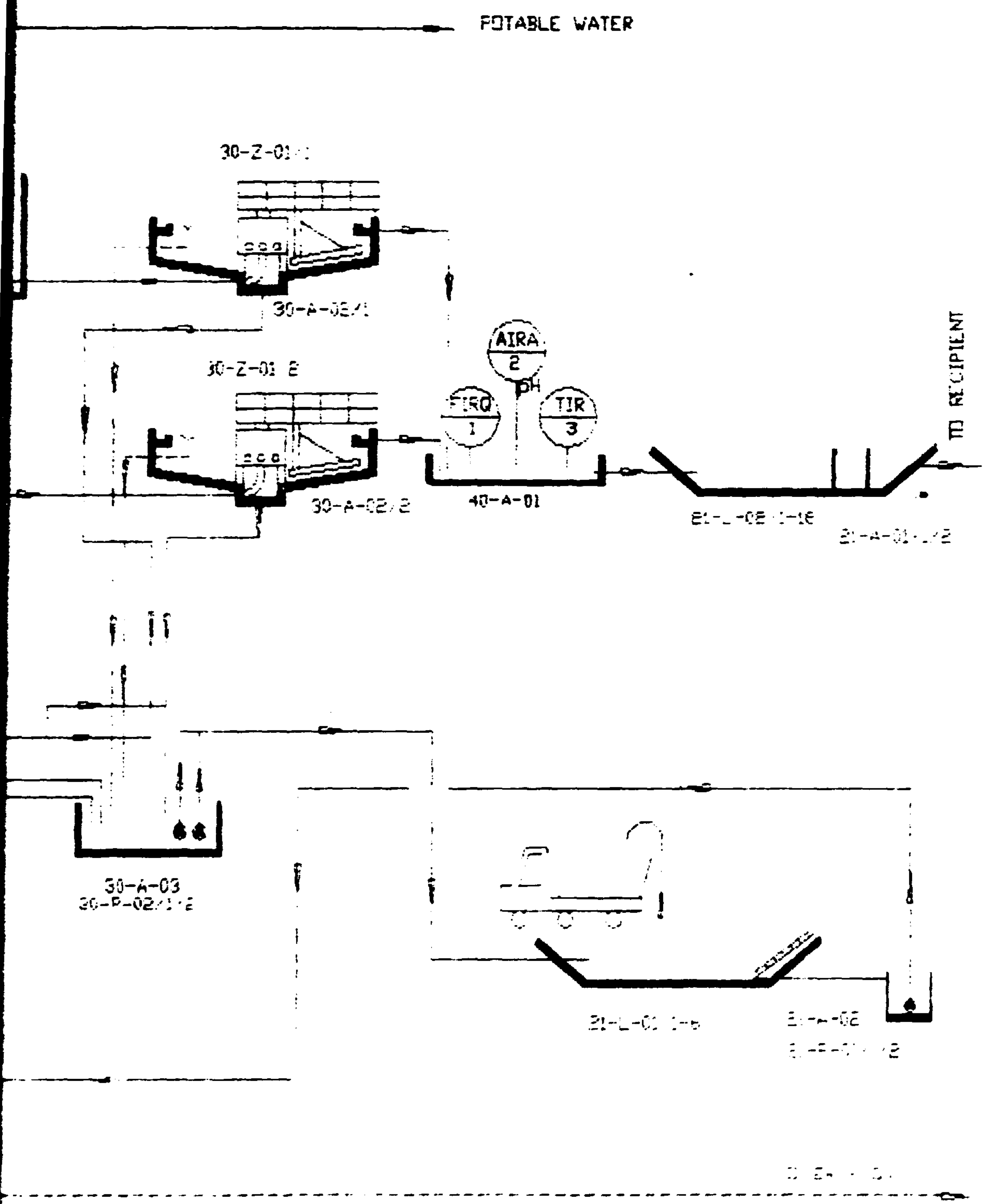
PROCESS DIAGRAM OF THE CETP WITH
PHISICAL EFFLUENT TREATMENT, EQUALIZATION,
SETTLING AND NATURALLY AERATED LAGOONS
(alternative 1a)

REVISION NO

1



SECTION 1



POTABLE WATER
30-Z-01/1
30-A-02/1
30-Z-01/2
30-A-02/2
AIRA
2
pH
FIRQ
1
TIR
3
40-A-01
TO RECIPIENT
30-A-03

SECTION 2

PROCESS DIAGRAM
of the C E P T P WITH PHYSICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS

20 PHYSICAL TREATMENT & EQUALIZATION

20-A -01 SUPPLY CHANNEL
20-RS-01 MANUALLY CLEANED SCREEN
20-RS-02 AUTOMATIC FINE SCREEN (WITH COMPACTOR.
20-K -01 SOLID WASTE CONTAINER
20-A -02 EQUALIZATION TANKS (CONCRETE TANKS)
20-AP-01 SURFACE AERATORS (IN EQUALIZATION TANKS)
20-A -03 EFFLUENT PUMPING STATION

30 SEDIMENTATION

30-A -01 DISTRIBUTION & DELIVERY TANK
30-P -01 EQUALIZED EFFLUENT PUMPS
30-A -02 SETTLING TANKS
30-Z -01 SLUDGE SCRAPERS
30-A -03 SLUDGE PUMPING STATION
30-P -02 SLUDGE PUMPS

40 MEASUREMENT, EFFLUENT DISPOSAL

40-A -01 FLOW MEASUREMENT CHANNEL

50 SLUDGE STABILIZATION

50-A -01 LIME PREPARING & SLAKING TANK
50-M -01 LIME SLAKING MIXER
50-P -01 LIME MILK DOSING PUMP

21 EFFLUENT TREATMENT IN LAGOONS

21-L -01 SLUDGE DRYING LAGOONS
21-L -02 EFFLUENT TREATMENT LAGOONS
21-A -01 OVERFLOW IN THE LAST LAGOONS
21-A -02 SLUDGE SUPERNATANT PUMPING STATION
21-P -01 SLUDGE SUPERNATANT PUMP

70 WATER SUPPLY SYSTEM

70-BU-01 PROCESS WATER WELL
70-P -01 WELL PUMP

80 BUILDINGS

80-UP 01 ADMINISTRATION & CONTROL BUILDING
80-GS 01 GENERATOR STATION
80-TS 01 TRANSFORMER STATION

SECTION 1

SECTION 2

TEAM LEADER

SRDJAN SELANEC

UNITED NATIONS DEVELOPMENT ORGANIZATION - VIENNA

PROJECT ENGINEER

MLADE BOSNIC

MIROSLAV REI

PREPARATORY ASSISTANCE IN THE TREATMENT OF TANNER WASTES IN K A S U R

-THE ISLAMIC REPUBLIC OF PAKISTAN-

TEH PROJEKT HIDRO RIJEKA

DRAFTSMAN

SLAVKO SEGON

DIRECTOR:

ZELJKO DRNJEVIC

PROJECT NO	ACTIVITY CODE	NIDO CONT. NO	DATE
DP PAK 89/025	13104	91/106	[illegible] 1993

PROJECT PHASE

[illegible]

SCALE

-

MAP NO

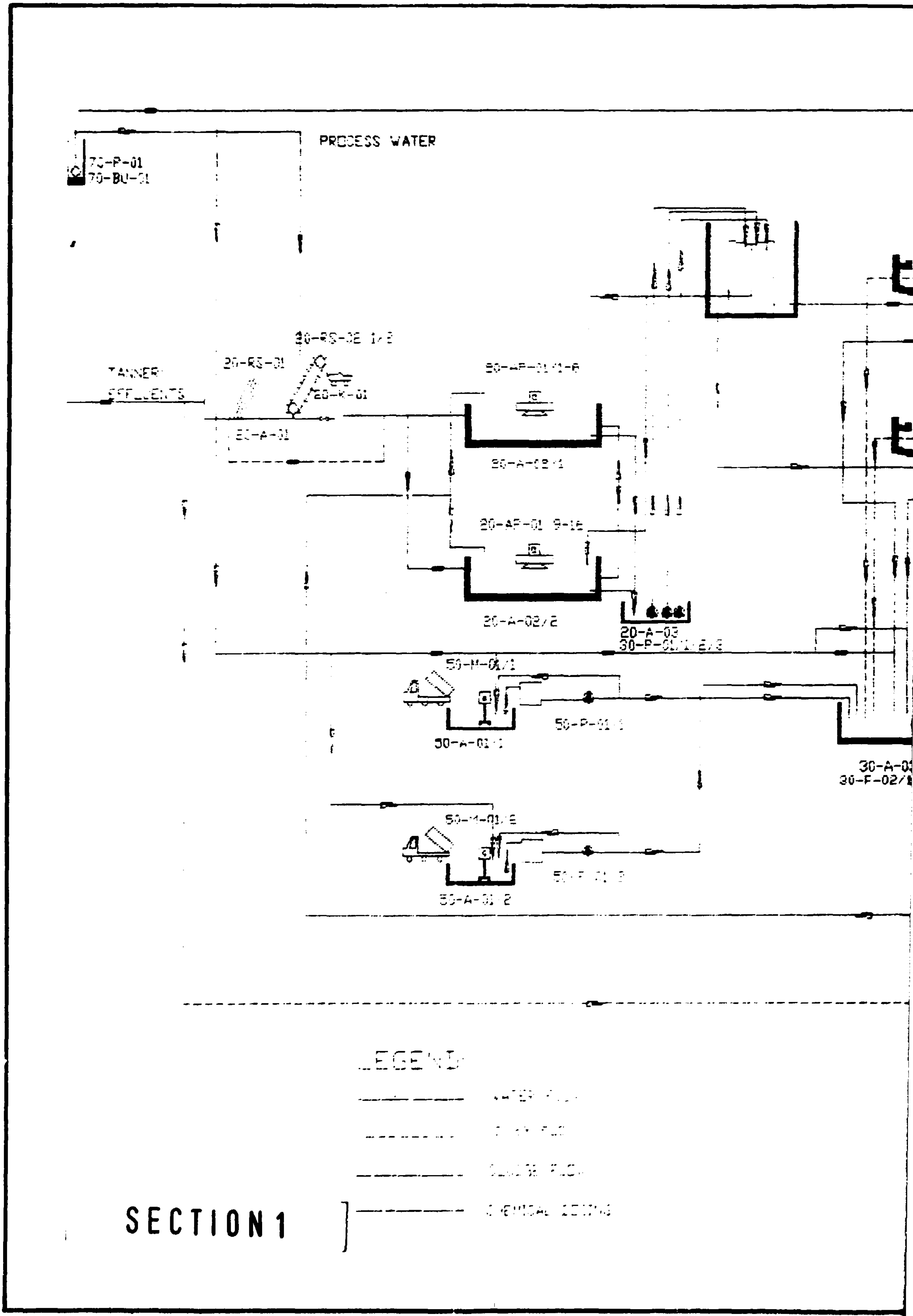
17/2

MAP NAME

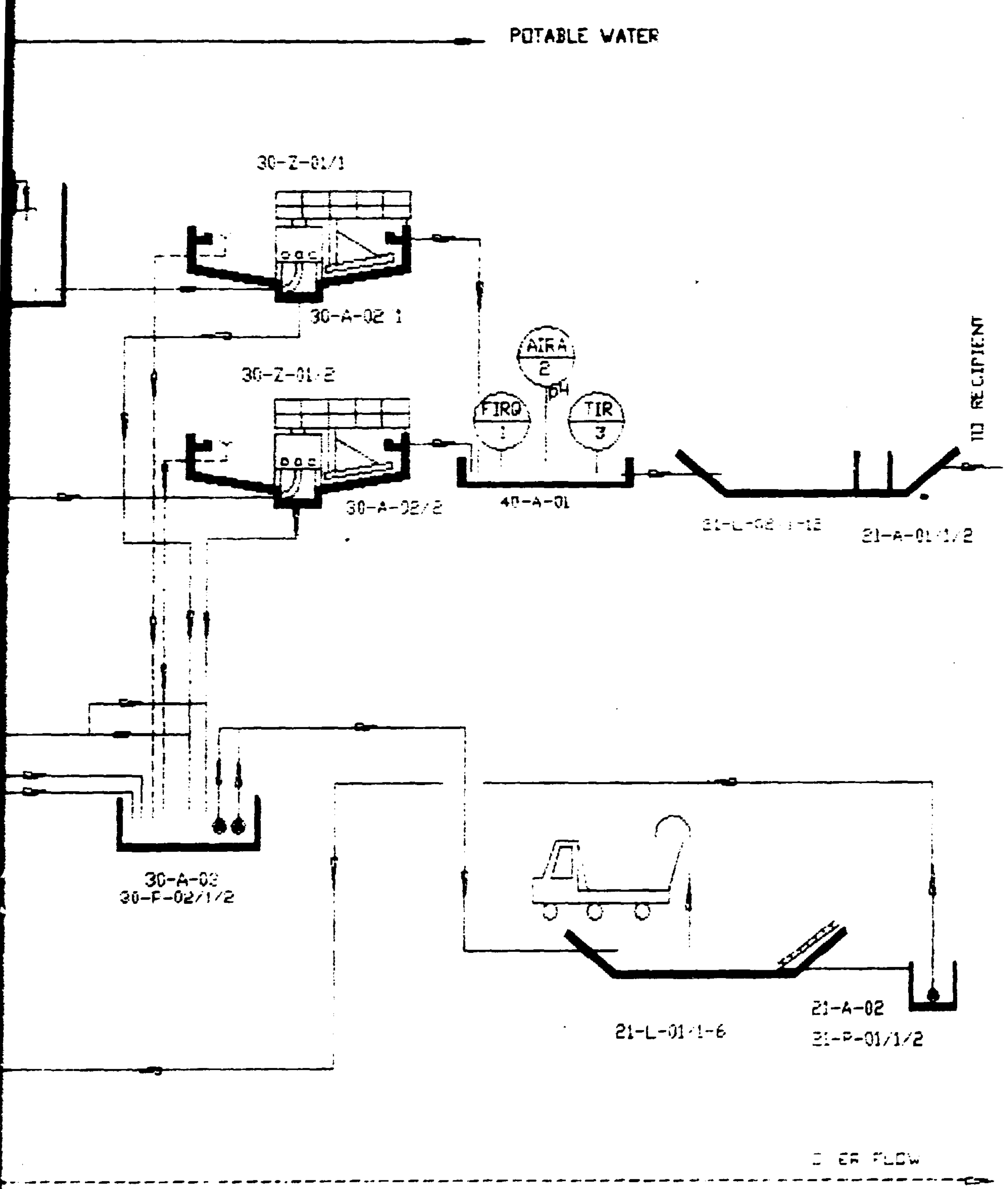
PROCESS DIAGRAM OF THE CEPTP WITH PHISICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS (alternative 1b)

REVISION NO

1



PROCESS WATER
70-P-01
TANNERY EFFLUENTS
20-RS-01
20-A-01
20-A-02/1
20-AP-01 9-16
20-A-02/2
20-A-03
50-M-01/1
50-A-01/1
50-M-01/2
50-A-01/2
30-A-0
30-F-02/
LEGEND
SECTION 1



POTABLE WATER
30-Z-01/1
30-A-02/1
30-Z-01/2
30-A-02/2
AIRA
2
pH
FIRQ
1
TIR
3
40-A-01
TO RECIPIENT
21-A-01/1/2
30-A-03
30-F-02/1/2
21-L-01/1-6
21-A-02
21-P-01/1/2

SECTION 2

PROCESS DIAGRAM
of the C E P T P WITH PHYSICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS

20 PHYSICAL TREATMENT & EQUALIZATION

20-A- 01 SUPPLY CHANNEL
20-RS-01 MANUALLY CLEANED SCREEN
20-RS-02 AUTOMATIC FINE SCREEN (WITH COMPACTOR)
20-K -01 SOLID WASTE CONTAINER
20-A -02 EQUALIZATION TANKS (CONCRETE TANKS)
20-AP-01 SURFACE AERATORS (IN EQUALIZATION TANKS)
20-A -03 EFFLUENT PUMPING STATION

30 SEDIMENTATION

30-A -01 DISTRIBUTION & DELIVERY TANK
30-P -01 EQUALIZED EFFLUENT PUMPS
30-A -02 SETTLING TANKS
30-Z -01 SLUDGE SCRAPERS
30-A -03 SLUDGE PUMPING STATION
30-P -02 SLUDGE PUMPS

40 MEASUREMENT, EFFLUENT DISPOSAL

40-A -01 FLOW MEASUREMENT CHANNEL

50 SLUDGE STABILIZATION

50-A -01 LIME PREPARING & SLAKING TANK
50-M -01 LIME SLAKING MIXER
50-P -01 LIME MILK DOSING PUMP

21 EFFLUENT TREATMENT IN LAGOONS

21-L -01 SOLID WASTE DISPOSAL
21-L -02 EFFLUENT TREATMENT LAGOONS
21-A -01 OVERFLOW IN THE LAST LAGOONS
21-A -02 SLUDGE SUPERNATANT PUMPING STATION
21-P -01 SLUDGE SUPERNATANT PUMP

70 WATER SUPPLY SYSTEM

70-BU-01 PROCESS WATER WELL
70-P -01 WELL PUMP

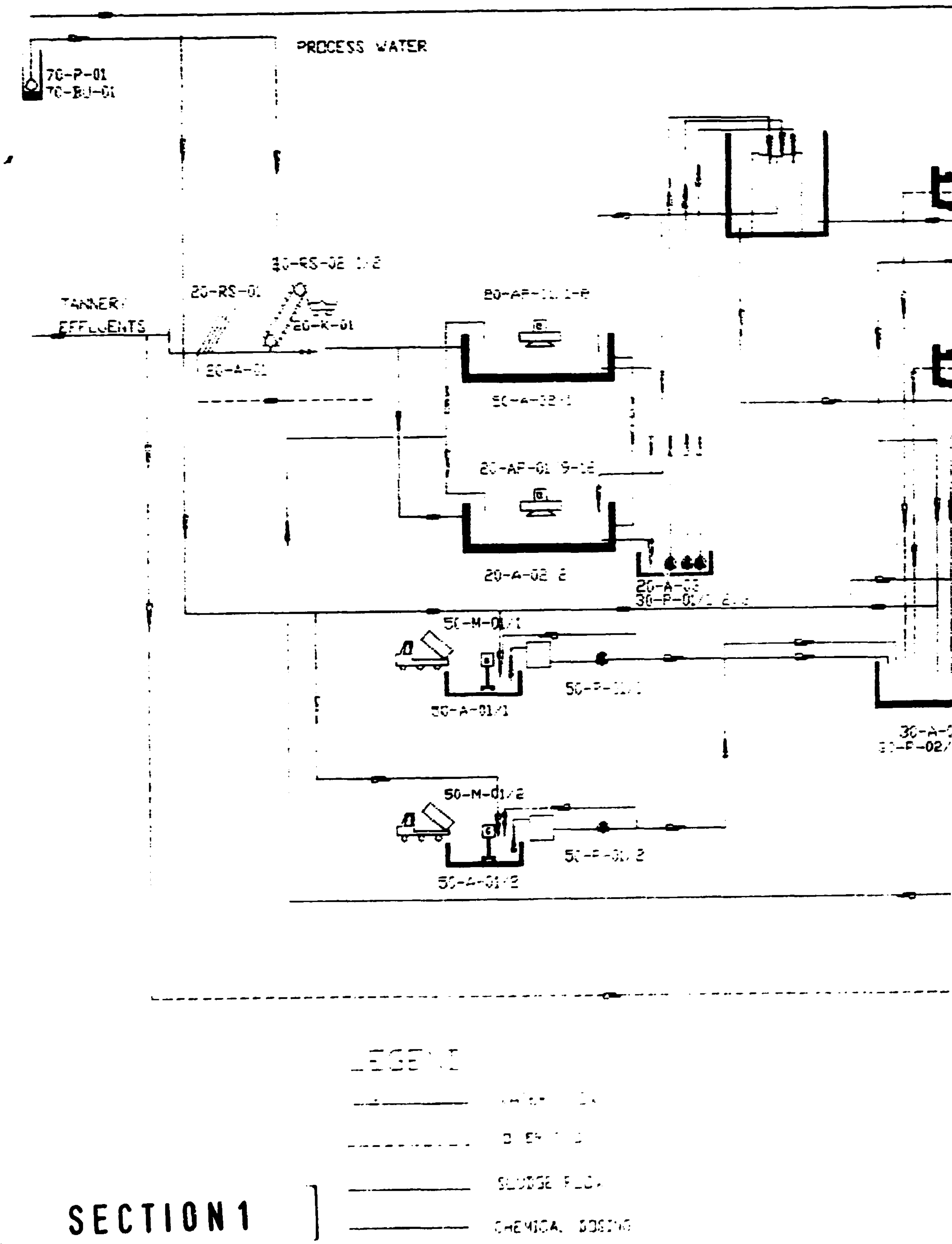
80 BUILDINGS

80-UP-01 ADMINISTRATION & CONTROL BUILDING
80-GS-01 GENERATOR STATION
80-TS-01 TRANSFORMER STATION

SECTION 1

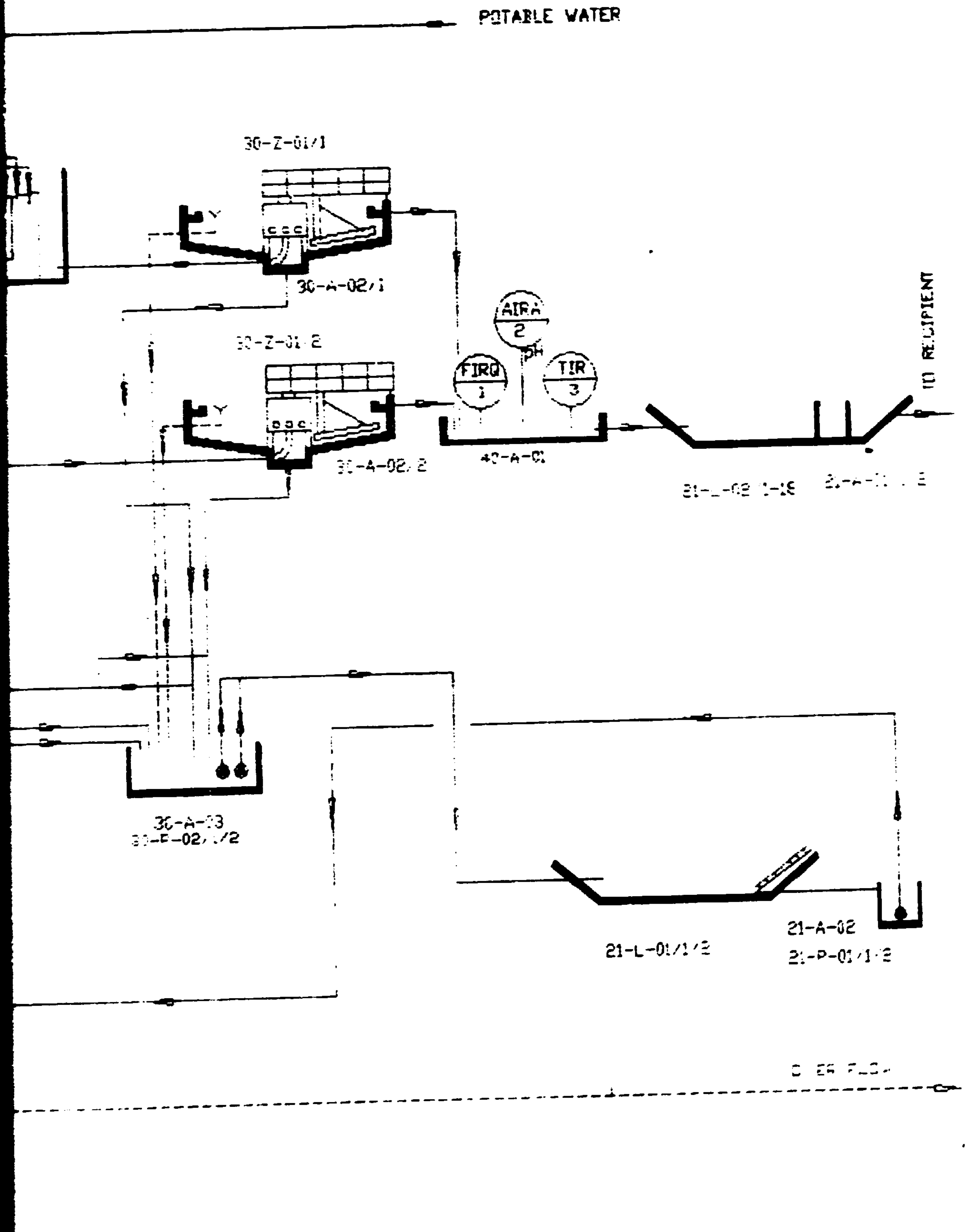
SECTION 2

TEAM LEADER: SRDJAN SELANEC	UNITED NATIONS DEVELOPMENT ORGANIZATION - VIENNA
PROJECT ENGINEER: MLADEN BOSNIC, MIROSLAV REK	PREPARATORY ASSISTANCE IN THE TREATMENT OF TANNERY WASTES IN KASUR -THE ISLAMIC REPUBLIC OF PAKISTAN-
DRAFTSMAN: SLAVKO SEGON	TEH PROJEKT HIDRO RIJEKA
DIRECTOR: ZELJKO DRNJEVIC	PROJECT NO: DP/PAK/89/025; ACTIVITY CODE: 13104; UNIDO CONTR. NO: 91/106; DATE: May 1993
PROJECT PHASE: TECH-ECONOMIC STUDY	SCALE: ; MAP NO: 17 3
MAP NAME: PROCESS DIAGRAM OF THE CEPTP WITH PHISICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS (alternative 2a)	REVISION NO: 1



PROCESS WATER
70-P-01
TANNERY
EFFLUENTS
20-RS-01
20-K-01
20-A-01
20-AF-01 9-16
20-A-02 2
50-M-01/1
50-A-01/1
50-M-01/2
50-A-01/2
LEGEND
SLUDGE FLOW
CHEMICAL DOSING

SECTION 1


POTABLE WATER
30-Z-01/1
30-A-02/1
30-Z-01/2
30-A-02/2
AIRA 2
pH
FIRQ 1
TIR 3
TO RECIPIENT
21-A-02
21-L-01/1/2
21-P-01/1/2
30-A-03

SECTION 2

PROCESS DIAGRAM
of the C E P T P WITH PHYSICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS

20 PHYSICAL TREATMENT & EQUALIZATION

20-A -01 SUPPLY CHANNEL
20-RS-01 MANUALLY CLEANED SCREEN
20-RS-02 AUTOMATIC FINE SCREEN (WITH COMPACTOR)
20-K -01 SOLID WASTE CONTAINER
20-A -02 EQUALIZATION TANKS (CONCRETE TANKS)
20-AP-01 SURFACE AERATORS (IN EQUALIZATION TANKS)
20-A -03 EFFLUENT PUMPING STATION

30 SEDIMENTATION

30-A -01 DISTRIBUTION & DELIVERY TANK
30-P -01 EQUALIZED EFFLUENT PUMPS
30-A -02 SETTLING TANKS
30-Z -01 SLUDGE SCRAPERS
30-A -03 SLUDGE PUMPING STATION
30-P -02 SLUDGE PUMPS

40 MEASUREMENT, EFFLUENT DISPOSAL

40-A -01 FLOW MEASUREMENT CHANNEL

50 SLUDGE STABILIZATION

50-A -01 LIME PREPARING & SLAKING TANK
50-M -01 LIME SLAKING MIXER
50-P -01 LIME MILK DOSING PUMP

21 EFFLUENT TREATMENT IN LAGOONS

21-L -01 SOLID WASTE DISPOSAL
21-L -02 EFFLUENT TREATMENT LAGOONS
21-A -01 OVERFLOW IN THE LAST LAGOONS
21-A -02 SLUDGE SUPERNATANT PUMPING STATION
21-P -01 SLUDGE SUPERNATANT PUMP

70 WATER SUPPLY SYSTEM

70-BU-01 PROCESS WATER WELL
70-P -01 WELL PUMP

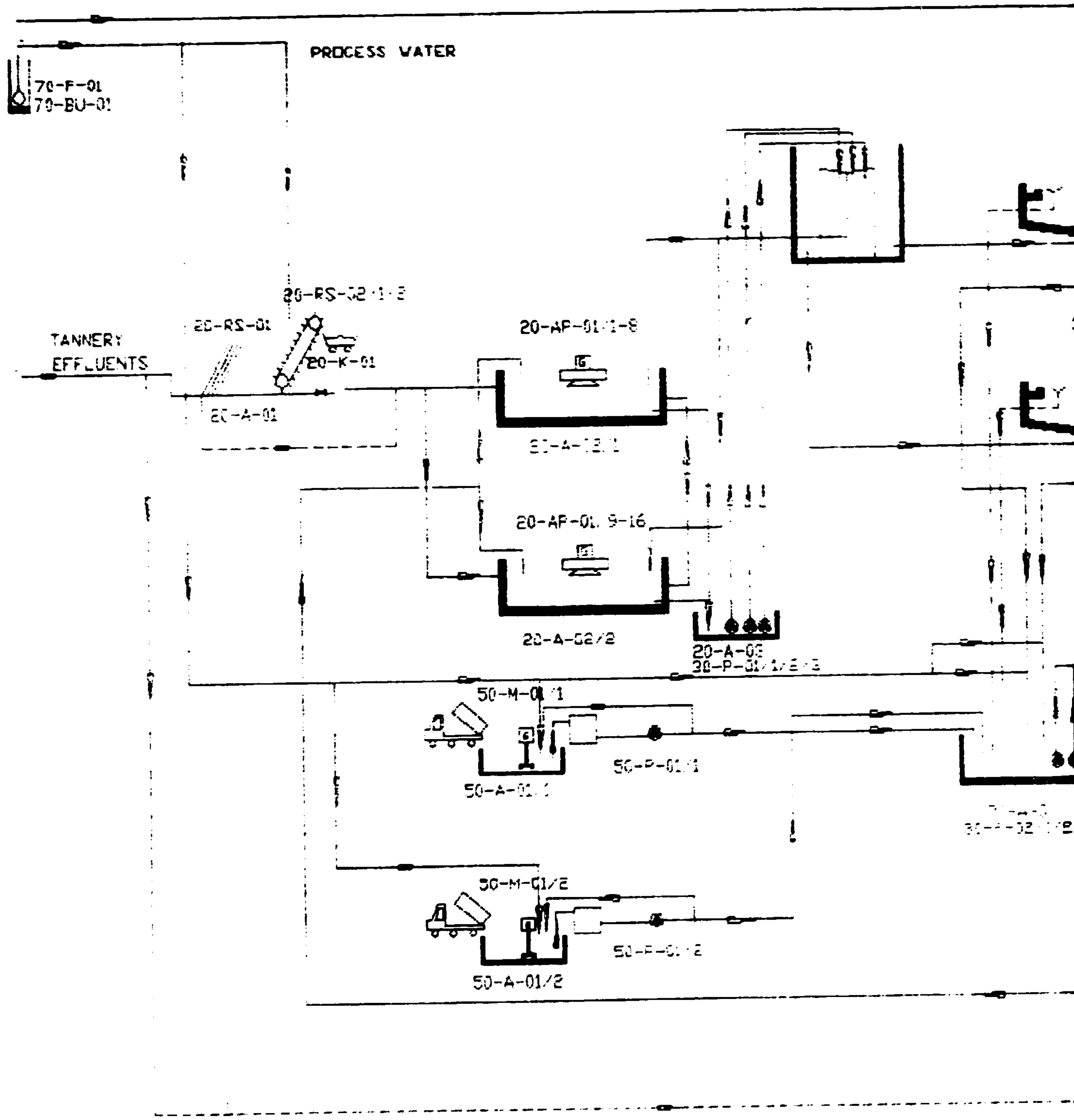
80 BUILDINGS

80-UP-01 ADMINISTRATION & CONTROL BUILDING
80-GS-01 GENERATOR STATION
80-TS-01 TRANSFORMER STATION

SECTION 1

SECTION 2

TEAM LEADER SRDJAN SELANEC	UNIDO UNITED NATIONS DEVELOPMENT ORGANIZATION - VIENNA	TEH PROJEKT HIDRO RIJEKA
PROJECT ENGINEER MLADEN BOSNJ... MIROSLAV REK	PREPARATORY ASSISTANCE IN THE TREATMENT OF TANNERY WASTES IN K A S U R -THE ISLAMIC REPUBLIC OF PAKISTAN-	
DRAFTSMAN SL...KO SEG...	PROJECT NO. DP/PAK/89/025 · ACTIVITY CODE 13104 · UNIDO CONT. NO. 91/106	DATE M... 1992
DIRECTOR ZE...KO DRN...I...		
PROJECT PHASE TECHNO-ECONOMIC STUDY		SCALE - MAPE NO 17.4
MAP NAME PROCESS DIAGRAM OF THE CEFTP WITH PHISICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS (alternative 2b)		REVISION NO 1



LEGEND

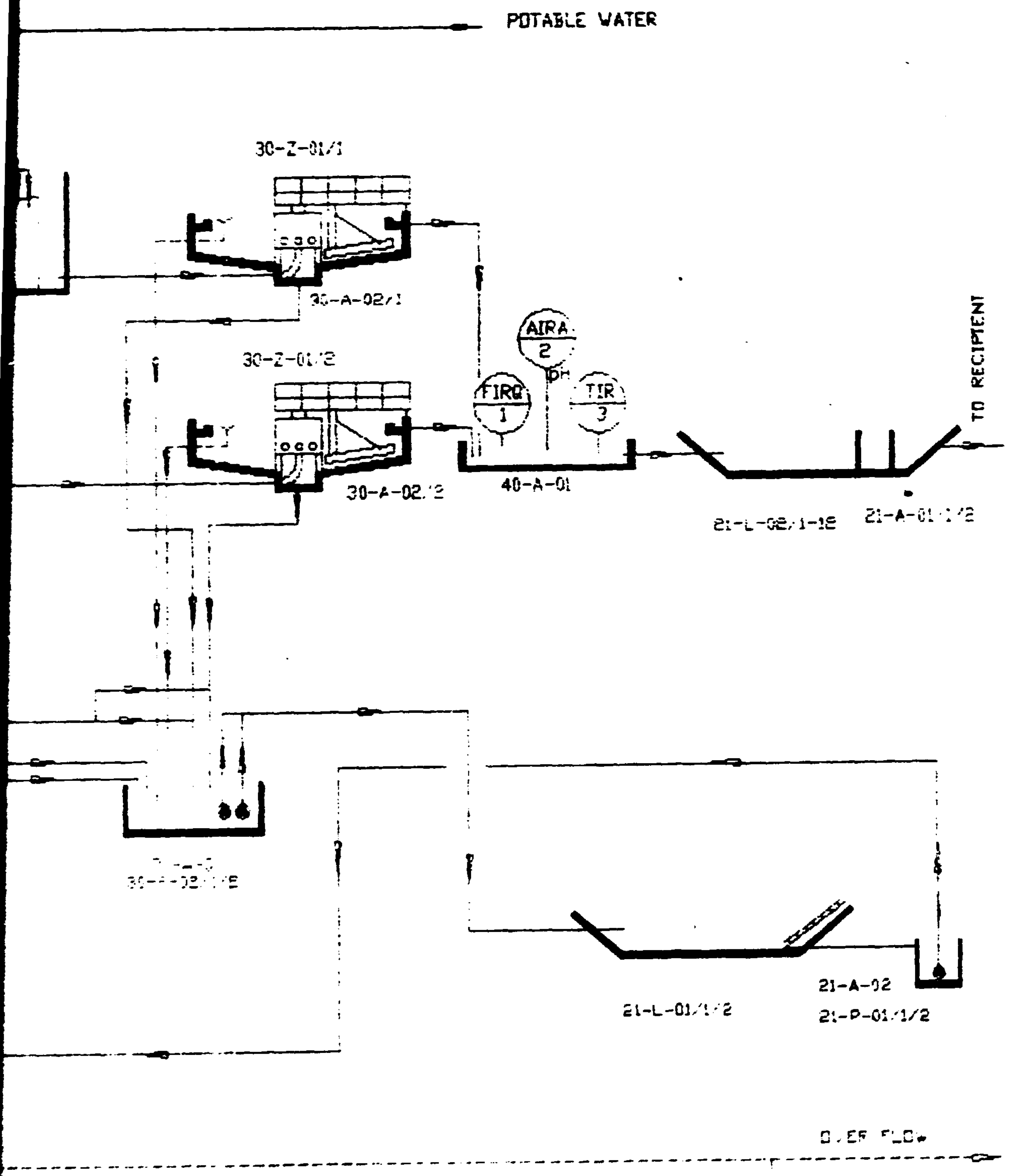
WATER FLOW

OVER FLOW

SLUDGE FLOW

CHEMICAL DOSING

SECTION 1



POTABLE WATER
30-Z-01/1
30-A-02/1
30-Z-01/2
30-A-02/2
AIRA 2
pH
FIRQ 1
TIR 3
40-A-01
TO RECIPIENT
21-L-02/1-12
21-A-01/1/2
30-A-02/1/2
21-L-01/1/2
21-A-02
21-P-01/1/2

SECTION 2

PROCESS DIAGRAM
of the C E P T P WITH PHYSICAL EFFLUENT TREATMENT, EQUALIZATION, SETTLING AND NATURALLY AERATED LAGOONS

20 PHYSICAL TREATMENT & EQUALIZATION

20-A -01 SUPPLY CHANNEL
20-RS-01 MANUALLY CLEANED SCREEN
20-RS-02 AUTOMATIC FINE SCREEN (WITH COMPACTOR)
20-K -01 SOLID WASTE CONTAINER
20-A -02 EQUALIZATION TANKS (CONCRETE TANKS)
20-AP-01 SURFACE AERATORS (IN EQUALIZATION TANKS)
20-A -03 EFFLUENT PUMPING STATION

30 SEDIMENTATION

30-A -01 DISTRIBUTION & DELIVERY TANK
30-P -01 EQUALIZED EFFLUENT PUMPS
30-A -02 SETTLING TANKS
30-Z -01 SLUDGE SCRAPERS
30-A -03 SLUDGE PUMPING STATION
30-P -02 SLUDGE PUMPS

40 MEASUREMENT, EFFLUENT DISPOSAL

40-A -01 FLOW MEASUREMENT CHANNEL

50 SLUDGE STABILIZATION

50-A -01 LIME PREPARING & SLAKING TANK
50-M -01 LIME SLAKING MIXER
50-P -01 LIME MILK DOSING PUMP

21 EFFLUENT TREATMENT IN LAGOONS

21-L -01 SOLID WASTE DISPOSAL
21-L -02 EFFLUENT TREATMENT LAGOONS
21-A -01 OVERFLOW IN THE LAST LAGOONS
21-A -02 SLUDGE SUPERNATANT PUMPING STATION
21-P -01 SLUDGE SUPERNATANT PUMP

70 WATER SUPPLY SYSTEM

70-BU-01 PROCESS WATER WELL
70-P -01 WELL PUMP

80 BUILDINGS

80-UP-01 ADMINISTRATION & CONTROL BUILDING
80-GS-01 GENERATOR STATION
80-TS-01 TRANSFORMER STATION

SECTION 1

SECTION 2

TEAM LEADER:
SRDJAN SELANEC

UNIDO UNITED NATIONS DEVELOPMENT
ORGANIZATION - VIENNA

PROJECT ENGINEER
MLADEN BOSNIC
NINOSLAV REY

PREPARATORY ASSISTANCE IN
THE TREATMENT OF TANNERY
WASTES IN K A S U R
-THE ISLAMIC REPUBLIC OF PAKISTAN-

TEH PROJEKT
HIDRO RIJEKA

DRAFTSMAN:
SLAVKO SEGO

DIRECTOR:
ZELJKO DRNJE

PROJECT NO	ACTIVITY CODE	UNIDO CONT. NO	DATE
IP/PAK/89/025	13104	91/106	MAY 1991

PROJECT PHASE
TECHNO-ECONOMIC STUDY

SCALE
1:2000

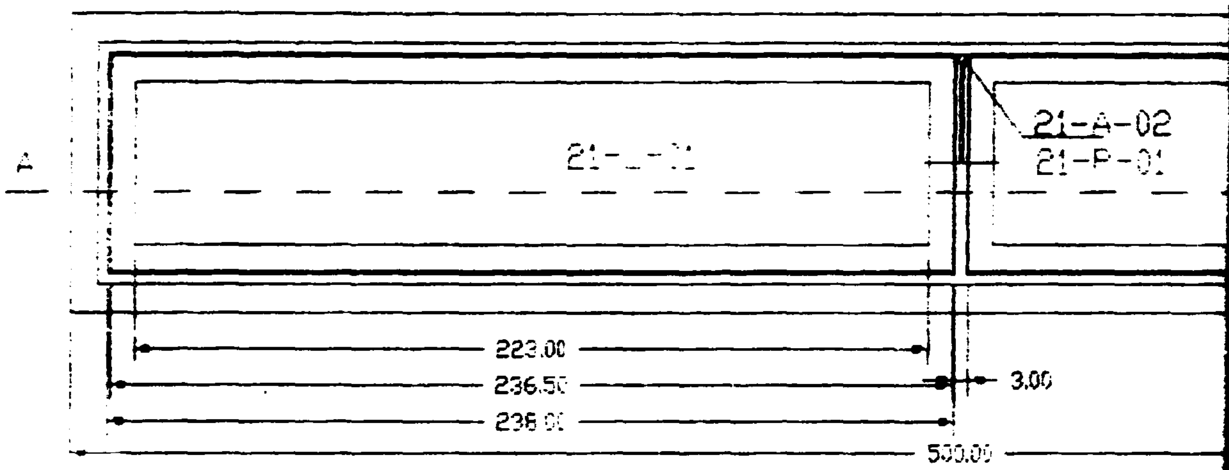
MAP NO.
5

MAP NAME.
SOLID WASTE DISPOSAL
- LAGOONS -

REVISION NO.
1

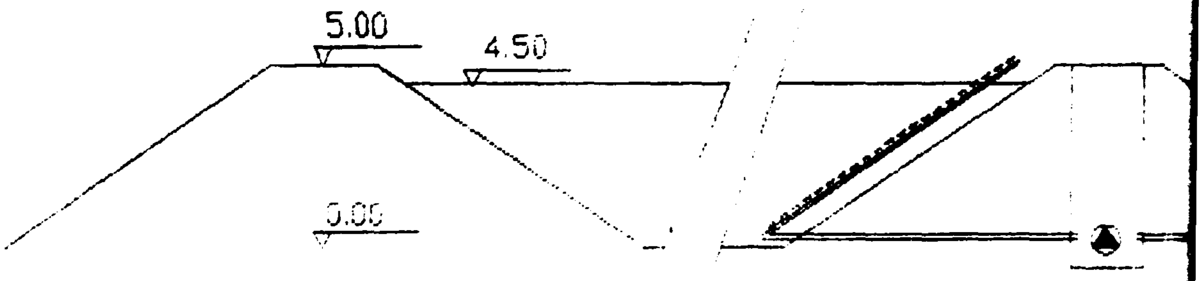
SOLID WASTE DISPOSAL (LAY-

Scale 1:2000



SOLID WASTE DISPOSAL (SEC

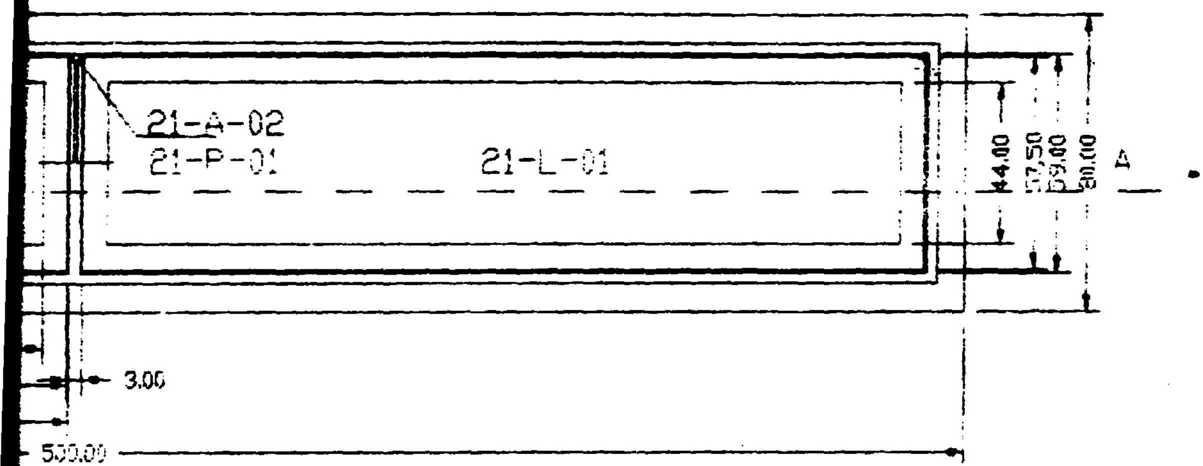
Scale 1:200



SECTION 1

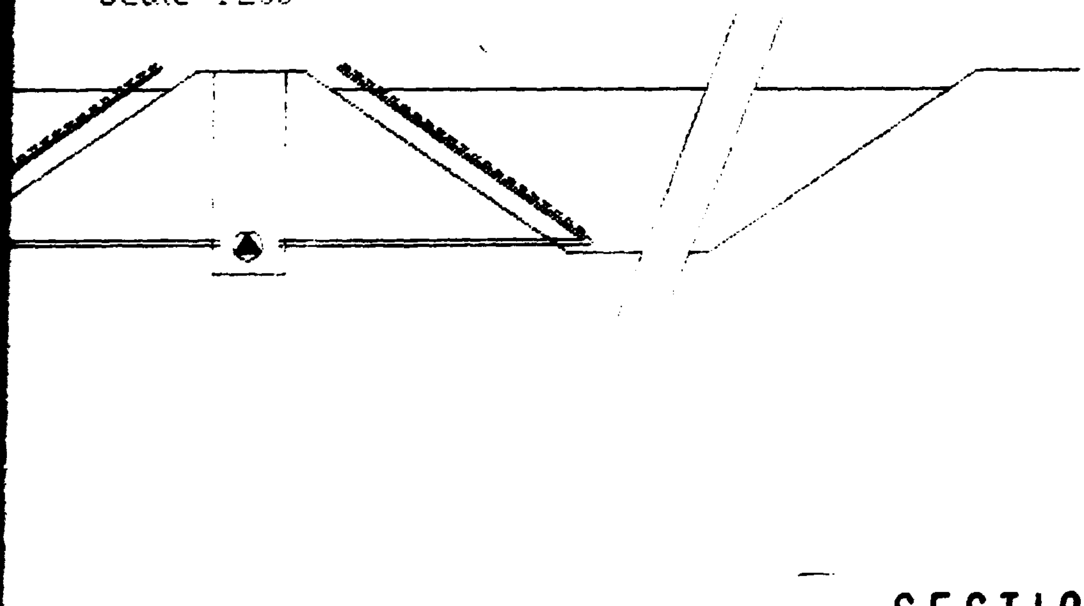
I DISPOSAL (LAY-OUT)

2000



TE DISPOSAL (SECTION A - A)

Scale 1:200



SECTION 2