UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

REGIONAL PROGRAMME FOR POLLUTION CONTROL IN THE TANNING INDUSTRY IN SOUTH EAST ASIA

US/RAS/92/120-MODEL CETPs

September 2001

COMMON EFFLUENT TREATMENT PLANT RANITEC, RANIPET, INDIA

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TABLE OF CONTENTS

Annexures

LIST OF SYMBOLS & ABBREVIATIONS

BOD_5	:	Biochemical oxygen demand, 5 days
BoD	:	Board of directors
CETP	:	Common effluent treatment plant
COD	:	Chemical oxygen demand
CO_2	:	Carbon dioxide
cm	:	Centimetre
^0C	:	Degree celsius
DS	:	Dry solids
d	:	Day
dia / ϕ	:	Diameter
FB	:	Free board
F/M	:	Food to micro organism ratio
FRP	:	Fibre reinforced plastic
h	:	hour(s)
HRT	:	Hydraulic retention time
HDPE	:	High density poly ethylene
INR	:	Indian Rupees
kg	:	Kilogram(s)
kW	:	Kilowatt(s)
l	:	Litre(s)
m^3	:	Cubic meter (1000 litres)
mg/l	:	Milligrams per litre
min.	:	Minutes
MLSS	:	Mixed Liquor Suspended Solids
MLVSS	:	Mixed Liquor Volatile Suspended Solids
ND	:	Not detected
no.	:	Number
RCC	:	Reinforced cement concrete
RPM	:	Revolutions per minute
pH	:	Negative logarithm of hydrogen ion concentration
SWD	:	Side water depth
SDB	:	Sludge drying bed
US $	:	US Dollar(s)
TDS	:	Total dissolved solids
TNPCB	:	Tamil Nadu Pollution Control Board
t	:	Tonne(l000 kg)
W	:	Watt(s)

(Rate of exchange: 1 US $ = INR 46.80)

1. INTRODUCTION

Ranipet is an industrial town in the state of Tamil Nadu. It is one of the important leather tanning centres of India. There are about 280 tanneries operating in and around this town. To treat the effluent from these tanneries six common effluent treatment plants were planned in the area. Three of these have been completed and are operational. Of these, the CETP managed by Talco Ranipet Tanners Enviro Controls Limited, CETP-Ranitec in short, is located in Ranipet, 110 km from Chennai (Madras), on the Ranipet by-pass road on the Chennai-Bangalore national highway.

The CETP is managed by CETP-Ranitec, a company formed by 76 tanners who are its members. This company is registered under the Indian Companies Act and managed by a BoD drawn from its members.

2. GENERAL INFORMATION

Total number of tanneries	76
Number of tanneries operating now	76
Date of commissioning	5 June 1995
Total processing capacity of the tanneries	125,000 kg/day
Current production from the cluster	78,000 kg/day
Raw material processed	Buffalo & cow hides & calf skins
Number of tanneries processing raw to El/finished leather	61
Number of tanneries processing wet blue/EI to finished leather	11
Number of tanneries doing chrome tanning	10
Number of tanneries doing vegetable tanning	62
Number of tanneries doing dry operations	4
Designed flow rate to the CETP	4,000 m^3/ d
Current flow rate to the CETP	2,480 m^3/d

3. FEATURES OF THE CETP

This CETP is the third to be commissioned for treatment of tannery effluent in Tamil Nadu, India. Due to interventions by UNIDO under projects US/IND/90/244 and US/RAS/92/120, the CETP has registered many innovative features such as:

- Pre-settling of raw effluent for removal of coarse solids
- Degassification of anaerobically treated effluent
- Mechanically cleaned screen for removal of solids
- Decanter centrifuge for sludge dewatering

4. PROJECT PLANNIING & EXECUTION

4 1. Design

The basic design of the project was done by Enkem Engineers, Chennai later modified by the UNIDO subcontractor M/s. TEH PROJEKT, Croatia.

4.2. Finance

The total investment in the Common Effluent Treatment Plant, as of date, is INR 60 million, of which INR 12.5 million each were received from the central and the state governments as grant and INR 10 million contributed as equity by the tanners. The balance of INR 25 million was raised as loan from the Industrial Development Bank of India (IDBI) on soft terms. CETP-Ranitec received assistance from UNIDO in the form of selected equipment like mechanical screen, decanter centrifuge, floating aerators for degassifier etc., valued at INR 5 million (not included in the figure of INR 60 million) besides continued technical assistance from national and international experts.

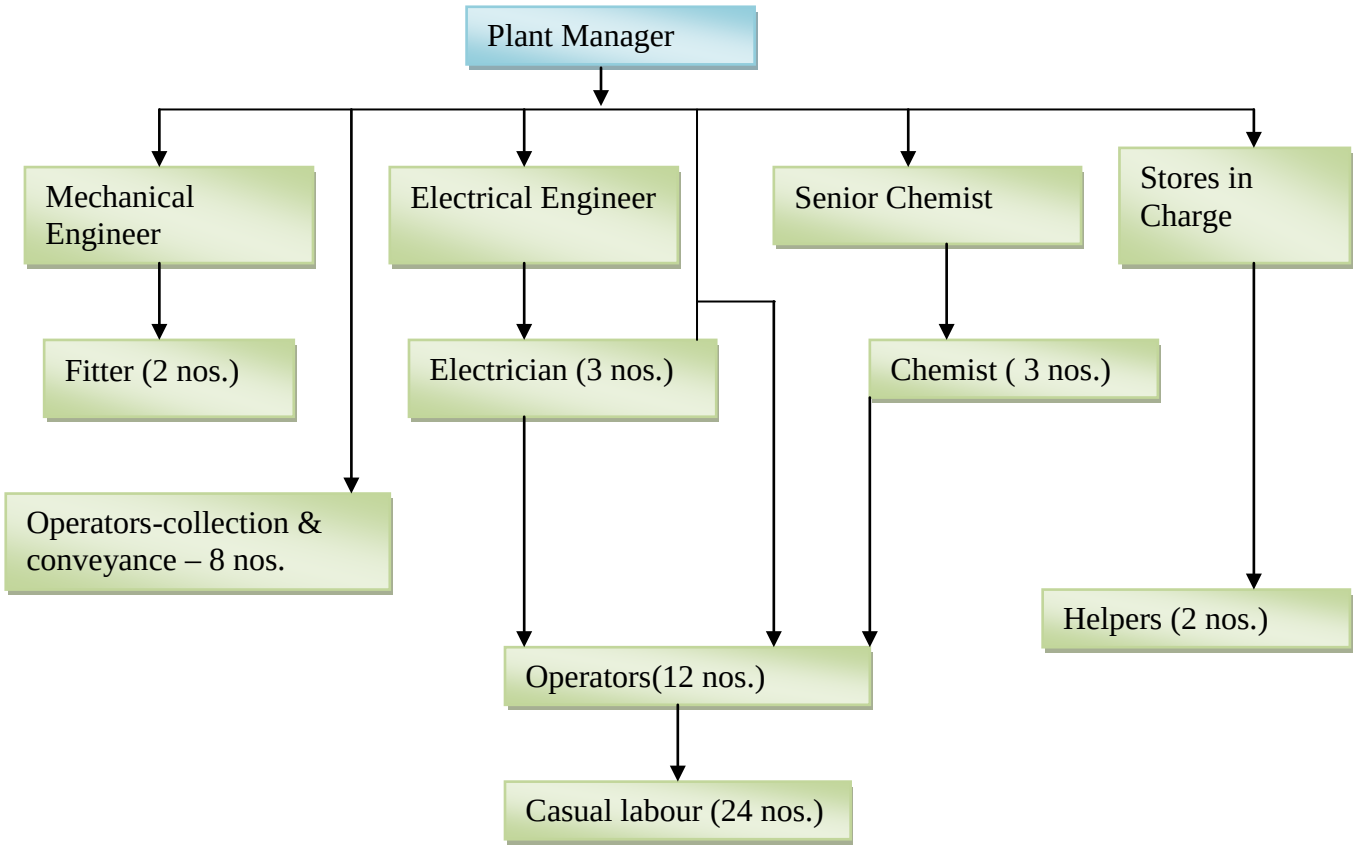
4.3. Implementation

The company formed by the tanneries jointly with Tamil Nadu Leather Corporation Limited (TALCO) by name TALCO RANIPET ENVIRO CONTROL SYSTEMS LTD (Ranitec) implemented the project.

M/s. Enkem Engineers, Chennai undertook the construction of the CETP on turnkey basis.

4.4. Management

The overall management of the CETP is carried out by the BoD and the day-to-day administration by a Plant Manager. The organigram of the CETP as at present is as follows:



The current Plant Manager, Mr. Sajid Hussain, is a qualified environmental scientist with considerable practical experience. He has been at the helm of affairs since 1998.

4.5. Recovery of operational cost

The cost of operation and maintenance of the plant, repayment of loan with interest and other expenditures relating to the plant are covered by monthly contributions made by the tanner members according to their respective production capacity The rate of recovery per kg of raw material processed is fixed at INR 29. The average monthly contribution by the tanners amounts to INR 1,750,000. Besides, for special purposes and emergencies, adhoc collections are made from the tanner members based on the resolutions of the BoD from time to time.

5. PRE-TREATMENT IN TANNERIES

5.1. Chrome segregation.

Five tanneries are utilising a common chrome recovery unit, capacity of 9 m^3/d, installed in PRC Leathers based on the design of Central Leather Research Institute (CLRI), Chennai.

Two tanneries have their own chrome recovery units. Other tanneries are mainly small units doing chrome tanning only occasionally. These small units segregate the chrome liquor, collect it in a tank and precipitate the chrome by adding magnesium oxide solution. A private company, Chemways, Vellore, takes the precipitated chrome sludge. This company regenerates chrome by adding sulphuric acid and sells the recovered chromium, after mixing the fresh basic chromium sulphate with it as required, to the small tanners in Ranipet on a commercial basis.

Fig. 1: A view of the chrome recovery unit in the CETP

5.2. Pre-treatment of effluent other than chrome liquor

The pre-treatment system provided in individual tanneries connected to CETP-Ranitec comprises the following:

1. Segregation of saline effluent streams i.e. soak & pickle liquor and evaporation in solar evaporation pans within the premises of each tannery. The solar pans have been designed on the basis of average rate of evaporation of 4.5 mm per day.

2. Screening & pre-settling of other combined effluent in a pre-treatment unit and removal & disposal of screenings and grit.

The area specified for the solar evaporation pans as well as the size of pre-treatment units depend on the production capacity of the tannery.

Typical design of a pre-treatment system is given in Annex 2, Dwg. 1.

5.3. Collection & conveyance system

The CETP has two collection wells the effluent from which finally joins a gravity line. Effluent from some tanneries reaches the CETP through a gravity line.

Effluent from 22 tanneries mostly located on both sides of Amoor road after pre-treatment is discharged into manholes in the collection & conveyance network which is collected in one of the pumping stations (PS-1) and then pumped to the second pumping station (PS-2). Effluent from 38 tanneries, mostly located on the north of national highway, NH. 4, after pre-treatment is discharged into manholes leading to a pumping station. Effluent from all these units is pumped from PS-2 to a catch pit from where it flows to the CETP through a gravity line. Effluent from 16 tanneries located in the south of national highway N.H. 4 is discharged into manholes in the gravity collection & conveyance line which is directly connected to the gravity line leading to the CETP receiving sump.

The layout of collection & conveyance system is given in Annex 2, Dwg.3.

6. TREATMENT PROCESS

The effluent collected in the receiving sump is pumped to a pre-settler for setting of coarse solids in the effluent. This prevents frequent breakdown of floating aerators in the equalisation tank.

The pre-settlers have been found to remove approximately 40% of the suspended solids in raw effluent and the sludge removed from the pre-settlers has been found to dry faster compared to the sludge from the primary clarifier.

The overflow of the pre-settlers passes through a mechanically cleaned screen (model Konica, Italprogetti make). The mechanical screen removes particles upto 3 mm size present in the raw effluent.

The effluent from the mechanical screen flows into an equalisation tank provided with 3 floating aerators for homogenisation of effluent and oxidation of sulphides.

The equalised effluent is then pumped to the flash mixer where alum, lime and polyelectrolyte slurry are added.

The effluent enters a primary clarifier via a baffle channel. The chemical sludge settles in the bottom of the primary clarifier. The physico-chemical treatment removes approximately 30-40% of BOD, 35-45% of COD and almost all chromium.

The overflow of the clarifier is admitted into an anaerobic lagoon with 8 days retention time.

The anaerobic treatment helps to reduce 25-30% of the organic load. The overflow of the anaerobic tank enters a degassifier provided with five floating aerators and then an aeration tank provided with six fixed type mechanical aerators for biological stabilisation of the effluent.

The biological treatment removes 90-95% of BOD and 85-90% of COD. The overflow of the aeration tank with active biological solids is admitted to a secondary clarifier. The settled sludge in the clarifier is pumped back to the aeration tank to maintain the MLSS at the required level. Some quantity of sludge, which is wasted, is sent to the sludge thickener.

The overflow of the secondary clarifier, which is the treated effluent, is discharged to a nullah, which ultimately joins river Palar. Provision for subjecting the effluent to tertiary treatment has been made to achieve further reduction of colour and suspended solids, as and when required.

The sludge settled during the physico-chemical treatment in the primary clarifier is taken to a sludge well and then pumped to a sludge thickener. The thickened sludge is dewatered either in a centrifuge or in sludge drying beds. The dewatered sludge is disposed of in the sludge dumping site.

The system has been regularly operating for the past over 5 years.

7. CETP COMPONENTS & THEIR SPECIFICATIONS

Treatment step	**Description/service**	**Dimension/capacity**
	Plant design capacity	4000 m^3/day
Primary Treatment		
Coarse screening	2 nos. manually cleaned screens	12 mm bar spacing
Collection	1 no. circular RCC receiving sump, two ejector pump type aerator 7.5 kW each	Capacity 190 m^3, specific mixing power 79 W/m^3
Pumping	3 nos. centrifugal pumps, 22.4 kW each	Retention time 30 min Pump capacity 400 m^3/h each
Grit removal	2 nos. circular FRP settling tank	Capacity 50 m^3 each, total retention time 15 min
Fine screening	One no. self cleaning drum-screen	3 mm bar spacing, 450 m^3/h
Equalisation	1 rectangular RCC tank	Capacity 2,520 m^3, retention time 15 h
	Aeration/mixing: three numbers high speed floating aerator 18.5 kW each	Specific mixing power 22 W/m^3
Equalised effluent pumping	2 nos. submersible pumps of 11.2 kW each	Capacity 200 m^3/h each
Flocculation	Flash mixer -RCC rectangular tank with 3.7 kW agitator Chemicals: alum (Al_2SO_4. 16 H_2O_2), lime ($Ca(OH)_2$) and anionic polyelectrolyte, mixing channel with baffles for flocculation	Capacity 12.5 m^3 Retention time 3.7 min, retention time in flocculation channel is 4.5 min

Primary sedimentation	1 circular RCC clarifier with sludge scraper 15 m dia	Capacity 530 m^3, retention time 2.65 h
Biological treatment		
Biological treatment	1 no. anaerobic lagoon: rectangular RCC tank	Capacity 27,500 m^3, retention time 6.88 days

Degassification	1 no. RCC degasification tank with 5 high speed floating aerator 15 kW each	Capacity 12,170 m^3, retention time 3 days, specific mixing power 6.2 W/m^3
Biological aeration	1 no. rectangular RCC tank with 6 nos. low speed fixed aerators 15 kW each	Capacity 5,040 m^3, retention time 1.26 days Specific mixing power 18 W/m^3
Sedimentation	1 circular RCC tank 15 m dia Recycle of biological sludge: 2 nos. centrifugal pumps 5.6 kW each	Capacity 440 m^3, retention time 2.2 h Pump capacity 45 m^3/h each
Tertiary treatment	1 flash mixer RCC rectangular tank with 3.7 kW agitator, 1 RCC flocculator tank with paddle mixer 1.5 kW, 1 RCC tube settler tank filled with corrugated sheet media, with 2 centrifugal sludge pump 5.6 kW	Capacities flash mixer 9.4 m^3, flocculator: 72 m^3, tube settler 54 m^3, retention times flash mixer 2.8 min, flocculator 20 min, tube settler 16 min
Sludge treatment		
Design capacity	About 16,000-20,000 tonnes DS per year	
Sludge pumping	1 circular RCC primary sludge well with 2 nos. centrifugal sludge pump 7.5 kW each	Capacity 85 m^3 Pump capacity 70 m^3/h each
Sludge holding	1 no. circular RCC sludge holding/ thickening tank	Capacity 100 m^3
Sludge dewatering	1 no. high speed decanter centrifuge 18.5 kW with screw impeller type feed pumps 5.6 kW, cationic poly-electrolyte dosing & sludge conveyor 45 nos. sludge drying beds and 10 nos. pre-settler sludge drying beds	Capacity centrifuge 12 m^3/h, feed pump 12 m^3/h Total area 6,600 m^2

Note: The addresses of suppliers may be seen at Annex 1.
The dimensions of the tanks can be seen in the drawings at Annex 2..

8. OPERATIONAL FEATURES

8.1. Operational parameters

Operational parameter	Factors maintained at present
Chemical dosage prior to primary clarifier	300-400 ppm of alum and 200 ppm of lime, anionic polyelectrolytes at the rate of 1 ppm
Nutrients	No nutrient is added at present
Dissolved oxygen	DO level in aeration tank is 2.5 mg/1
Sludge recirculation	Around 35%
MLSS concentration	Degassifier tank: 200 mg/1 & aeration tank 2200 mg/1
Sludge wasting	Approximately 10% of the aerobic bio sludge
Screenings removal and sludge withdrawal timing	The screenings from screens are removed once a shift. Sludge from primary clarifier is withdrawn once every 2-3 hours

Maintenance	
Oiling & greasing cycle	15 & 20 days respectively
Frequency of painting	Once in six months

Power consumption	
Total connected load	373 kW
Operating load	312kW
Capacity of diesel generating set	380KVA

8.2. Laboratory

The laboratory is accommodated in two small rooms in the first floor of the chemical house, with sizes: 10 ft. x 12 ft and 8 ft. x 10 ft respectively.

Room No. 1 is generally used for the main analysis. The equipment available in this room are:

#	Instrument/equipment	Number of units
1.	Hot air oven	1
2.	Fume cupboard	1
3.	COD apparatus	1
4.	Distilled water still	1
5.	Electric Bunsen	2
6.	Heating mantle - 3 Nos.	2
7.	Vacuum pump	1

Room No. 2 is used as the instrumentation room. The instruments in this room are:

#	Instrument/equipment	Number of units
1.	BOD incubator	1
2.	Spectrophotometer	1
3.	pH meter	1
4.	DO meter	1
5.	Electronic balance	1
6.	Dhona monopan balance	1
7.	Refrigerator	1
8.	Flame photometer	1
9.	Microscope	1

8.3. Analysis done in the laboratory

Various analyses done in the laboratory are as follows:

Parameter	Raw effluent	Pre-settler outlet	Equalised raw effluent	Clariflocculator outlet	Anaerobic lagoon outlet	Degassifier outlet	Clarifier outlet	Final treated effluent
PH	daily	daily	daily	daily	daily	daily	daily	Daily
Suspended solids	daily	daily	daily	daily	daily	daily	daily	Daily
Total dissolved solids			daily	daily	daily		daily	daily
Chlorides			weekly					Weekly
Sulphides	daily		daily					
Sulphates			weekly		Monthly			monthl
BOD5	Daily		daily	daily	daily	Weekly	daily	Daily
COD	Daily		daily	daily	daily	daily	daily	Daily
Total chromium	Daily		daily	daily				Daily
Phosphates			weekly					Weekly
Ammonia nitrogen			weekly	weekly				Weekly
Nitrates			weekly					Weekly
Total Kjcldahl Nitrogen			weekly	weekly				Weekly
Total nitrogen								Weekly

Parameter			Anaerobic lagoon	Degassifier	Aeration tank			Treated effluent
DO				Daily	daily			Daily
MLSS					daily			
MLVSS					daily			
Acidity			daily					
Volatile acids			daily					
Alkalinity			daily					

Note: All values except pH are reported in mg/1.

Testing of samples from other points such as outlet of receiving sump, anaerobic lagoon, primary and secondary sludge samples etc. is done occasionally and when required.

8.4. Manpower

Personnel	Qualification & experience
Plant manager	M.Sc. (Env. Toxicology.) with 5 years experience in ETP management.
Plant Engineer	Graduate in mechanical engineering with 6 years experience in the Ranipet CETP project
Sr. Chemist	B.Sc. Chemistry with 5 years experience in effluent testing
Lab Chemist	B.Sc. Chemistry with 1 year experience in effluent testing
Chemist	Post Graduate in Chemistry, 6 months experience in effluent testing.
Electrical Engineer	Diploma in electrical engineering with 6 years experience in electrical maintenance
Civil Engineer	Diploma in civil engineering with 2 years project experience
Stores in charge	Graduate with 3 years experience in material management

8.5. Monitoring

Following is the list of log sheets presently maintained in the CETP:

- Pumping details
- Chemical dosages and stock
- Aeration details
- Operation details of other equipment
- Sludge details
- Complaints register
- Stores & spare parts register
- Maintenance schedule

The log sheets are reviewed on a daily basis by the Plant Manager and necessary instructions for modification in operation and maintenance are given in consultation with the chemist and other engineers.

9. EFFLUENT CHARACTERISTICS BEFORE & AFTER TREATMENT

(Average for the period from 01 January 2000 to 30 June 2001)

#	Parameter	Unit	Raw effluent	After chemical	Degassifier outlet	Final treated effluent*	TNPCB norms*
1.	pH		7.3	8.05	7.4	7.3	5.5 – 9.0
2.	Suspended solids	mg/1	3980	652	220	92	100
3.	BOD	mg/1	1815	1325	550	28	30
4.	COD	mg/1	6945	2980	1615	245	250
5.	Chromium	mg/1	78	9	1.2	1	2
6.	Sulphides	mg/1	105	32	18	2	2
7.	TDS	mg/1	12110	11450	11320	11405	2100

**** After biological treatment***
****for discharge to inland surface waters***

10. COST OF TREATMENT

(Average monthly cost from 01 January 2000 to 30 June 2001)

#	Cost component	Cost in INR	Cost in US$
1.	Power	631,282	13,489
2.	Chemicals	238,512	5,096
3.	Salary & labour	178,922	3,823
4.	Repair and maintenance	163,242	3,488
5.	Laboratory analysis	19,425	415
6.	Sludge dewatering	105,300	2,250
7.	Miscellaneous	45,000	962
8.	Consents & license	2,905	62
9.	Loan repayment	585,000	12,500
10.	Other costs (R&D etc.) lumpsum	400,000	8,547
11.	Depreciation on investment	476,660	10,185
12.	Total	2,846,248	60,817

Treatment cost per cubic meter of effluent:	INR 38.25 (US $ 0.82)
Cost per kg. of BOD removed:	INR 21.40 (US $ 0.46)
Cost per kg. of COD removed:	INR 5.71 (US $ 0.12)

11. UNIDO ASSISTANCE

Besides giving technical assistance during the design, implementation and ongoing operation and maintenance, UNIDO at the request of the plant management conducted a detailed assessment of the CETP and identified specific measures for upgrading this as a model CETP in 1997. As a follow up of this report, UNIDO supplied the following equipment to the CETP.

- Improved maintenance of collection and conveyance system.
- Providing two submersible mixers in the receiving sump.
- Installation of two pre-settlers to reduce solids load in subsequent treatment units.
- Repair of sludge centrifuge.
- Obtaining additional laboratory instruments such as a portable DO meter, flame photometer, online DO meter and online pH meter.
- Spare floating aerator for degasification tank.
- Improved operation & maintenance.
- OSH improvement measures including PPE

The total cost of the UNIDO inputs works out to US $ 160,000, including the software component of technical assistance.

A three-week in house training programme for the operating staff of the CETP was organised by UNIDO during October-November, 1998.

Besides this, a number of training workshops were organised by UNIDO and participated by key staff of the CETP. This also included training in occupational safety and health.

UNIDO has initiated some pilot and demonstration projects at this CETP, such as safe landfill for disposal of sludge from the CETP, experimental reed bed etc.

12. CLRI/NEERI INTERVENTIONS

In 1997, AISHTMA (All India Skin and Hide Tanners & Merchants Association) had engaged Central Leather Research Institute (CLRI) and National Environmental Engineering Research Institute (NEERI), the two leading national organisations to study the tanneries connected to the CETP and the CETP itself with a view to identify scope for improvement. While CLRI focused its efforts towards introduction of cleaner technologies in the tanneries connected to the CETP, NEERI gave recommendations on optimisation of the CETP. NEERI's main recommendations relating to the CETP were:

1. Chrome bearing wastewater should be segregated in tanneries.
2. Regularisation of pumping from receiving sump to equalisation tank.
3. Desludging of equalisation tank and additional mixing in the tank.
4. Replacing raw effluent pumps with submersible pumps.

5. Extending wall between equalisation tank and anaerobic lagoon.
6. Dosing tanks for coagulant dosing. Online pH meter for chemical dosing control.
7. New pumps for primary sludge pumping.
8. Increased oxygenation power in degassifier.
9. Construction of a tertiary treatment.
10. Magnetic flow meter in outlet for flow measurement.
11. Additional sludge drying beds.
12. Repair of centrifuge.
13. High rate transpiration system for treatment of TDS in the effluent.

The CETP has implemented all these measures with assistance provided by UNIDO except magnetic flow meter and high rate transpiration system.

The CLRI/NEERI project was completed by the end of 1997.

13. UNIDO's ASSESSMENT

The CETP, the first one in the region to obtain ISO 9002 certification, has truly emerged as a model for the South-East Asian region. With the modifications carried out in the CETP, with technical assistance of UNIDO, good improvement in CETP performance has been achieved. The analysis reports of effluent prior to the upgradation (end of 1997 - June 1998) and after upgradation (June, 98 onwards) indicates approximately 13.3% further reduction in suspended solids, 38% reduction in BOD values, 50% reduction in sulphides and 9% reduction in COD values.

The following measures would further improve the performance of the CETP:

Present drawbacks/scope for improvement	**Recommendations**
The collection of funds from individual members is not regular and an arrear to the tune of INR 11 million is pending to be collected from tanner members.	Improvement in the collection of funds from individual tanner members will help effective operation & maintenance of the CETP.
Maintenance of the pre-treatment units can be improved as some of the units have been corroded.	Better maintenance of pre-treatment units will ensure better performance of the collection & conveyance lines as well as the CETP.
The labour engaged in cleaning of the manually cleaned bar screen is exposed to H_2S gas for prolonged periods.	A mechanically cleaned bar screen in the inlet of CETP works would prevent the labour from exposure to H_2S.
The performance of anaerobic lagoons is low, owing to large deposits of sludge.	Desludging and re-commissioning of anaerobic lagoon will ensure good removal of pollution.
Part of the sludge from the CETP is dumped in the open.	Disposal of sludge in an engineered safe landfill is to be ensured and a separate larger landfill may be required for the purpose. Construction of the encapsulated landfill for the accumulated sludge, planned by CETP, should be completed early.
The cost of operation, particularly that of the tertiary treatment is quite high.	The operation of costly tertiary treatment system could be possibly avoided by more efficient operation of the biological system. Possibility of replacing this system with other alternatives such as reed beds may be explored.

Annex-1
List & address of suppliers of equipment

Item	Supplier	Local service / person / agent
CETP turnkey contractor / supplier of all drives	Enkem Engineering P. Ltd., 824, Poonamalle High Road, Chennai. 600010 India Tel: 91-44-6411362/6428992 Fax:691-44-411788	Enkem Engineering P. Ltd., 824, Poonamalle High Road, Chennai. 600010 India Tel: 91-44-6411362/6428992 Fax:691-44-411788
Decanter centrifuge	Humboldt Wedag India Ltd., 12A, Carnac Street, Kolkata. 700017, India Tel: 91-33-2422097 Fax: 91-33-2428068	Humboldt Wedag India Ltd., 12A, Carnac Street, Kolkata. 700017, India Tel: 91-33-2422097 Fax: 91-33-2428068
Mechanical screen	Italprogetti Engineering, Via Lungarno, Pacinotti, 59A-56020, San Romano, Pisa, Italy. Tel: 0039-571-450477 Fax: 0039-571-450301	Tanmac India, 25, Jawaharlal Nehru St., 3rd Floor, Pondicherry. 605 001 Tel: 91-413-39429
Submersible pumps	Kishor Pumps Ltd. A - 13/H, MIDC, Pimpri Pune 411 018 India Tel: 91-20-772 616 / 773 570	Beam Engineers 102, Mogappair Chennai 600 050 India Tel: 91-44-625 7915
Centrifugal pumps	Johnson pumps, No. 3, Anthu Street, Santhome, Chennai 600 004 India. Tel: 91-44-4933341 Fax: 91-44-4941176 e-mail: pumps@mds.ateel.com	Fabriken Agencies P. Ltd, 11, 7th Cross St, Shastri nagar, Adyar, Chennai-600 020 India Tel: 91-44-4462605/4460602 Fax: 91-44-4461359/4913601 e-mail: sridhark123@eth.net
Screw pumps	Alpha Helical Pumps, 2/131-A, Venkitapuram Road Venkitapuram Post, Coimbatore: 641 014 India Tel: 91-422-827329/828469/470 Fax: 91-44-827298 e-mail:corporate@alphapumps.com	Alpha Helical Pumps, Asha Mansion, 3rd Floor 59A, Montieth Road Egmore, Chennai 600 008 India Tel: 91-44-8413262/8418171 Fax: 91-44-8555018 e-mail: chennai@alphapumps.com
Floating aerator	Biotim Polutech Ltd. 1, A Electrical Industrial Estate, Kakkalur Thiruvallur. 602 003 Tel: 91-4116-60 271	Biotim Polutech Ltd Tiam House 28, Rajaji Salai Chennai. 600 001 Tel: 91-44-5223223 e-mail: ravichandrank@murugappa.co.in