CETPS AND POLLUTION ABATEMENT IN SSIS

Rita Pandey
Saubhik Deb

March 1999

National Institute of Public Finance and Policy
New Delhi

PREFACE

Small scale industries (SSIs) constitute a considerable part of total industrial structure in India. The monitoring and enforcement of environmental laws on SSIs have been highly unsatisfactory. This study focuses on ways of improving compliance from SSIs.

The study was undertaken at the instance of the Ministry of Environment and Forests, Government of India. The terms of reference required the NIPFP to: (i) examine the feasibility of combined treatment in controlling pollution from SSIs; and (ii) to explore the feasibility of introducing incentive-based-cost-sharing arrangements.

The study brings out that combined treatment is a cost effective option for SSIs, and recommends various changes that should be effected in the existing system for environmental management in SSIs to become more effective.

At the NIPFP, the study was designed and conducted by Dr. Rita Pandey with Mr. Saubhik Deb. The Governing Body of the institute does not bear any responsibility for the views expressed in the report. This responsibility lies mainly with the authors of the report.

Ashok Lahiri
Director

New Delhi
March, 1999.

ACKNOWLEDGEMENTS

In the course of this study, I have received help and support from various individuals and organisations. I would like to place on record the assistance of Uttar Pradesh Jal Nigam (UPJN) and Uttar Pradesh Pollution Control Board (UPPCB). At the UPJN, I am indebted to Shri D.V.S. Gupta, General Manager, and Shri Y.N. Khare, Project Manager. At UPPCB, Shri S. Sachan, Regional Officer provided useful information. I also had some useful discussions with Shri B. Sikka, Director, and Dr. M. Hota, Deputy Director, at the Ministry of Environment and Forests, and Shri U.N. Singh, Senior Environmental Engineer, Central Pollution Control Board.

I am particularly grateful to Dr. Ashok Lahiri, Director, NIPFP for valuable guidance during the course of the study and extremely useful suggestions given on an earlier draft of the report. I have benefited enormously from interactions with Professors U. Sankar, T.V.S. Ramamohan Rao, Stephan Barg and L.P. Selvam. I would like to thank Ms. Rita Wadhwa for meticulous editing. Shri Rajinder Negi provided excellent secretarial assistance.

Finally, I would like to thank the Ministry of Environment and Forests for providing funds to carry out this study.

RITA PANDEY

March, 1999.

CONTENTS

INTRODUCTION 1

1.1 Need for the study

Under the Water (Prevention and Control of Pollution) Act of 1974, each industry must provide adequate treatment to its effluents prior to their disposal. The Act mandates both general and industry specific standards for the discharge of various pollutants into water bodies. Discharge of wastewater, carrying pollutant concentration beyond the specified standards into surface water, on land for irrigation, and marine coastal waters is prohibited. The Act lays down penalties for non-compliance. The source – specific pollution standards are the same for all firms – whether large or small – in a particular industry. While the regulatory agencies have achieved partial success in enforcing the environmental legislations on large polluting industries, monitoring and enforcement of laws on small scale industries (SSIs) have been highly unsatisfactory.

This is due to three main reasons. First, the administrative deficiency of the regulatory agencies. Second, as SSIs are large in number and often scattered, with no reliable database on their production processes, inputs used, and wastes generated, enforcing environmental legislation on these are often costly. Third, since pollution abatement entails monetary costs on the part of the firms, many State governments are concerned that tight enforcement of the environmental legislations might hurt the very survival of these industries. Such concerns about SSIs which have an important role in country's economy, has hampered the enforcement of environmental legislation on SSIs.

Pollution from SSIs, constitutes a considerable part of the total industrial water pollution in India. Most SSIs lag in technical devices to comply with the environmental legislations owing to financial, and land availability constraints (Gupta *et.al.* 1989; MSE 1998). As a result, a majority of these units either fail to treat their effluents or use inefficient treatment technologies which are neither cost-effective, nor adequate. The inability to comply with the prescribed standards has, therefore in recent years, resulted in the closure of many SSIs.

In this context, combined treatment of waste water is considered a cost-effective alternative to effluent treatment by individual small scale units, both because of the presence of scale economies[1] in waste water treatment, and ease of monitoring and enforcement. Joint treatment of industrial and municipal wastewater has some additional advantages as the nutrients and diluting potential of domestic sewage make industrial waste more amenable to degradation.

Under the Industrial Pollution Control Project, the Ministry of Environment and Forests (MoEF), in 1990, had instituted a scheme to promote common effluent treatment plants (CETPs) for the SSIs. Under this scheme, financial assistance in terms of capital grant and low interest loans is provided for setting up CETPs in industrial estates/SSI clusters.

However, in spite of the above scheme, only a small number of CETPs have been set up since the start of the scheme in 1991. For instance, as on January 1, 1997 the total number of CETPs approved under the scheme was only 71 (MoEF, personal communication) as against a requirement of 70 CETPs for tanneries alone (report of a committee set up by the Directorate General of Technical Development, 1986). Also, many existing CETPs are

---

See Gupta, Murty and Pandey, 1989, P. 14.

not operational, and many of those that are operational are in violation of the prescribed standards (see MSE, 1998). This has been attributed to many factors such as the cumbersome procedures in seeking financial assistance under the CETP scheme, lack of incentives for pollution control due to poor enforcement of the environmental laws, institutional structure of the CETPs, and inequitable cost sharing methods used by the CETP management in distributing the treatment cost among the member units.

1.2 Objectives and plan of the study

1.2.1 The study aims to:

- examine the feasibility of CETPs in controlling pollution from SSIs in India;

- examine the CETP scheme and suggest measures for improvement; and

- review the methods used in cost sharing and explore the feasibility of introducing incentive-based cost-sharing arrangements.

1.2.2 The report is organised as follows:

Chapter 2 examines the cost savings in combined treatment relative to the costs of treatment of individual treatment plants. Using the game theoretic approach, it also explores how CETPs can help to achieve better compliance from SSIs. Chapter 3 provides an overview of the Government of India scheme to promote CETPs for the SSIs. It also suggests changes in the design and implementation of the scheme to make it more effective. Chapter 4 reviews the existing cost-sharing methods and suggests an equitable cost-sharing method for sharing of financial cost of joint treatment. Chapter 5 presents a detailed case study of a CETP at Jajmau. It highlights the problems both technical and organisational in nature and provides specific recommendations. Finally, Chapter 6 presents the constraints of the present system and recommendations from the analysis.

Feasibility of CETPs in Controlling Pollution 2

With the help of the available data, this chapter examines the cost savings in combined treatment relative to the costs of treatment of individual treatment plants in the context of SSIs. Using a game theoretic approach, it also explores how CETPs can help achieve better compliance from SSIs with a lower or the same monitoring and enforcement budget.

2.1 Cost savings in combined treatment

Court decisions generally give three options to polluting SSIs – to set up an individual effluent treatment plant (IETP), to join a CETP, or to relocate the industry. The third option has usually found the least favour with the industry owing to the costs associated with relocating the industry, such as, foregone locational advantages and uncertain future in the absence of clear zoning policy/laws. The choice between the other two options is largely determined by the relative costs of treatment of the CETP and IETP.

The cost of treatment of waste water varies both across and within industries as the characteristics of waste water and the treatment technology used, are firm - specific. Thus, in examining the relative costs of treatment, a sample of CETPs and IETPs has been taken from tanneries which produce similar outputs and use similar treatment processes. The estimates of treatment costs of CETPs and IETPs at 1995-96 prices are presented in Tables 2.1 and 2.2, respectively.

Table 2.1. Waste Water Treatment Costs of CETPs

S. No.	Year of CETP operation	No. Of beneficiaries	Volume of effluent Cu. m/d	Cost per KLD of water treated (Rs.)	Cost per kg of BOD treated
1.	1995	76	3000	16.30	5.45
2.	1997	22	1200	29.85	16.58
3.	1995	81	1300	24.77	23.13
4.	1991	110	2400	21.14	14.30
5.	1995	10	200	40.28	27.25

Source: Based on MSE, 1998.

Notes: cu. m/d is cubic metre per day.
KLD is kilo litre per day.
BOD is a measure of the amount of oxygen required to oxidise various compounds present in waste water.

Table 2.2. Waste Water Treatment Cost of IETPs

S.No.	Year of IETP operation	Volume of effluent Cu. M./d	Total cost per KLD treated (Rs.)	Cost per kg of BOD treated
1.	1995	60	48.08	98.79
2.	1995	38	48.75	32.67
3.	1987	30	64.50	65.37
4.	1995	30	42.67	86.49
5.	1979	400	35.87	18.05

Source: Based on MSE, 1998.

All CETPs met the standards for pH, sulphide and total cromium. Four CETPs met the standards for BOD. Member firms of all CETPs, excepting CETP 3, are processing raw skin and hides into finished leather. Firms connected to CETP 3 convert semi-finished leather into finished leather. All the IETPs are meeting BOD, COD, TSS and pH standards. Estimates of treatment costs per KLD of waste water treated presented in Tables 2.1 and 2.2 show that there are scale economies in waste water treatment. For, the total cost per kilo litre of waste water treated varies inversely with the actual volume treated, the lowest being Rs. 16.3 per KLD for CETP 1 (the largest CETP) and the highest Rs. 40.28 for CETP 5 (the smallest CETP). Also, IETP

5 has a lower cost per KLD of water treated than CETP 5 because of economies of scale. With the exception of IETP 5 costs per kg of BOD treated are higher for IETPs vis-a-vis CETPs. A lower cost of Rs. 18.05 per unit of BOD in IETP 5, appears to be because of a very high inlet BOD of 2.74 kg/m^3 of waste water, as against an average inlet BOD of 0.55 kg/m^3 for the sample.

It appears that, CETP is the cost effective option for small tanneries.[1] CETPs also provide an opportunity for learning by doing and experimenting with ad-on technologies for improvement, which may be difficult with small individual treatment plants. Further, CETPs provide opportunities for recoveries in the treatment process, in the form of biogas (energy), metals, manure etc., which may not be viable in the case of small IETPs.

An important question that must be asked in this context is *what is the optimum size of a CETP?* While the economies of scale and subsidy reduce the unit cost of treatment of CETP, the costs of conveyance and pumping of effluent from firms to a CETP increase with the number of units and their location. Hence, there may be an optimum size for a CETP. Given the limited experience in the formation and operation of CETPs, *detailed feasibility studies are needed to examine the optimum size of CETPs as well as the grouping of industries producing heterogeneous outputs.* The State Pollution Control Boards (SPCBs), under the guidance of the Central Pollution Control Board (CPCB) can conduct such studies.

---

[1] Earlier studies of sugar, distilleries and pulp and paper industries have also demonstrated scale economies in waste water treatment in these industries. See Pandey, (1996, 1998), and Mehta, Mundle, and Sankar (1994).

2.2 The issue of improving compliance of SSIs

2.2.1 The present status of compliance

The pollution control legislation and regulation in India, in their attempt to achieve the goal of pollution reduction, have concentrated mainly on forcing the installation of equipment capable of attaining the allowable discharge levels. This is evident from the government statistics on the status of initial compliance.[2] According to the MoEF records, as on December 31, 1996, 1259 medium/large industrial units out of the total identified 1551 units across different States had the requisite facilities to comply with the stipulated discharge standards [81 percent initial compliance (Table 2.3)]. However, 112 units were closed down either owing to penal actions or because of their own problems. Such an achievement in initial compliance is unlikely to have led to a corresponding fall in the number of industrial units violating the provisions concerned.[3] Achievement of initial compliance usually has little effect on environmental quality. For, environmental quality will not be affected unless the equipment is operated continuously. *There are no statistics available for SSIs, even on the status of initial compliance. In the case of SSIs, even the fact finding inspections are rare or non-existent, let alone inspections intended to detect violations.*

---

[2] Initial compliance is a demonstration that shows a particular plant is capable of meeting the required limit on discharges.

[3] Unfortunately, no data are available on continuing compliance to verify this conjecture.

Table 2.3. Status of Pollution Control in 17 Categories of Industries (as on December 31, 1996)

S.No.	States/U.T.	Total No. of units belonging to 17 categories	Closed	Status (No. of units)	
				Having adequate facilities to comply with the standards	Not having adequate facilities to comply with the standards
1.	Andhra Pradesh	173	24	141	08
2.	Assam	15	00	10	05
3.	Bihar	62	14	35	13
4.	Chandigarh	01	00	01	00
5.	Delhi	05	00	02	03
6.	Goa	06	00	06	00
7.	Gujarat	177	02	167	08
8.	Haryana	43	03	32	08
9.	Himachal Pradesh	09	00	09	00
10.	Jammu & Kashmir	08	03	01	04
11.	Karnataka	85	04	68	13
12.	Kerala	28	04	20	04
13.	Madhya Pradesh	78	02	57	19
14.	Maharashtra	335	17	296	22
15.	Meghalaya	01	00	00	01
16.	Orissa	23	01	12	10
17.	Punjab	45	02	25	18
18.	Pondicherry	06	00	02	04
19.	Rajasthan	49	05	42	02
20.	Sikkim	01	00	00	01
21.	Tamil Nadu	119	02	114	03
22.	Uttar Pradesh	224	15	187	22
23.	West Bengal	58	14	32	12
	Total	1,551	112	1,259	180

Source: MoEF, 1996-97.

A pertinent question that must be asked in this context is whether the existing system provides incentives to SSIs for continuing compliance?[4]

[4] Continuing compliance is the ongoing meeting of a discharge limit over days, weeks, and years of routine operation.

In India, the probability of a firm being monitored is very low. This is especially true in the case of SSIs, because of both political[5] and budgetary pressures, and administrative deficiency of the regulatory authorities, namely, the SPCBs. Thus, the incentive for firms to comply with the discharge standards remains low.[6] Also, the way the system has been set up, the entire burden of proof of a violation falls on the regulatory agency reducing the probability of conviction and weakening enforcement. Fines and penalties for non-compliance are generally low and fail to induce industries to invest in pollution control equipment. A more focused approach of monitoring and enforcement is needed.

2.2.2 The role of CETPs

This section discusses how CETPs and the voluntary compliance approach of monitoring and enforcement can contribute to improving compliance of SSIs while still meeting the monitoring budget constraint.

In the literature on monitoring and enforcement, the relationship between an environmental protection agency and the polluter it regulates is seen as a game (Russel, 1992). This regulator-regulatee relationship can be examined in a game theoretic framework which takes into account both the polluter's option to choose wilful non-compliance and the inherent uncertainty of the agency's knowledge about the polluter's behaviour. The framework developed here is potentially applicable to any public monitoring problem, where costs of enforcement and opportunities for non-compliance combine to make it a difficult resource allocation problem.

---

[5] It is shown that the stringency with which regulations are enforced is not merely a function of budgets, but also of interest group politics (Cropper *et. al.*, 1992).

[6] For evidence of the importance of inspections in deterring violations see Helland (1997); and Harrington (1988).

In this framework, the regulatory agency sets a discharge standard for a firm, the firm has the choice of trying to comply, or of flouting the standard. On the other side, the agency can choose to monitor or not the performance of the firm. Each can be seen as having to choose a strategy in the absence of knowledge of the other's choice, a particular pair of choices producing a particular pair of payoffs, dependent on such features as the agency's skills at monitoring and its costs, the damages of uncontrolled emissions, the firm's control costs, and the penalties levied by the agency for discovered violations.

In this game, the players are the firms (source) and the environmental protection agency (agency). The agency has prescribed limits on the firm's discharge. The firm has the choice of achieving initial compliance but fail in continuing compliance or fail in achieving both initial and continuing compliance. The agency would prosecute[7] a particular firm if it is found in violation with the environmental standards, but not otherwise. On the other hand, the firm would comply only when it faces a strong threat of being caught and prosecuted. Table 2.3 shows payoffs which represent this situation.

Table 2.4. Payoffs to Agency and Source

Agency	Source	
	comply	**do not comply**
Inspect	$-\beta, \pi - c$	$a - \beta, \pi - \alpha$
Do not inspect	$0, \pi - c$	$-a, \pi$

Payoffs to : (Agency, Source)

`$\pi$' is the total profit of the firm and `c' is firm's cost of compliance. `a' is the social benefit that accrues to the agency (society) if it inspects a non-

[7] The assumption is that detection of violation will always lead to prosecution of the violator.

complying firm. It can also be viewed as the social cost of pollution. `β' is the cost of inspection and `α' is the penalty imposed by the agency for non-compliance.

If the agency inspects a compliant firm, the cost of inspection is a waste and consequently the agency's payoff is -β and firm's payoff is its profit net of the cost of compliance. If the agency does not inspect, it gets a payoff of 0. However, if the firm is a non-compliant and is inspected, the firm's payoff is its profit net of penalty for non-compliance, whereas the agency gets a payoff which is equal to the social benefit net of the cost of inspection. But if a violating firm is not inspected and thus not prosecuted, the firm's payoff is its total profit and the agency's payoff is – a, which represents the cost society has to bear due to pollution caused by the non-compliant firm.

$$\pi, c, a, \beta, \alpha > 0$$

In this particular game, for $\alpha \leq c$, the strategy `do not comply' becomes a dominant strategy for the firm. A strategy is a `dominant strategy' if it is a player's strictly best response to any strategy the other player (agency) might pick, in the sense that whatever strategy the other player picks, its (the firm's) payoff is highest with that particular strategy. In other words, if the penalty for non-compliance is less than or equal to the cost of clean up, the firm will never comply with the standards and assuming that the agency knows that the firm will always play the dominant strategy, a pure strategy Nash equilibrium is given by the strategy combination (inspect; do not comply). However, the social optimum is given by the strategy combination (Do not inspect; comply). Thus, any penalty less than or equal to the cost of cleaning up will lead to sub-optimum outcome.

However, for $\alpha > c$, neither player has a dominant strategy and no Nash equilibrium exists in pure strategies either.

The strategy combination (inspect, comply) is not a Nash equilibrium, because the agency prefers `do not inspect' if the firm picks comply.

(Do not inspect, comply) is not Nash, because the firm prefers `do not comply'.

(Do not inspect, do not comply) is not Nash, because the agency prefers `inspect'.

(Inspect, do not comply) is not Nash, because the firm prefers `comply', which brings us back to the first strategy combination.

However, this game does have a mixed strategy Nash equilibrium. Using *Von Neumann-Morgenstern* utility, the player's payoffs are the expected values of the payments from Table 2.4. If the agency plays `inspect' with probability p and the firm plays `comply' with probability q, the firm's expected payoff is

$$
\begin{aligned}
E_{\pi\ \text{firm}} &= p\,[q\,(\pi-c) + (1-q)\,(\pi-\alpha)] + (1-p)\,[q(\pi-c) + (1-q)\,\pi] \\
&= p\,[q\,(\alpha-c) + (\pi-\alpha)] + (1-p)\,[\pi-q.c] \\
&= p.q.\alpha - p.\alpha + \pi - q.c \\
&= p\,(q\alpha - \alpha) + \pi - qc
\end{aligned}
$$

If only pure strategies are allowed, q equals zero or one, but in the mixed extension of the game, the firm's action of q lies on the continuum from zero to one, the pure strategies being the extreme values. Following the usual procedure for solving a maximisation problem, we differentiate the payoff function with respect to the choice variable to obtain the first order condition.

$$\frac{dE_{nfirm}}{dq} = p\alpha - c = o$$

$$p = \frac{c}{\alpha}$$

In a mixed strategy equilibrium, the agency selects 'inspect' with a probability $\frac{C}{\alpha}$. If the agency selects 'inspect' with a probability higher than or equal to $\frac{C}{\alpha}$, the firm always selects 'comply'. If the agency selects 'inspect' with probability less than $\frac{C}{\alpha}$, the firm never selects 'comply'.

So, if a mixed strategy is to be optimal for the firm, the agency must therefore select 'inspect' with probability $\frac{C}{\alpha}$.

To obtain the probability of the firm choosing 'comply', we turn to the agency's payoff function, which is specified as:

$$\begin{aligned} E_{\pi\ agency} &= p\ [-q.\beta + (1-q)\ (a-\beta)] + (1-p)\ [q.o - (1-q)a] \\ &= p\ [a-\beta - qa] + (1-p)\ [q.a - a] \\ &= p.a - p.\beta - p.q.a + q.a - a - p.q.a + p.a \end{aligned}$$

The first order condition is

$$\begin{aligned} \frac{dE_{\pi\ Govt.}}{dp} &= a - \beta - qa - qa + a = 0 \\ &= 2a - \beta - 2qa = 0 \\ &or, \end{aligned}$$

$$q = \frac{2a - \beta}{2a} = 1 - \frac{\beta}{2a}$$

In the mixed strategy Nash equilibrium, the agency selects 'inspect' with probability $\frac{C}{\alpha}$ and the firm selects 'comply' with probability $1 - \frac{\beta}{2a}$.

For example, if $a = 10$, $\beta = 5$, $c = 4$ and $\alpha = 8$

then $p = 0.5$

and $q = 1 - \frac{5}{20} = 0.75$

Here the values of p and q have been calculated based on some hypothetical figures for illustration. However, it is important to note that the value of q cannot be 1 unless 'β' i.e., the cost of inspection is zero. [$q = 1 - \frac{\beta}{2a}$ if $q = 1$ then $1 - \frac{\beta}{2a} = 1$ or $\frac{\beta}{2a} = 0$ or $\beta = 0$].

Since the cost of inspection is not zero, $q = 1$ is a theoretical impossibility. In other words, there will always be some firms who will not comply with the standards.

So, when the agency selects 'inspect' with probability 0.5 and the firm selects 'comply' with probability 0.75, the equilibrium outcome could be any of the four entries in the outcome matrix. The entries having the highest probability of occurrence are (inspect, comply) and (do not inspect, comply), each with probability $\frac{3}{8}$[8].

[8] If the agency is playing the strategy 'inspect' with probability ½ and the firm plays the strategy comply with probability ¾, the probability that both players play the above mentioned strategies simultaneously is ¾ x ½ = 3/8.

If we consider all the firms together, then this game has a pure strategy equilibrium: 75 percent of the firms choose the pure strategy 'comply' and 25 percent of the firms choose the pure strategy 'Do not comply'.

So far we have considered the case where the firm has only two options 'comply' and 'do not comply', and the agency does not have any prior information about what strategy the firm is going to play. *Outcomes of this case seem to lead to a very expensive advice to the agency - a very high monitoring requirement, which does not result in full compliance.* To deal with this problem an alternative scheme can be envisioned. In this scheme, the sources have more choices than in the earlier case. This enables the agency to categorise the sources according to their behaviour as determined by the costs of compliance under alternative choices which, in turn, allow the agency to choose varying monitoring frequencies/schemes for different categories. This system makes it possible, in principle, to reduce non-compliance to relatively low levels with the same monitoring budget.

Let us consider a situation where the SSIs have four possible strategies: Join a CETP; set up an IETP and comply with the standards; set up an IETP but do not comply; and do not set up even IETP. Corresponding to each strategy of the source, the agency has two strategies, 'inspect' and 'do not inspect'.

Payoffs in this situation can be represented as:

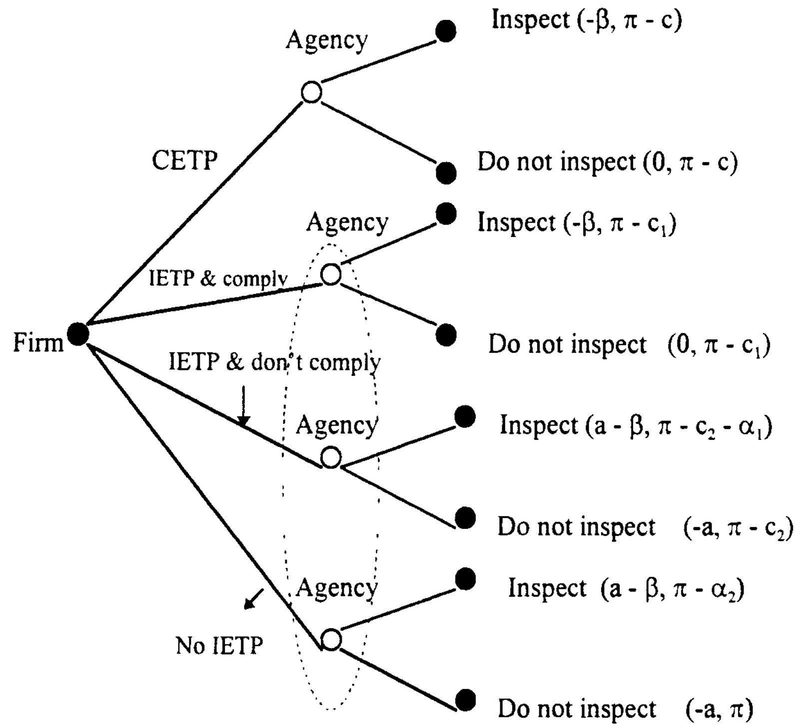

Figure 2.1 Payoffs to Agency and Source

The firm moves first and picks one among the four possible strategies. If the firm chooses 'CETP', the agency takes no further action and the game ends there. However, if the firm chooses any of the three remaining strategies, the agency's information set is the set of these three different strategies, one of which might be the actual move of the firm. But which of the three strategies the firm will choose, the agency can not discern by direct observation. This is shown by the dotted lines around the three nodes.[9] Respective payoffs for the agency and the source are shown in the parenthesis.

---

[9] A node is a point in the game at which some player takes an action, or the game ends.

'π' is the total profit of the firm. 'c' is the total cost of compliance for 'CETP'. 'c_1' is the cost of compliance for IETP. 'c_2' is the cost of compliance if the firm chooses 'IETP and do not comply'[10]. 'a' is the social benefit that accrues to the agency if it inspects a non-complying firm. 'β' is the cost of litigation and α_is are the penalties imposed by the agency for non-compliance.

$$\pi, c, c_1, c_2, a, \beta, \alpha_i > o$$

It is assumed that

$$c_1 > c > c_2$$

i.e. the cost of compliance for CETP is less than the cost of compliance for IETP[11] owing to the presence of economies of scale.

It is further assumed that $\alpha_1 < \alpha_2$

Given that the existing system in India, relies heavily on 'initial compliance' namely, verifying that pollution control devices are installed, rather than on monitoring actual discharges (i.e. continuing compliance), this is a reasonable assumption. That is, penalties for non-compliance will be lower for firms with some effluent treatment facility than none at all. In other words, penalty for non-compliance will be lower for a firm with IETP than otherwise.

---

10 Cost of compliance in this case is the cost of installing an IETP.

11 It is important to note here that for the large and medium industries, which have IETPs bigger than that of the existing CETPs, the cost of compliance of IETP may be lower than that of CETP due to economies of scale.

In this particular game, however, the strategy `IETP and comply' is dominated by the strategy `CETP'[12]. Whatever be the response of the agency, the firm's payoffs are higher with the strategy 'CETP' than with 'IETP and comply'. Assuming that the agency knows that firm will always play the dominant strategy, the firms which have not joined CETP will either play the strategy 'IETP and do not comply' or 'do not have IETP'. In either case, they will be violating. So, the agency should 'prosecute' all the firms which have not joined CETP.[13]

Now, if $\alpha_2 > c$ and $c_2+\alpha_1 > c$,

the firm will respond by joining CETP. Thus socially optimum equilibrium will be reached and this will be a Nash equilibrium.

However, if $c_2 + \alpha_1 < c$

i.e. $\alpha_1 < c - c_2$

the pure strategy Nash equilibrium will be (IETP, and do not comply, inspect). *Thus, in order to attain social optimum, the penalty must be greater than the difference of the cost of compliance with CETP and the cost of treatment of a non-compliant IETP.*

The above result holds good when the agency plays rationally and inspects all the firms who have not joined a CETP. In reality, however, the agency's decision 'to prosecute' or 'not to prosecute' depends on the detection of a violation. Although, the environmental regulators are authorised to

---

[12] Depending upon the stringency of enforcement, SSI may install an IETP and comply when it does not have the option of joining a CETP.

[13] It may, however, be noted that joining a CETP is only a necessary condition, but not a sufficient condition, for ensuring compliance with the standards.

punish violators with fines or injunctions, such sanctions are not as easy to use as the common assumption implies. The first obstacle to the use of legal sanctions is their cumbersomeness. Secondly, the use of sanction is hampered by the difficulty of gathering evidence of non-compliance which will stand in the courts. Thus, the probability of a violating firm actually being prosecuted is low. If we incorporate this (i.e., the agency prosecutes only a small proportion of the violators) into our framework as *a priori* information available to the firms, the equilibrium outcome changes. Let us assume that the firms know *a priori* that the agency will play the strategy 'inspect' with probability 'p'. The expected payoffs to the firm for each strategy can be written as below.[14]

Strategy	Expected Payoff
Join CETP	π - c
Install IETP and do not comply	$p(\pi-c_2-\alpha_1) + (1-p)(\pi-c_2)$
Do not install IETP	$p(\pi-\alpha_2) + (1-p)\pi$

The firm will play the strategy for which the expected payoff is the highest. Unless the penalty is substantially higher than the cost of abatement for CETP, the expected payoff from 'do not install IETP' will always be higher than that from 'join CETP'. In that case, the firm will always play the strategy 'do not install IETP'. This can be illustrated as follows:[15]

Let $\pi = 10$, $c = 4$, $c_2 = 2$, $\alpha_1 = 3$, $\alpha_2 = 8$ and $p = 0.1$

$$\text{expected payoff}_{\text{join CETP}} = 10 - 4 = 6$$

$$\text{expected payoff}_{\text{instal IETP do not comply}} = 10 - 2 - 0.1 \times 3 = 8 - 0.3 = 7.7$$

[14] The strategy 'IETP and comply' is not considered because it was shown earlier that this is dominated by the strategy 'CETP'.

[15] This is based on hypothetical numbers and not on any data.

expected $\text{payoff}_{\text{do not instal IETP}} = 10 - 0.1 \times 8 = 10 - 0.8 = 9.2$

The expected payoff in this numerical example is the highest with the strategy 'do not instal IETP'. Thus, the firms will always choose the strategy 'do not instal IETP'.

From the above discussion the following main points emerge:

- The penalty imposed for non-compliance must be higher than the cost of compliance. Otherwise, the firms will always prefer not to comply with the standards.

- Penalties for firms which have their own effluent treatment plants but are not complying with the standards should be such that the sum of the penalty and their cost of treatment is higher than the cost of compliance C_1.

- *Firms will join CETP only if they consider the threat of punitive action from the regulator viable.* However, the way the regulatory system has been set up in India, the entire burden of proof of any violation falls on the regulatory agency, which makes it difficult for them to detect violations which ultimately result in conviction. This reduces the probability of conviction and thus the expected penalty. *Since in the context of SSIs, the cost of compliance with IETPs is likely to be generally higher than that with CETP, the SSIs which have not joined CETP can be taken to be in violation with the standards.*[16]

- CETPs, besides being low cost alternatives for pollution control for firms, are cost effective mechanisms for regulatory agencies as well in enforcing environmental regulation on SSIs. For, with CETPs in existence, lower

[16] According to an estimate IETPs are viable in the case of large tanneries with installed capacities of 6000 kg/day or more (MSE 1998).

levels of surveillance effort would be required, because monitoring will be at the level of CETP and not at individual firms, resulting in less pressure on regulator's budget. Further, existence of CETPs allows the regulator to adopt a more focused strategy of monitoring, resulting in achieving better compliance.

- SSIs which have not joined CETP should be placed on a special list and served notices to prove that they are complying with the standards. These firms should be subject to higher than average frequency of inspection. Self reporting of discharges by firms should be made mandatory. If firms fail to submit these statements, a presumptive value should be used for the amount of pollution generated by them and should be penalised accordingly. Presumptive value should be calculated on the basis of the highest pollution intensity per unit of output for firms in the same industry.

2.3 Motivating CETPs for continuous compliance

The literature on monitoring and enforcement of environmental legislation examines how polluters can be motivated for continuous compliance. Two different types of approaches can be identified in this context (Russel, *et. al.* 1986). First approach is characterised by the threat of penalty against violators. It may take various forms such as monetary fines, disconnection of electricity supply to the polluters, closure of polluting activity and imprisonment. The second approach involves the development of continuing relationship of trust between the regulator (agency) and the polluter (source) to ensure compliance within the system. This has been termed as voluntary compliance approach. Given the difficulties of surveillance, the latter approach appears to be more promising, especially in improving compliance from the CETPs.

In the voluntary compliance approach, the sources are seen as willing but imperfect complier. No fines are levied for each discovered violation, but the source is assumed to act and return to compliance. Justification for the assumption that the sources will make efforts to comply and the agency does not make use of fines or other legal sanctions for each violative incident lies in the costs and benefits to the sources and the agency regulating their actions.

Voluntary compliance is seen as an arrangement founded on mutual trust between the source (in this case a CETP) and the agency. While the agency agrees to take a tolerant attitude towards failures in continuous compliance giving a violating CETP a chance to return to compliance before seeking penalties, the CETP agrees to make a "sincere" effort to comply with the regulations. That is, the voluntary compliance approach requires some degree of compliance.

This system seems feasible as the costs to both parties for breach of trust are substantial. For the agency, the assurance that sources are making some effort to comply with the regulation, allows for lower levels of monitoring efforts. The engineering inspections need not be very elaborate as there is no need to gather evidence of a violation that will stand up in the court. Moreover, this approach makes it possible to further reduce the monitoring requirement by concentrating more on wilful violators as determined by monitoring.

For the CETP, the member firms would value the voluntary compliance status. For, the loss of this status may attract penalties and penalties can be substantial. It may be noted that these incentives (costs and benefits to firms and agency) are similar to fines that appear in the economic approaches of enforcement, except that in those approaches the sanctions are invoked whenever a violation is discovered. In the voluntary compliance approach, sanctions arise only when the agency considers the CETP/firm to be uncooperative.

The enforcement strategy in this case would be a mix of both promotion and coercion in compliance i.e., the regulator helps CETPs technically when required, and yet creates a perception among polluters that it is prone to use sanctions against violators.

The small number of CETPs, *vis-a-vis*, the large number of member firms of CETPs enables the regulators to work closely with the business community and influence it for compliance with the standards.

THE CETP SCHEME 3

The Government of India (GOI) has been providing fiscal incentives in the form of direct and indirect tax concessions to encourage industrial pollution control,[1] the benefits from which accrue mainly to the large firms. Since the accrual of benefits from fiscal incentives depends upon the installation of pollution control equipment by the firm, small firms are not able to reap the benefits due to their inability to mobilise the resources for setting up their own IETP. To encourage pollution control in SSIs, the GOI has started a scheme to promote CETPs for the SSIs. Under the scheme, capital grant and low interest loans are provided for setting up CETPs in industrial estates/SSI clusters. All proposals for loan and grant assistance have to fulfill the eligibility criteria.

3.1 Eligibility and procedures

In an industrial estate or cluster of SSIs, only one CETP can be promoted and only cluster of SSIs set up prior to January 1, 1990, are eligible for the scheme. A company or society constituted specifically to own, operate and maintain common facilities for treatment and disposal of waste generation by estates/clusters is eligible for assistance under the scheme. State infrastructural/industrial development agencies promoting CETPs are also eligible. The promoter company/society set up for implementing and commissioning the CETP, is required to undertake a thorough survey of the effluent situation at the site and make provisions for adequate pre-treatment or disposal of effluents not suitable for common treatment. A feasibility study regarding the economic and financial viability has to be conducted since the project should be self-financing for servicing the loan and meeting operation and maintenance costs. In addition, the project must enunciate adequate

[1] See Pandey, 1998.

institutional arrangements for the management, cost sharing, recovery of dues and ensure observance of the prescribed standards.

Once the above conditions are fulfilled, the promoter company/society has to submit a proposal in the prescribed form to the concerned State Pollution Control Board (SPCB) for approval. The project proposals are prioritised on the basis of toxicity of pollutants, pollution load proposed to be treated and number of units covered. Once the proposal is approved by the concerned SPCB, the promoter company/society is required to submit the proposal to the Industrial Development Bank of India (IDBI) and the National Environmental Engineering Research Institute (NEERI) with a copy to the MoEF. NEERI reviews the proposal and the detailed engineering design on behalf of MoEF. When satisfied with all aspects of the proposal, it forwards the technical clearance to the IDBI and the MoEF. The financing plan of the project is then approved by the IDBI. Once the proposal for setting up of a CETP is approved, the CETP project is entitled to grants from the Central and State governments as well as loan assistance from IDBI or other financial institutions. The IDBI sanctions the loan assistance and advises the company/society, the MoEF and the concerned SPCB of the acceptance of the financial proposal and the final cost of the project. The steering committee of the MoEF formally approves the release of grant component (see Table 2.1) in the financing plan and advises the concerned State government for release of the matching grant.[2] The grants from the GOI and the concerned State government besides the loan funds are released by the IDBI and channelled through the SPCB to the company/society. The SPCB monitors and reports the progress of the scheme to the GOI.

---

[2] Initially 25 percent of the total assistance is released. The second instalment of 50 percent and the last instalment of 25 percent are released only when utilisation certificates for the previous instalments have been submitted and duly verified by the SPCBs, subject to the release of proportionate shares by the State governments.

3.2 Financial assistance under the scheme

The grant and loan assistance is provided only in respect of capital costs of the CETP. This implies that the promoter company/society and/or members of the scheme have to bear the operation and maintenance cost of the CETP. Until the year 1995, grants from the Central and State governments were subject to a ceiling of Rs. 50 lakh each (Table 2.1, row 1).

Table 3.1. Financial Assistance to the CETP

Period	Central govt. Grant	State govt. Grant	Loan	Entrepreneurs Contribution	Total
upto 1995	25%*	25%*	30%	20%	100%
Since 1996	25%	25%	30%	20%	100%

* 25% subject to a ceiling of Rs. 50 lakh.

Source: Row 1: MoEF, 1996.

Row 2: GOI, 1996 (details on the reference page).

In view of the rising costs and the perception that ceiling on grant would encourage the formation of small size CETPs which may not fully reap the benefits of economies of scale in the wastewater treatment, the ceiling on grants have been eliminated since December, 1996 (Table 3.1, row 2). The grants from Central and State governments were limited to SSIs, but the loan included SSIs and the medium scale units in a cluster.

3.3 Adherence to financing norms

Available information on the financing pattern of CETPs under this scheme shows that while the government (both Central and State) grants have been at 50 percent of the project cost, the entrepreneur's contribution in the 18 out of 20 cases examined is less than the stipulated share of 20 percent (Table 3.2).

Table 3.2. Financing Pattern of the CETPs

S.No	Name/Location of CETP scheme	Financing pattern			
		grant		loan	entrepreneur contribution
		Central Govt.	State Govt.	Financial institution	Member firms
1.	CETP for Mallanpur, A.P.	25%	25%	50%	-
2.	CETP for Nacharam, A.P.	25%	25%	50%	-
3.	CETP for cluster of tanneries in Pammal & Pallavaram, T.N.	25%	25%	40%	10%
4.	CETP for cluster of tanneries in Erode, T.N.	25%	25%	40%	10%
5.	CETP for Dyeing units in T.N.	25%	25%	40%	10%
6.	CETP for Bollaram, A.P.	25%	25%	50%	-
7.	CETP for Vapi, Gujarat	20%	20%	50%	10%
8.	CETP for cluster of tanneries at Kadugondama, Karnataka	25%	25%	45%	5%
9.	CETP at Jeedimetla, A.P.	25%	25%	-	50%
10.	CETP at Govindpura, M.P.	25%	25%	50%	-
11.	CETP for cluster of dyeing industries in Textile colony, Industrial Area `A', Ludhiana, Punjab	25%	25%	40%	10%
12.	CETP for cluster of textile mills at Batala Road, Amritsar, Punjab	50%	-	40%	10%
13.	CETP for cluster of dyeing industries along Rahan Road, Ludhiana, Punjab	25%	25%	40%	10%
14.	CETP at Panoli, Dist. Bharuch, Gujarat	25%	25%	40%	10%
15.	CETP for Sarigam, Valsad, Gujarat	25%	25%	40%	10%
16.	CETP for Sachin, Gujarat	25%	25%	40%	10%
17.	CETP at Jayasingpur Industrial Cooperative Estate Ltd., Kolhapur, Maharashtra	25%	25%	40%	10%
18.	CETP at Pattancheru, A.P.	-	-	-	19.7%

S.No	Name/Location of CETP scheme	Financing pattern			
		grant		loan	entrepreneur contribution
		Central Govt.	State Govt.	Financial institution	Member firms
19.	CETP at Vaniyambadi, T.N.	25%	25%	35%	15%
20.	CETP at Kanpur, U.P.	65% by NRCD*	17.5%	-	17.5%

* NRCD: National River Conservation Directorate.

A.P. - Andhra Pradesh; T.N. - Tamil Nadu; M.P. - Madhya Pradesh and U.P. - Uttar Pradesh.

In the case of 4 out of 20 CETPs, the entrepreneurs' contribution is zero, in 12 CETPs member firms' contribution is 10 percent or less of the project cost as against the stipulated contribution of 20 percent. In these cases, the gaps have been filled up with loans from the financial institutions. Notable exceptions are CETPs at Jeedimetla and Pattancheru where the member units contributed as much as 50 percent and about 20 percent of the total cost respectively. It may be interesting to note that in these cases the initiative to set up CETPs have been taken by the industries themselves who have floated separate companies for the purpose of owning and operating the CETP. The general lack of initiative is reflected in their low contribution and can be attributed to lack of incentive stemming from a weak enforcement of legislation.

3.4 Institutional structure of promoter company

According to the procedural requirements, the initiatives for setting up CETPs have to be taken by the promotor company. If the promoter company/society is a co-operative or association of the participating industries, it is more likely that the participating firms would have adequate involvement in various aspects of CETP. On the contrary, if a government or semi-government body plays the key role in setting up a CETP, the likelihood of sufficient participation of member firms remains low. The table below, provides information in respect of 22 CETPs about who have taken the initiatives in setting up these CETPs.

Table 3.3. Existing CETPs and their Promoter Companies

S.No.	Name/Location of CETP	Promotor company/society
1.	CETP at Mallapur, A.P.	Andhra Pradesh Industrial Infrastructure Corporation (APIIC)
2.	CETP at Nacharam, A.P.	APIIC
3.	CETP at Pyara Nagar, Medak, A.P.	M/s Bonthapally Envirotech Pvt. Ltd.
4.	CETP at Bollaram, A.P.	M/s. Progressive Effluent Treatment Ltd.
5.	CETP at Ankaleshwar Estate, Gujarat	Gujarat Industrial Development Corporation (GIDC)
6.	CETP at Vapi Industrial Estate, Gujarat	GIDC
7.	CETP for industrial waste water at Jeedimetla, A.P.	Jeedimetla Effluent Treatment Ltd.
8.	CETP at Pattancheru, A.P.	Pattancheru Enviro Tech Ltd.
9.	CETP at Pashamylaran, A.P.	APIIC
10.	CETP for cluster of dying industries in Textile Colony, Industrial Area `A', Ludhiana, Punjab	Punjab Water Supply & Sewerage Board
11.	CETP for cluster of textile mills at Batala Road, Amritsar, Punjab	Punjab Water Supply & Sewerage Board
12.	CETP for cluster of dying industries, Rahon Road, Ludhiana, Punjab	Punjab Water Supply & Sewerage Board
13.	CETP for cluster of electroplating industries, Gill Road, Ludhiana, Punjab	Punjab Water Supply & Sewerage Board
14.	CETP at Panoli Dist. Bharuch, Gujarat	GIDC
15.	CETP at Sarigam, Valsad, Gujarat	GIDC
16.	CETP at Sachin, Gujarat	GIDC
17.	CETP at Tarapur, Maharashtra	Maharashtra Industrial Development Corporation (MIDC)
18.	CETP at Trans-Thane, Maharashtra	MIDC

S.No.	Name/Location of CETP	Promotor company/society
19.	CETP at Pali, Rajasthan (non-functional)	Rajasthan Industrial Investment Corporation (RIICO)
20.	CETP at Vaniyambadi, Tamil Nadu	Vaniyambadi Tanners Environmental Control System Limited (VANITEC)
21.	CETP at Nandesari, Gujarat	GIDC (in Nov. 1994, Nandesari Industries Association took up the operation and maintenance of the CETP)
22.	CETP at Jajmau, Kanpur, U.P.	Uttar Pradesh Jal Nigam (UPJN)

It can be seen from the above table that in a majority of cases, the initiative for construction of CETP has come from different government bodies. In most of the cases operation and maintenance of CETPs has remained with them.[3] Low contribution by industries towards the capital cost of CETP and the involvement of government bodies in setting up as well as operation and maintenance of CETPs can be attributed to the following:

- Lack of incentive in the absence of any strong threat of punishment against violators. In other words, under the current command and control (CAC) regime, without strict enforcement of discharge standards, there is no incentive for firms to voluntarily avail of the incentives available for setting up CETPs.

- Pollution abatement involves extra cost to the industries including the SSIs which generally operate in a competitive environment. Thus a group of firms or a firm will be inclined to bear the cost of abatement only if every other firm in that industry bears the cost. Hence, there is a tendency on the part of firms to adopt 'wait and see' attitude (MSE 1998).

[3] This information is received through personal communication with MoEF officials.

- Since there is heavy reliance on monitoring the "initial compliance", when under pressure, firms join the CETP – only half heartedly – which makes it possible for them to achieve the initial compliance status, perceived to be consistent with the current enforcement strategy of the regulators. However, achievement of initial compliance, usually has no effect in itself on environmental quality.

- The role of institutions such as the industrial development corporations (IDCs) and others in setting up CETPs can be explained as follows. While these corporations are concerned with the growth of industries in their regions, the mandate of SPCBs is to mitigate environmental problems. CETPs in this context can be seen as a bargain struck between the IDCs and the SPCBs. On one side of this bargain, the SPCB appears to be content, at least on first consideration, with the initial compliance status of a number of firms in its jurisdiction, in view of the fact that existence of a CETP would require lower levels of surveillance effort. This, in turn, reduces the pressure on the SPCB's budget. On the other hand, the promoter company, for example IDC, appears to gain by being able to use CETP as a cover against probable sanctions on polluting firms at least until such time as the focus of regulators shifts from initial compliance to continuous compliance. Sanctions in this type of arrangement are rare. The probability of sanctions is further reduced when a government body is involved in the operation and maintenance of the CETP. The arrangement, however, leads to a situation where huge capital investment in CETPs lie unproductive.

From the above it should not be concluded that the CETPs are inherently ineffective in controlling pollution from SSIs. In fact, CETPs are, in principle, a cost effective mechanism in containing pollution generated by the SSIs. While the case for promoting CETPs continues to be valid, there is a need to reorient the design and implementation of the CETP scheme to make it more effective.

3.5 Suggestions for making the scheme more effective

While the CETP promotion scheme provides much of the needed financial support for pollution abatement by the SSIs, certain weaknesses in its design and implementation constrain its effectiveness in controlling pollution. The following suggestions on changing the eligibility and implementation procedures of the CETP scheme could prove more effective:

- First, the process of forming a CETP from its concept to its completion requires the interface of its organisers with multiple government agencies at different levels, and financial and technical institutions which makes it cumbersome and time consuming. Delays in the release of subsidy, and loan from IDBI are reported to have led to considerable cost and time overruns. To expedite the completion of various formalities the government should set up a "Single Window Clearance System".[4] For technical evaluation of the project proposals, however, one or two other institutions should be designated in addition to NEERI.

- Second, the eligibility criteria under the scheme may be questioned. As per the rules "A company or society constituted specifically to own, operate and maintain the common facilities for treatment and disposal of waste generation by estates/clusters is eligible for assistance under the scheme." There are no provisions to ensure adequate representation of member firms in the promoter company, let alone their leadership role in the company. Lack of adequate participation of member units may have implications for the technical design, designed capacity as well as day to day working of the CETP:

---

[4] Review reports of the SPCB, as the monitoring agency, and NEERI and IDBI, as agencies responsible for evaluating the technical and financial aspects of the proposal respectively, should form the basis for the final approval of the proposal.

(i) Technical design of CETP is an important aspect in establishing and operating CETPs to achieve compliance with the standards. Efficient technical design is based on firm specific information on pollution profile. Firms have no incentive to reveal the true information unless they have adequate representation in the promoter company and thus commitment to make the CETP a success. Two cases where CETPs were designed on the basis of dated/wrong information are worth mentioning here. These are CETP in Jajmau, Kanpur (see chapter 5), and the CETP in Badli industrial area. Officials have alleged that the units located here have provided wrong information to lower their share of contribution to the construction cost of the CETP (TOI, 1998).

(ii) Where CETPs are operated and maintained by government bodies, member firms often default on payment of their share of treatment costs. This is because firms tend to perceive that pollution control is primarily the government's responsibility. This affects the smooth operation of the CETP. Chapter 5 deals with this issue in detail in the context of a case study of the CETP in Jajmau, Kanpur. However, it is important to mention that the most essential ingredient to successful combined treatment is the spirit of cooperation among the member industries. The member firms are likely to cooperate more when they perceive CETP as a cooperative institution owned by all of them. It is only then that they would be more inclined to abide by the rules relating to obligations of the members of the CETP and strive for cost minimisation by improving its efficiency over time. A purely private ownership of CETP may not work in the present context where cost of violating the discharge standards is less than the marginal cost of joining the CETP.

(iii) Public management of CETP poses a peculiar problem for the regulator, as one government body may find it difficult to take stern actions against another government body. For instance, statistics on the incidence of non-compliance among the large and medium firms by type of ownership shows that more than half (approximately 57 percent) of the non-complying units belong to the public sector, while the remaining 43 per cent are in the private sector (CPCB, 1995). This could be because of both inefficiency at the firm level and relatively more relaxed monitoring by the regulators.

- The role of agencies like IDCs and other public sector bodies in local industrial pollution control should not be undermined. Such agencies can play a very significant role in disseminating information, in motivating and organising the SSIs, providing guidance in preparation of technical and financial proposal, and technical expertise in operating the CETP. However, an association or a cooperative of member firms should have the control and responsibility for the establishment and successful operation of the CETP. Experts having experience in the formation and running of CETP should be included in the CETP management committee/board.

- The regulatory authority has the responsibility of examining and approving the cost sharing method proposed by the promoter company. Available information on existing cost sharing methods (see chapter 5) reveals that these are far from being equitable. A clear set of guidelines needs to be formulated in this respect for the regulating agencies.

- CETP, as an organisation should be made liable if any of its member firms discharges its effluents on public land or water. Strict liability with CETPs would not only require CETPs to keep a strict vigil on polluting activities of member firms, which is essential for the efficient operation of CETP, but would also result in considerable savings to the regulatory agency, as it would then be required to generally monitor the CETPs and not the member firms. At the same time, CETPs should be given sufficient powers to inspect and test effluents of any of its member firms at the firm's outlet level and take action against firms not complying[5] with the rules regarding payment of dues, strict adherence to their stated limits of discharge, pre-treatment obligation, framed by CETPs for member firms.

- An approved list of consultants for drawing up project proposals and also a list of contractors for construction and commissioning the plants will reduce delays at various stages of the project.

[5] While steps towards disconnection of power, water etc. are taken up by the IDCs and SPCBs, individual units remain under the control of SPCBs as far as pre-treatment of effluents is concerned.

SHARING OF EFFLUENT TREATMENT COSTS 4

Equitable sharing of the cost of CETP is crucial for efficient functioning of CETP and thus in achieving the goal of clean environment. Factors, such as, the volume of effluents, their nature and composition are important determinants of the cost of a CETP. In the literature, a number of methods for sharing of financial cost of joint treatment are discussed.[1]

These methods take into consideration (a) volume of the effluent, (b) both volume and pollutant concentrations, (c) noxiousness of effluent, (d) separate charges for different pollutants, and (e) *adhoc* measures, such as, plot size, production capacity, and net profits for calculation of charges.

However, these formulations have limitations which are either conceptual in nature, or implementational, or both. The conceptual problems relate to the choice of base for calculation of charges and the assumptions of constant marginal abatement cost. Recent empirical studies show that the latter is not valid.[2] The implementation problems include immense and accurate data requirements which are hard to obtain. Moreover, none of these methods of charging seem to provide incentives for pollution prevention. The following section examines some of the cost sharing arrangements prevalent in India and other countries.

1 For a review, see NEERI, 1992.

2 See Mehta, Mundle, and Sankar (1994) and Pandey, Rita (1996; and 1997).

4.1 Cost sharing arrangements in practice

4.1.1 Joint treatment plant for the Williamsport Tannery of the Armour Leather Co., USA:

A two – part tariff is levied based on water used by the firms and suspended solids (SS) in the waste water discharged by them. While a basic rate is charged per unit of waste water containing SS upto 300 mg/l, a surcharge is levied on those industries which discharge effluents containing suspended solids in excess of 300 mg/l. The surcharge varies according to the amount of the suspended solids in excess of the prescribed amount (300 mg/l). The schedule of rates also provide for a 30 percent discount on the basic rate to any industry which delivers its wastes directly to the sewage treatment plant instead of public sewage collection system. This method considers only one pollution parameter while ignoring those which have a bearing on the abatement costs. Further, this method uses water used instead of waste water discharge for calculation of tariff.

4.1.2 Bayport Central Waste Treatment System, Texas, USA

Bayport Central Waste Treatment System serves ten industries of heavy industrial class in Bayport Industrial Estate, Texas. Each waste stream is monitored for strength and volume on a regular basis. Volume measurements are made by flowmeters with continuous recorders, and samples are obtained at two or four hour intervals. A seven – day composite is made from the samples of each respective stream and analysis of the composite alongwith volumetric measurements serve as a basis for treatment charge. The waste treatment charges are scheduled in such a way, that these recover the operation and maintenance costs and a nominal return on the developer's investment. The schedule of charges is reviewed every year and necessary adjustments are made. This method does not differentiate between pollutants in waste water by the costs associated with their treatment, thus is not equitable for cluster of firms producing heterogeneous outputs and hence heterogeneous effluent streams.

4.1.3 CETP at the city of Winnipeg

A CETP caters to a number of industries including tanneries and metal plating industries as well as domestic sewage. Wastewater from each source is monitored regularly for strength and volume. The CETP authority (a government body) may impose a flow restriction limit to control maximum discharge rates to any sewer or body of water. In general, a uniform sewer rate is charged to all users whose wastewater has a biochemical oxygen demand within 300 mg/l and/or contains total suspended solids less than or equal to 350 mg/l. Any person or industry discharging overstrength wastewater into any city sewer is required to take an Overstrength Wastewater Discharge License from the CETP authority in advance. A person discharging such wastewater has to pay a surcharge over and above the uniform sewer rates. The surcharge is calculated as follows:

$$S = Q.R \text{ and}$$

$$R = [\frac{f_s(S_i - S_n)}{S_n} + \frac{f_p(P_i - P_n)}{P_n}].R_n$$

where

S = surcharge in dollars

Q = discharge to sewer in kilolitres for the billing period

R = surcharge rate, dollars per kilolitre

f_s = factor derived from costs of reducing total suspended solids

f_p = factor derived from costs of reducing BOD

S_i = total suspended solids (mg/l) of wastewater (minimum 350 mg/l)

P_i = BOD (mg/l) of wastewater (minimum 300 mg/l)

S_n = total suspended solids (mg/l) of normal wastewater (350 mg/l)

P_n = BOD (mg/l) of normal wastewater (300 mg/l)

R_n = unit charge based on cost of treating normal wastewater, in dollars per kilolitre

The CETP authority estimates the cost of treating the wastewater expected during the next one year. The factor R_n is computed based on the cost of treating normal wastewater. The factor f_s is estimated fraction of R_n associated with total suspended solids removal. The factor f_p is the estimated fraction of R_n associated with BOD removal.

The participating members can ask for an adjustment in charges for which they have to pay in advance the fees for the purpose of recovering the cost of administration, field investigation, meter inspection as well as the fee for the chemical analyses of the wastewater. This method has incentives built in the charging scheme to discourage overstrength wastewater with respect to only two pollutants, namely, BOD and suspended solids.

4.2 CETPs in India

4.2.1 CETP at Vaniyambadi, Tamil Nadu

For recovering fixed cost, a fixed amount is charged from the tanneries based on their production capacity as per the details given in Table 4.1.

Table 4.1

Production capacity (Kg/day)	Amount (Rs.)	No. of tanneries in the production range
200	60	1
250	60	2
400	60	1
500	85	43
750	125	7
1000	170	23
1500	250	1
2000	350	2
3000	600	2

Variable costs are recovered on the basis of actual hides processed at the rate of Rs. 0.10 per kg. This method assumes that tannery output is homogenous in nature and all tanneries are using same process technology. These assumptions are, however, incorrect (See section 4.3).

4.2.2 CETP at Nandesari, Gujarat

This plant serves the cotton dyeing and printing units. For the primary treatment plant, the annualised fixed costs are shared on the basis of net profits as follows:

Table 4.2

Net profits	% of annualised fixed costs to be shared
50 lakhs and above	80%
20 - 50	10%
10 - 20	7.5%
0 - 10	2.5%

The variable costs are recovered on the basis of water consumed, at the rate of Re. 0.50 per kl of water.

For the secondary treatment plant, fixed costs are shared on the basis of Rs. 3/KL of water consumed. The variable costs are shared on the basis of Rs.30/KL of water consumed. While, net profits are a strange proxy for pollution load, the amount of water consumed can be misleading in assessing the quantum of waste water generated.

4.2.3 CETP at Jeedimetla, Andhra Pradesh

The individual industrial members are required to undertake some treatment of their wastewater before sending it to the CETP. Waste water generated by firms is transported to the CETP through tankers. COD concentrations in waste water form the base for calculating the cost shares of each member industry. The rate structure is given below.

Quality of effluent COD, mg/L	**Rate of charge per 10000 litres (Rs.)**
1 - 5000	150
5001 - 10000	175
10001 - 15000	200
15001 - 20000	225
20001 - 35000	250
Above 35000	Additional charge of Rs. 25 per 10,000 litres for every 1000 units of COD. However, for such high loads, prior approval should be obtained by the firm from the Treatment Company.

A fixed charge is levied on member units, when they do not send effluents for treatment. This method assumes a constant marginal abatement cost of COD.

It may be noted here, that the member firms send their effluents to the CETPs by tankers instead of pipeline. Even while it makes the transportation of effluents costly, it allows the CETP management to measure the volume and other characteristics of effluents coming into CETP. It also ensures that the revenue collection is regular. For, the CETP company can refuse to take the effluent if any firm fails to pay its due share of total cost or sends over-strengthened waste water.

4.2.4 CETPs in Tamil Nadu

All the five CETPs examined in MSE, 1998 are registered as companies under the Companies Act, 1956. These CETPs use stock measures based on installed capacity for apportioning the capital, operation and maintenance, and loan service costs among the member firms. The advantage of these measures is that measurements have to be made only at the planning stage. These measures are, however, far from being equitable.

4.3 An alternative cost–sharing method

The existing cost–sharing methods mainly suffer from two limitations: (i) these are not equitable, and (ii) do not provide incentives to the member units for preventing and controlling pollution.

In designing a cost–sharing method which is free from the above limitations, it may be useful to distinguish between two different kinds of levies, each serving a different purpose. First, the levies that are intended to recover the costs of treatment of wastewater. These levies are also called users' fees, since they represent a fee for a service used. Second, a levy aimed at providing incentives to firms to reduce their pollution load. On considerations of economic efficiency, the latter seems to score over the former. For, under a system of charging based on pollution load, the industries have the incentive to upgrade their production technology, thereby, improving upon their effluent quality and the consequent savings in their share of abatement costs. Thus, an important attribute of the charging method chosen should be to encourage the polluting firms to recognise pollution as an economic problem.

4.3.1 Sharing of capital cost

In sharing the capital cost of a CETP, the expected volume of effluent and member specific cost, i.e. cost of conveyance form an appropriate base. Metering of the volume of effluent at each discharge point is, therefore, necessary. Until the time a dependable metering and measuring system is set up, this information can be gathered either through a survey, or random sampling procedures or on estimates based on technical norms. However, if in a cluster, there is a proportional relationship between the volume of effluent generated by the firms and their installed capacity, then either the output produced or the input used by the firms can be taken as the base for sharing capital costs among the members.

4.3.2 Sharing of operation and maintenance cost

The operation and maintenance costs of a CETP depend upon the volume of waste water treated, composition of waste water, treatment process and the extent of treatment. Since pollution characteristics of effluents and the process used in treatment may vary from industry to industry, it would be more appropriate to identify an industry in discussing the cost–sharing method. We thus focus on tanneries. To appreciate the suggested method of cost–sharing in Section 4.3.3, it may be useful to briefly discuss the tanning process and the effluent treatment process which bring out that different tanning processes as well as stages of these processes have a bearing upon the effluent quantity and quality which, in turn, have implications for the cost of treatment.

(i) The tanning process

The process of converting hides and skins into leather is called tanning. The whole process can proceed in two stages: conversion of raw hides to semi-finished leather, and conversion of semi-finished leather into finished leather. All tanneries do not necessarily undertake both the processes. Thus, on the basis of various stages of processing, tannery units can be classified into three categories: (i) which undertake both the processes; (ii) which convert raw hides to semi-finished leather; and (iii) which process semi-finished leather into finished leather. For conversion of hides into leather, two types of tanning processes are used, namely, chrome-tanning and vegetable-tanning. The stage of production as well as the tanning process used have a bearing upon the quantity and quality of waste water generated. The general characteristics of tannery waste water are given in Tables 4.1 to 4.3.

Table 4.1. Characteristics of Vegetable and Chrome Tanning (Raw to Finish) Waste Water

S.No	Parameter	Concentration range		Prescribed limits when discharged into	
		Vegetable Tanning	Chrome Tanning	Inland Surface Water	On land for irrigation
1.	pH	8.7 - 9.5	7.8 - 8.5	5.5 - 9.0	5.5 - 9.0
2.	SS	3000 - 5600	3000 - 4500	100	200
3.	TDS	8500 - 19680	14000 -20500	2100	2100
4.	BOD	2300 - 2650	1200 - 2500	30	100
5.	COD	5320 - 7160	3000 - 6000	250	-
6.	Sulphide	75 - 90	20 - 40	2	2
7.	Total Chromium	8 - 22	80 - 250	0.1	1.0
8.	Oil and Grease	17 - 43	28 - 55	10	10

Source: MSE, 1998.

Table 4.2. Characteristics of Raw to Semi-Finish Process Water

S. No.	Parameters	Concentration range		Prescribed limits when discharged into	
		E.I.	Wet Blue	Inland surface Water	On land for irrigation
1.	pH	8.5 - 9.3	7.3 - 8.5	5.5 - 9.0	5.5 - 9.0
2.	SS	570 - 2450	2080 - 3600	100	200
3.	TDS	8100-12600	9500-14300	2100	2100
4.	BOD	1570 - 2650	980 - 2350	30	100
5.	COD	2400 - 3800	1780 - 3200	250	-
6.	Sulphide	15 - 12	20 - 50	2	2
7.	Total Chromium	ND*	560 - 870	0.1	1.0
8.	Oil and Grease	60 - 75	12 - 32	10	10

* ND - Not detected.

E.I. and Wet Blue are process stages reached using vegetable-and chrome-tanning processes respectively.

Source: MSE, 1998.

Table 4.3. Characteristics of Semi-Finished (E.I. and Wet Blue) to Finished Leather Process Waste Water

S. No.	Parameters	Concentration range	Prescribed limits when discharged into	
			Inland surface Water	On land for irrigation
1.	pH	6 - 7.2	5.5 - 9.0	5.5 - 9.0
2.	SS	670 - 920	100	200
3.	TDS	3800 - 4926	2100	2100
4.	BOD	760 - 1500	30	100
5.	COD	2800 - 4400	250	-
6.	Sulphide	ND*	2	2
7.	Total Chromium	ND*	0.1	1.0
8.	Oil and Grease	22 - 39	10	10

* ND - Not detected.

Source: MSE, 1998.

From the tables above two points are worth noting. One, the stages of processing have a strong bearing on the quality of effluents; and two, vegetable tanning is more polluting, *vis-a-vis,* chrome-tanning in terms of BOD, COD, SS and sulphide discharges.

(ii) Effluent treatment

Various pollutants present in tannery waste water are controlled through a joint treatment process. Treatment of tannery effluent basically includes controlling alkalinity/acidity, primary solid separation, biological treatment – using both anaerobic lagoon and aeration tank or aeration tank alone, and secondary treatment in either aerated lagoon or aeration tank. Sludge is taken care of either by drying it in sludge drying beds or by using sludge thickening process in sludge thickeners.

(iii) Cost-sharing method

Since the operation and maintenance costs of effluent treatment depend on the volume and characteristics of effluents, the share of each firm in the total cost should, therefore, be based on the volume and characteristics of the effluent discharged by them. The cost-share of each firm can be calculated as follows:

$$\text{Cost} = P_i\, Q_i\, Z \,/\, \Sigma(P_i.Q_i)$$

Where, Q_i = Annual wastewater discharged by ith firm

Z = Total cost of treatment (per unit of effluent)

P_i = a measure of degree of pollution in the waste water of the ith firm

P can be seen as an index of pollutant concentrations present in the effluent.

This is calculated as follows:

$$P = \left[\alpha \frac{A}{A_0} + \beta \frac{B}{B_0} + \nu \frac{C}{C_0}\right]$$

Where, A = settleable matter in wastewater, mg/l

B = concentration of BOD in wastewater, mg/l

C = concentration of COD in wastewater, mg/l

A_0, B_0 and C_0 are the prescribed discharge standards, specified in mg/l, for settelable matter, BOD and COD respectively. The α, β and γ are expressed in fractions, and represent the relative costs of treatment of settlable matter, BOD and COD respectively.

This method has the advantage of being transparent. Besides, it results in equitable cost-sharing and provides incentives to firms for pollution prevention.

Successful implementation of this method would require accurate metering devices for measuring the quantity and strength of waste-water. Until this is done, estimates generated through random sampling and testing should be used. Self-reporting of discharges (both in terms of volume and pollution characteristics) by firms should be made mandatory. For, firms which fail to submit these statements, a presumptive value should be used for the amount of pollution generated by them. Any significant variation between the stated pollution and the actual amount of pollution (detected through random checks) should entail a penalty. Such firms should also be entered in a special list. Firms on such a list should be subject to higher than average frequency of inspection.

Cost shares should be estimated at the beginning of the year, to be paid in advance on a quarterly basis. Settling of accounts should take place in the last quarter. There should be penalties when emissions exceed the stated levels, and rebates where emissions are below the stated levels. Penalties and rebates can be pro rated depending upon the length of time the emissions exceeded (were lower than) the stated levels.

CETP AT JAJMAU - A CASE STUDY 5

Tanning industry is one among the important export-oriented industries of the country. It has also been identified as one of the major polluting industries and among the 17 priority industries for action. According to an estimate (Rajamani, 1993), there are more than 2500 tanneries in India with a total processing capacity of 600,000 tonnes of hides and skins per year. The total waste water has been estimated at 80,000 cubic metre per day.

The tannery complex at Jajmau, Kanpur, U.P. largest in the country, is situated on the banks of the river Ganga. Until recently, tannery units in this complex discharged their waste water directly into the river, thus severely polluting it. Since most tanneries in this cluster are small, it was difficult for them to obtain finances and space for individual effluent treatment plant. Thus, there was a case for a combined effluent treatment plant. In view of the cost advantages in treating the industrial and domestic (sewage) waste together, a joint waste water conveyance and treatment system was envisaged with minimal pre-treatment at individual tanneries. In March, 1994, a 36 mld Upflow Anaerobic Sludge Blankets (UASB) Process Waste-water Treatment Plant was commissioned.

5.1 Ownership and management of CETP

The CETP was conceived, planned and comissioned by the Uttar Pradesh Jal Nigam (UPJN) with the assistance of Dutch consultants. It was proposed that the UPJN would operate and maintain the CETP until the stabilisation stage, thereafter, Kanpur Jal Nigam (KJN) would take over this function from the UPJN. However, till date UPJN continues to operate and maintain the CETP. To oversee the operation and management of the CETP, a committee which is advisory in nature has been formed. The committee constitutes of a chairman, a member secretary and 12 members. The District

Magistrate of Kanpur and the Project Manager, Ganga Pollution Control Unit are the chairman and member secretary of the committee respectively. Of the twelve members, three each[1] are nominees of Small Tanners Association, Jajmau and Hindustan Merchant Chambers of Commerce, Jajmau. The other members are the General Manager, GPCU; a nominee of Kanpur Municipal Corporation; General Manager, Kanpur Jal Sansthan; General Manager, Kanpur Electricity Supply Authority; Managing Director, Industries; and Regional Officer, Kanpur, UPPCB.

While there may be certain advantages in a public agency owning and managing a CETP, there are numerous disadvantages of this arrangement:

- Potential inefficiency in public sector enterprises.
- Lack of flexibility in operation and choice of staff.
- Lack of incentives to be innovative.
- Poor recovery of dues from the users.
- Lax monitoring resulting in compromises in compliance.

With the help of the available data, an attempt is made to examine the performance of UPJN, responsible for the operation and maintenance of the Kanpur CETP, in respect of its three main functions: compliance with the standards; billing and recovery of dues; and monitoring of discharges of the member units.

---

[1] Until recently there were only two representatives of the tannery associations.

So far as compliance with the standards is concerned, the UPJN claims of meeting the discharge standards. The UPPCB, however, could not comment on this. The fact that the farmers, on whose land the CETP is discharging its treated water, have not protested against the CETP seems to provide some support to UPJN's claim in that the discharged water is not harmful to the soil, at least in the short-run. However, the quality of crops and long term effects of this water on soil are yet to be checked for any harmful elements because of the discharges of CETP.

The performance of UPJN in recovering the dues from industrial users has been very poor with only 30 percent recovery of the total outstanding amount as on January 1, 1998. This has raised serious doubts about the financial viability of the CETP. This issue is discussed in detail in section 5.3.

There is no provision for regular monitoring of the effluents of user industries. Surprise checks are conducted occasionally by teams comprising officials from the UPPCB and UPJN only to check whether primary treatment plants of the member units are working adequately. Those found violating are, however, warned. UPJN is not empowered to take direct action against violating industries, these powers are vested with the UPPCB. Penalties which would act as a deterrent are rare.

Fluctuations in effluent quality and quantity fed to the CETP can be a serious impediment to proper functioning. It is reported that the Kanpur CETP has so far been able to absorb the fluctuations in effluent quality resulting from non-compliance by user industries, because of the excess capacity it has, and the treatment technology used. This, however, does not undermine the need to develop systems for monitoring and penalising the defaulters.

5.2 Profile of tanneries

The tannery complex at Jajmau consists of 300 firms. On the basis of their final output, these are categorised into tanneries, leather board and split leather industries. Processing capacities of these firms show substantial variation, ranging from 5 to 760 hides or hide-equivalents per day, using vegetable, chrome, and mixed tanning operations. Most tanneries process buffalo hides while the remaining use calf, goat, and sheep hides. Most of the firms in this complex were earlier doing vegetable tanning. However, the growing export orientation of the industry and the consequent rise in demand for fine leather has resulted in widespread adoption of chrome-tanning operation. Of the 300 units, 50 are undergoing chrome-tanning process and another 50 are using mixed tanning operations. The chrome utilisation in tanning operation is in the range of 55 to 60 percent, depending upon the type of hide processed, its temperature, and additives used etc. The remainder find their way in spent tan liquor resulting in high chrome concentrations in the effluent.

5.3 Characteristics of waste-water

The Environmental and Sanitary Engineering Project (ESEP) conducted a survey to characterise the tanneries' waste water in Jajmau. The main pollutants of the most unclean processes are, as an illustration, compared with the prescribed standards in Table 5.1.

Table 5.1. Comparison of Characteristics of Composite Waste Water from the Most Polluting Tanning Processes with Some Standards

S. No.	Pollutant	Concentration of composite waste water	Type of process (most polluting only)	Prescribed standards*
1.	pH	9.2	raw to wet blue (chrome tanning)	5.5 - 9.0
2.	Alkalinity (as CaCO3)	7,100	headpieces	
3.	BOD5	6,100	vegetable tanning	100
4.	COD	18,300	headpieces	-
5.	Total solid	65,900	headpieces	-
6.	Dissolved solids	49,000	headpieces	2100
7.	Suspended solids	16,900	headpieces	200
8.	Chloride (as CL)	27,500	headpieces	-
9.	Sulphate (as SO4)	4,000	chrome tanning	-
10.	Sulphides (as S)	180	chrome tanning	-
11.	Kjeldahl nitrogen (as N)	1,700	headpieces	-
12.	Phospate (as P)	5	veg. tann. and head pieces	-
13.	Chromium (as Cr)	400	chrome tanning	-

* For discharge on land for irrigation.

From the table above, three main points can be seen. One, processing of head pieces (skin on the head of the animals) is most polluting. Two, tanneries produce waste water which have pollutant concentrations far beyond the prescribed limits. Finally, discharge standards have not been specified for several pollutants harmful to environment.

Owing to the highly polluting nature of the effluent, primary treatment of effluents is compulsory for all tanning units. The effluent quality of the tannery waste water after primary treatment and the corresponding standards have been presented in Table 5.2. Since the effluent quality shows variation due to seasonal and other factors over the year, the figures in Table 5.2 reflect the range of variation.

Table 5.2. Characteristics of Tannery Waste Water

Parameter	Tannery effluent after primary treatment	Standards for primary treatment
pH	8 - 9	6.5 - 9.0
BOD	1000 - 2000 mg/l	-
TSS	3000 - 6000 mg/l	600 mg/l
COD	4000 - 6000 mg/l	-
Chromium (for Chrome tanneries)	50 mg/l	45 mg/l

Source: UP Jal Nigam and CPCB, 1995.

Pollution of river Ganga, in Kanpur, is not limited to tanneries only. Domestic sector of the city of Kanpur severely pollutes this river. It is estimated that 55-60 percent of the total organic load in Kanpur (BOD) originates from the domestic sewage lines. However, in terms of concentration of pollutants per unit of waste water, the quality of domestic sewage is better as compared to tannery waste water (see Table 5.3).

Table 5.3. Characteristics of Domestic Sewage

Parameter	Effluent
BOD	247 mg/l
COD	644 mg/l
pH	8.5 mg/l
Total Suspended Solids	640 mg/l
Volatile Suspended Solids	258 mg/l
Total Dissolved Solids	1540 mg/l
Total Fixed Solids	1855 mg/l

5.4 Effluent treatment

In Jajmau, 36 mld UASB treatment plant has been designed to treat 9 mld tannery waste water and 27 mld domestic sewage water. Tannery waste water which is currently of the order of 8 mld is transported to the common effluent treatment plant through a network of collection and conveyance system. The waste water is transported through the collection drains to the four pumping stations. The channel type collection drains are provided in such a way that they go along the tanneries, as close as possible. The effluent is pumped and conveyed under pressure to the treatment plant through a common pipe from the four pumping stations. Each pumping station is provided with a grit chamber and a screen to remove the suspended matters from the waste water.

Domestic sewage (25 mld) is pumped through a pumping station to the treatment plant. As in the case of tannery effluent, the domestic waste water also enters the treatment plant through the screen and grit chambers before it is collected in the mixing tank.

In the mixing tank, tannery and domestic waste water is mixed. The mixed effluent is pumped from the main pumping station (MPS) and fed to the UASB reactors for treatment. In the treatment plant, biological treatment takes place. In this type of treatment, the organic pollutants are broken down through bacteriological processes. UASB is a very high rate and compact anaerobic process which requires a retention time of only 8 hours, which is substantially lower than the retention time required in Anaerobic lagoons (10-20 days) and Aerated lagoons (4 - 6 days) processes.

The treated effluent from the UASB reactors is diverted to post treatment plant for further treatment. The first stage post treatment plant for 36 mld UASB effluent treatment plant was commissioned in April, 1996. In this plant, effluent is subjected to aerobic treatment for further reduction in BOD. After this treatment, the effluent is mixed with the treated waste water of 130 mld sewage treatment plant and discharged for irrigation. Sludge is pumped to the sludge thickener for thickening. The thickened sludge is gravitated to the sludge drying beds for dewatering. Dried sludge is used as manure by local farmers. Characteristics of waste water after UASB process and post treatment are shown in Table 5.4.

Table 5.4 Performance Monitoring of 36 MLD UASB Treatment Plant

Parameter	Influent	Effluent		Prescribed standard*
		UASB	Post Treatment	
BOD	434 mg/l	193 mg/l	98 mg/l	100
COD	1040 mg/l	433 mg/l	218 mg/l	-
pH	8.6	7.7	8.1	5.5 - 9.0
Temperature (°C)	30.8	30.8	31	
Total Suspended Solids	1023 mg/l	393 mg/l	180 mg/l	200
Volatile Suspended Solids	430 mg/l	208 mg/l	102 mg/l	
Total Dissolved Solids	2641 mg/l	1261 mg/l	607 mg/l	2100
Total Fixed Solids	2770 mg/l	1225 mg/l	598 mg/l	

Source: UP Jal Nigam.

* For discharge on land for irrigation.

It can be seen from the above table that the post treatment brings the pollutant concentration below the prescribed standards.

5.5 Sharing of cost of CETP

5.5.1 Capital cost

The capital cost of CETP was estimated at Rs. 7 crore. However, the actual cost incurred including the first stage post-treatment plant was Rs. 21.91 crore. The difference in the estimated cost and actual cost can be attributed to both cost escalation and the first stage post treatment plant which was not included in the initial plan. Of the total capital cost, 65 percent was contributed by the National River Conservation Directorate and the remaining 35 percent was proposed to be shared equally between the State government and the tanneries. That is, the tanners were expected to pay 17.5 percent of the total cost. The tanners, however, did not agree to pay initially, but after a Supreme Court ruling that they must pay their contribution towards the capital cost of CETP within a specified timeframe or face closure, the tanners paid 17.5 percent of the initial estimated cost i.e., Rs. 7 crore. After a lot of persuasion, they paid 10 percent of the balance amount while the rest was contributed by the *Mandi Samiti Parishad.* The *Mandi Samiti Parishad* charges a levy on raw hides from the tanners. The amount thus collected is used for the development of the industry.

5.5.2 Operation and maintenance cost

(i) Cost sharing between municipal authority and tanners

Initially it was proposed that 30 percent of the O & M cost would be borne by the Kanpur Nagar Nigam (KNN), the municipal organisation responsible for domestic sewage and water supply besides other functions. The remaining 70 percent would be borne by the tanners. However, owing to a growing discontent among the tanners on the proposed cost sharing arrangement, a committee was constituted by the UP Government to look into it. The Committee consisted of representatives of UPJN, *Nagar Maha Palika*, UPPCB and two representatives of tanneries.

The committee identified BOD as the single most important factor having a bearing on the cost of effluent treatment and decided that the costs will be shared proportionately on the basis of the BOD load. The UPPCB was given the responsibility of collecting and testing the discharge samples from the tannery effluents and domestic effluents to determine their BOD levels.[2] The respective BOD levels were found to be 1100 mg/l and 236 mg/l. It may be recalled that the tannery and domestic wastewater discharge ratio is 1:3. Based on the volume and BOD concentrations, the cost sharing arrangement for the O & M costs of the Kanpur CETP was worked out in the following

[2] We were not given access to this information inspite of vigorous persuasion from our side, as also written advice from the MoEF.

way:

share of tanneries = (1x1100)/(3x236 + 1x1100) = 60.80 %

= 60% approx.

similarly, share of KNN = (3x236)/(3x236 + 1x1100) = 39.2%

= 40% approx.

Accordingly, it was decided that the O & M cost would be borne by the tanneries and the KNN in the ratio of 60 and 40 respectively.

However, cost sharing on the basis of BOD load alone has some serious limitations. It assumes that the total cost of treatment and maintenance of CETP is solely attributed to BOD removal. Other important factors like COD, TSS, TDS and pH are totally ignored. For example, pH level in the waste water is an important determinant of the maintenance cost because any basic or acidic effluent might result in substantial wear and tear of plant equipment and consequently escalate the maintenance cost.

Further, the O & M cost of industrial waste water common conveyance system and the 25 mld raw sewage pumping station should be borne entirely by the tanners and KNN respectively. There is no justification for sharing these costs in the ratio of 60 and 40.

(ii) Rate of levy for recovering tanners' share of O & M cost

Once the O & M cost is apportioned between the tanners and KNN, the UPPCB's task is to determine a tariff to recover the tanners' share from the user tanning units. For recovering the tanners share of O & M cost, the UPPCB has worked out a tariff based on per unit of hide processed. As noted earlier, in the tannery cluster in Jajmau, there are three types of tanning industries: firms processing raw hides to finished leather; firms processing split leather to finished leather; and leather board industries. Since these industries vary considerably in raw material usage as well as production processes, in order to compare across heterogeneous units producing various types of products, it is necessary to bring down all such units to a common base. The UPPCB has done this by converting the main input (hides) used. The input used is estimated on the basis of the hides' processing capacity of firms. Inputs used by split to finished leather units and leather board industries have been converted into raw hide equivalents. The tariff is then determined as:

tariff per unit of raw hide processed

$$= \frac{\textit{Tanners' share} \text{ of total cost}}{\textit{no.} \text{ of working days x total no. of hides processed per day}}$$

contribution of an individual tannery = tariff per unit of hide processed x total no. of hides processed by the tannery

For 1996-97 the rate of tariff per unit of raw hide processed was Rs.1.74. However, this method of determining the tariff fails to take into account significant variations in production processes and thus BOD levels among the member units. Chemical analysis of effluent samples from tanneries in Jajmau shows that the BOD concentration in tanning effluents varies from 380 mg/l to 3100 mg/l (NEERI, 1992). Thus calculations based on mean values of BOD levels would lead to incorrect results because the variation around the mean is significant. In other words, units with BOD level higher than the average will be subsidised by the units whose BOD levels are below the average. This is clearly not in line with the polluter pays principle. Also, it does not provide incentive to the member units to reduce their pollution load. It only acts as a users' fee, *albeit* inefficiently.

The following table gives the volume of effluent generated and BOD concentration in effluent of a representative firm for three categories of tanning industries in Jajmau, Kanpur:

Table 5.5 Effluent Characteristics of Representative Firms

S. No.	Process	Production capacity (no. of raw hides or equivalent processed per day)	Volume of effluent (Kl/d)	Concentration of BOD (mg/l)
1.	Raw to finished	30	14.4	1600
2.	Split to finished	30	4.8	800
3.	Leather board	30	10	800

Source: UPPCB.

While the category 'Raw to Finished' leather defines the production capacity in terms of number of raw hides processed, for the other two categories the production capacity has been defined in terms of the raw hide equivalent (table 5.5). It can be seen from the same table that while production capacities of the representative firms are same for all the three categories, there exist significant variation in the volume of effluent generated and BOD concentration in effluent. This is somewhat puzzling. For, when the underlying principle of cost sharing in Kanpur CETP is BOD load, then inputs used by the industries in the second and third category should also be converted into raw hides equivalent using the BOD load. In that case units with same production capacity (defined either in terms of raw hide processed or equivalent) should have the same BOD load (volume x BOD concentration).

Using the data in Table 5.5, the BOD load per unit of raw hide processed has been calculated and presented in Table 5.6:

Table 5.6 BOD Load of Representative Firms

S.No	Process	Effluent generation per unit of raw hide processed (lt/hide)	BOD (mg/l)	BOD load per unit of raw hide processed (gm/hide)
		(1)	(2)	(3) = (1) x (2)
1.	Raw to Finish	480	1600	768
2.	Split to Finish	160	800	128
3.	Leather Board	330	800	264

The above table shows that the BOD load of raw to finished leather category is thrice as high as that of leather board category and six times as high as BOD load of split to finished leather. From the above, it may be inferred that the BOD load is not used as a criterion for converting other inputs into raw hide equivalent. As in the case of this CETP, BOD has been identified as the single most important factor in cost apportionment between tanners and KNN, the same should be used as the criterion for cost-sharing among the tanners.

Using the effluent generation and BOD load figures in Table 5.5, the cost shares of each category can be calculated by using the following procedure:

Let us denote the above three categories of industries by R, S and L respectively. Let the total number of raw hides processed by each of them be H_R, H_s and H_L respectively. Now if the total cost to be apportioned among the tanners is X, then

$$\text{share of raw to finish industry} = \frac{6H_R}{6H_R + H_S + 2H_L} . X$$

$$\text{share of split to finish industry} = \frac{H_S}{6H_R + H_S + 2H_L} . X$$

$$\text{share of leather board industry} = \frac{2H_L}{6H_R + H_S + 2H_L} . X$$

Once the share of each category of industry has been determined, then a flat tariff can be used to distribute the share within each category according to the production capacity.

Alternatively, BOD can be used to determine the raw hide equivalence of split to finished leather and leather board industries rather than using any other equivalence criterion. This can be done by using the following simple formula:

raw hide equivalence of split to finished leather

$$= \frac{\text{BOD concentration(S - F) x Vol. of effluent(lt / d)}}{\text{BOD load Raw to Finish(mg / hide)}}$$

and

raw hide equivalence of leather board

$$= \frac{\text{BOD concentration(L - B) x Vol. of effluent(lt / d)}}{\text{BOD load Raw to Finish(mg / hide)}}$$

Thus from Table 5.5, we can calculate the production capacities of split to finish and leather board by making use of the raw to finish data and BOD concentration and volume of effluent data of split to finish and leather board.

Raw hide equivalence of a split to finish industry whose effluent generation is

4.8 kl/d = $\frac{800x4800}{768x1000} = 5$

and

Raw hide equivalence of a leather board industry whose effluent generation is

10 kl/d = $\frac{800x10000}{768x1000} = 10.5$

Once the raw hide equivalence is calculated on the basis of BOD load, it can be added up across industries to determine a flat tariff rate per unit of hides processed.

However, though this method of determining the rate of tariff would be an improvement over the method currently in use, as mentioned earlier, the tariff rate so determined will not reflect the true share of the member units in effluent treatment cost due to significant variations in the production processes and effluent characteristics within each category of industries and among categories.

5.6 Recovery of dues from tanners

Majority of the tanners are permanent defaulters so far as paying of the dues is concerned. As on January 1, 1998, only 30 percent of the total outstanding dues were paid by the tanners. This has raised serious doubts about the financial viability of the CETP.

Table 5.7 Distribution of Tanneries According to Production Capacity and the Corresponding Recovery Rate (1996-97)

Size of the tanneries (according to no. of hides processed per day)	No. of tanneries	No. of tanneries within each recovery rate bracket					
		100%	99-75%	74-50%	49-25%	24-10%	Less than 10%
Small :	183	11	2	11	6	1	152
5 - 50		(6.01)	(1.09)	(6.01)	(3.28)	(0.55)	(83.06)
Medium:	104	10	1	13	11	14	55
51 - 250		(9.62)	(0.96)	(12.50)	(10.58)	(13.46)	(52.58)
Large:	8	1	1	5	0	1	0
251 and above		(12.50)	(12.50)	(62.50)	(0.00)	(12.50)	(0.00)
Total	**295**	**22**	**4**	**29**	**17**	**16**	**207**
		(7.46)	**(1.36)**	**(9.83)**	**(5.76)**	**(5.42)**	**(70.17)**

Source: UP Jal Nigam.

Note: Figures in brackets indicates percent of tanneries within each group.

The above table shows the distribution of tanneries in Jajmau according to the production capacity and the recovery rate. Recovery rate is defined as the amount paid by an individual tanner as percent of total outstanding dues against him. The above table shows that the recovery rate is less than 10 percent for 70.17 per cent of the tanneries, whereas only 7.46 percent of the tanneries have paid their entire dues. A low correlation coefficient of 0.16, between recovery rate and the production capacity, also rules out the possibility of any relationship between willingness to pay and production capacity. On the one hand, units with low production capacity (5 hides per day) have paid their entire dues; on the other hand, units with production capacity of 400 hides per day are yet to pay more than 80 percent of their total dues.

One of the major reasons behind non-payment is the non-co-operative attitude of the tanners. Despite the Supreme Court ruling which requires the tanneries to install their own primary effluent treatment plants and share 60 percent of the O & M cost of the CETP, the tanners continue to default. The UPJN is not empowered to take any direct action against defaulters. However, it can issue a Recovery Certificate (RC) in the name of defaulters through the District Magistrate, who is empowered to execute the RCs using various means including attachment of property. But because of political compulsions, RCs were never issued and action against defaulters have remained restricted to pleading and pursuance.

In a meeting, some of the tanners, however, did indicate that they were prepared to contribute to the treatment of their waste water. However, they believe that the O & M cost of the treatment need not be as high as shown. They also indicated that they would like to be involved in the management of the treatment plant.

In an attempt to involve the tanners in the management of the CETP, a 12 member working committee was formed in 1996 with 6 representatives from two different associations of the tanners. This committee being supervisory in nature with no effective powers has failed to improve the situation. It is reiterated that direct involvement of the tanners in the management of the CETP is essential. Since the CETP caters to the domestic sewage and the tannery wastewater, the management of the CETP should comprise of the representatives from the tanners and *Kanpur Jal Sansthan.* The role of UPJN should be reduced to providing technical help to the CETP management for the purpose of its successful operation and maintenance.

ASSESSMENT AND RECOMMENDATIONS 6

Pollution is caused by both SSIs as well as medium/large-scale firms. The former, though small in scale of operation, are large in number such that the pollution from these SSIs constitute a considerable part of the total industrial pollution in India. However, owing to both political and budgetary considerations and general administrative deficiency of regulatory agencies, the enforcement of environmental regulations on SSIs is poor. Another important factor constraining the effective enforcement is lack of comprehensive data on the polluting activities of industries.

Financing for pollution abatement and clean technology adoption is difficult to obtain for SSIs. Owing to substantial economies of scale in joint treatment and lower costs of monitoring and enforcement, CETPs are a cost effective mechanism in addressing the pollution problems of SSIs. The GOI scheme of providing financial assistance for setting up CETPs is a welcome policy in encouraging pollution control in SSIs.

6.1 Constraints of the present system

The success of any pollution control policy depends on both the design and effective implementation of the policy. In reviewing the CETP scheme of the GOI and the monitoring and enforcement of environmental laws on SSIs, some facts are listed below.

- Monitoring and enforcement of environmental legislation on SSIs is very poor. Complete lack of statistics on the compliance status of SSIs is a good indicator of the poor monitoring by regulatory agencies. Also, the current system lacks economic incentives to encourage industries to either voluntarily set up an IETP, or avail the incentives available for setting up the CETPs, or voluntarily join a CETP coming up in their estate.

- The process of forming a CETP requires the interface of its organisers with multiple government and non-government agencies which in turn makes the process of obtaining various clearances and subsidies cumbersome and time consuming. This results in time and cost overrun of the projects.

- Under the CETP scheme, any company formed to own and operate the CETP is eligible for financial assistance whether in the public, or private, or joint sector. A majority of CETPs have been set up with the initiative of public sector agencies. Many CETPs are operated and maintained by them. Where CETPs are operated and maintained by government bodies, the user firms often default on payment of their share of treatment costs, thus affecting their proper functioning. This is because firms tend to believe that pollution control is primarily the government's responsibility.

- Public management of CETP poses a peculiar problem for the regulator. A government body finds it difficult to take stern actions against another government body. Government statistics on initial compliance in respect of large and medium firms reveal that more than half of the non-complying units belong to the public sector, while the remaining are in the private sector. This reflects upon both public sector industries' inefficiency in pollution control as well as the relatively relaxed monitoring and enforcement of environmental regulation on public sector industries.

- CETPs established by government bodies are generally designed on the basis of either dated information or on information generated using technical norms which is far from the actual pollution profile of the industries. Such designs are not optimal and fail in achieving the desired results.

- Cost-sharing methods currently in use are far from being equitable. They lead to disputes between the CETP management and user industries, resulting in long delays in payment which, in turn, affect the operation and maintenance of the CETP. Also, these do not provide incentive to the user firms to reduce their pollution load.

- In recent years, several pollution generating units have been closed down through court orders. However, in most of the cases, these industries have appealed against the closure in the higher courts. While many of the cases are still pending in the higher court, these industries are maintaining *status quo*. The lengthy legal procedure provides a shield to the polluting firms.

6.2 Recommendations

Reliable statistics are absolutely essential for policy formulation as well as its evaluation. Each State should collect data on the pollution profile of their SSIs by type of industry and assess the number of CETPs required in different locations in their respective States. This information should be very useful in better targeting of monitoring and enforcement efforts, in grouping of industries for proposed CETPs, in determining the optimum size of CETPs and in reviewing the proposals submitted by interested groups for setting up CETPs.

- In the absence of a viable threat, the SSIs cannot be expected to take the initiative for setting up a CETP. While in the short-run, initiatives have to come from government bodies, in the longer run, efforts should be made to encourage industries to initiate setting up of CETPs. However, the management of the CETP should not be the responsibility of a government body. It should be handed over to the respective industries' association for operation and maintenance.

- Monitoring and enforcement should be made more effective by focusing on wilful and habitual offenders and by measuring actual performance of industries instead of simple monitoring of the ability to meet discharge standards. Barring a few, all the SSIs who have not joined or set up a CETP can be listed as wilful violators (see chapter 2).

- There is a need to constitute an 'Environmental and Pollution Court' to hasten legal procedures.

- Single window clearance should be introduced to expedite the process of clearance for CETPs.

- The SPCBs which are also the primary agency for reviewing a CETP proposal should encourage the CETP management to follow the built-in incentive and penalty-based cost sharing methods which would result in reducing the overall cost of effluent treatment at the existing level of their output. *Ad hoc* and inequitable methods should not be approved by the SPCBs. The methods used, however, should be simple and transparent so that the participating industries can verify their respective cost shares.

- CETPs should be given the power to penalise the individual errant industries. An enabling provision may be made in the 'Act'.

- The most essential ingredient to successful combined treatment is the spirit of cooperation and trust among the member industries. In this context, a cooperative company formed by the member industries to own and operate the CETP, *vis-a-vis,* a purely public or private CETP company, appears most desirable.

REFERENCES

CPCB (Central Pollution Control Board), 1995. Implementation Status of the Pollution Control Programme in Major Polluting Industries. *Programme Objective Series*: PROBES/62/1994-95, March. Delhi: CPCB.

Cropper, M. *et. al.,* 1992. The Determinants of Pesticide Regulation: A Statistical Analysis of EPA Decision Making. *Journal of Political Economics.* Vol. 100, No. 1, pp. 175-197.

Gupta, D.B., M.N. Murty and Rita Pandey, 1989. Water Conservation and Pollution Abatement in Indian Industry – A Case of Water Tariff. Mimeo. NIPFP, New Delhi.

Helland, E., 1997. The Revealed Preferences of State EPAs: Stringency, Enforcement and Substitution. *Journal of Environmental Economics and Management.* Vol. 35, pp. 242-61.

Harrington, Winston, 1988. Enforcement Leverage when Penalties are Restricted. *Journal of Public Economics.* Vol. 37, No. 1, pp. 29-53.

MSE (Madras School of Economics), 1998. Economic Analysis of Environmental Problems in Tanneries and Suggestions for Policy Action. Chennai: Madras School of Economics.

Mehta, S., Sudipto Mundle and U. Sankar, 1994. *Controlling Pollution: Incentives and Regulation.* New Delhi: Sage Publication.

MoEF (Ministry of Environment and Forest), 1996. Annual Report, 1995-96. New Delhi: MoEF, Government of India.

MoEF, 1997. Annual Report, 1996-97. New Delhi: MoEF, Government of India.

NEERI (National Environmental Engineering Research Institute), 1992. Common Effluent Treatment Plant: State-of-the-Art. Nagpur: NEERI.

Pandey, Rita, 1997. Designing of Pigouvian Taxes for Pollution Abatement in Sugar Industry. Working Paper No. 3. NIPFP, New Delhi.

Pandey, Rita, 1998. Pollution Taxes for Industrial Water Pollution Control. Mimeo, NIPFP, New Delhi.

Rajamani, S., 1993. Technology Package: A System for Recovery and Reuse of Chromium from Spent Tanning Liquor/UNIDO. Techpack/UNIDO/REPO/1.

Russel, Clifford, Winston Harrington, and William Vaughan, 1986. Enforcing Pollution Control Laws. *Resources for the Future.* Washington, D.C.

Russel, Clifford, 1992. Monitoring and Enforcement of Pollution Control Laws in Europe and United States, in Riidiger Pething, ed. *Conflicts and Cooperation in Managing Environmental Resources, Heidelbeg.*

TOI (Times of India), 1998. Did Units Discharging Effluents in Badli File False Information?.