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STUDY ON THE INTRODUCTION OF EFFLUENT CHARGES AS A MEANS FOR CONTROLLING INDUSTRIAL WATER POLLUTION

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Abbreviations

BOI	Board of Investment
BOD	Biochemical Oxygen Demand
CEA	Central Environmental Authority
COD	Chemical Oxygen Demand
CUA	Colombo Urban Area
EFL	Environmental Foundation Limited
EIA	Environmental Impact Assessment
EPL	Environmental Protection License
ERM	Environmental Resources Management
MEIP	Metropolitan Environmental Improvement Programme
NAREPP	Natural Resources and Environmental Policy Project
NDB	National Development Bank
NESC	National Environmental Steering Committee
NWSDB	National Water Supply and Drainage Board
PCAF	Pollution Control and Abatement Fund
SCOPE	Scheme for the Control of Pollution from Existing Industries

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Terms of Reference

Background to study: In cooperation with the Metropolitan Environmental Improvement Programme (MEIP) and the Central Environment Agency (CEA), NAREPP has initiated a discussion on the possible application of pollution taxes as environmental policy measures. These are also recommended as part of the environmental policy package, which includes a proposed national pollution enforcement strategy.

Terms of Reference: The analysis will be based on the MEIP/CEA report on a "Scheme for the Introduction of Effluent Charges in Sri Lanka". The study will be carried out in consultation with CEA, industries in the area, industry chambers, NAREPP, MEIP, NWSDB and other relevant parties.

The report will investigate the feasibility and effectiveness of using effluent charges to achieve water quality goals and to motivate industry to treat their effluent. The key issues to be addressed are:

> the enforceability of the proposed scheme, its likely influence on polluter's behaviour, the recommended levels of the fees based on an assessment of treatment costs, the revenue generation potential from such fees, the ability to meet pre-specified ambient water quality targets and the compatibility with other environmental policy measures-including common wastewater collection /treatment/ disposal system for industrial estates. The report will also explore alternative allocations of revenues generated, including the primary option of supporting the new Pollution Control and Abatement Fund.

Timing: The activity will require approximately 24 days effort of international consultant expertise an 24 days effort of a local specialist. The preliminary work will carried out over approximately a five week period beginning in early July 1995.

Executive Summary

This report has set out to evaluate the feasibility and effectiveness of an effluent charge scheme for Sri Lanka. Following consultation with key public and private sector representatives, this report concludes that effluent charges would be both feasible and effective. The extent of feasibility and effectiveness however depends on the details of the scheme.

This report sets out details of a charge in terms of:

1. Objectives of charge

2. Type of charge: unit of charge, cut-off point of charge, industries to be charged.

3. Level of charge (based on industrial treatment costs).

4. Effects of charge: effect on water quality, size of revenue raised, and costs of charge: (including industrial compliance costs,charge collection costs and monitoring costs).

5. Institutional issues: charge and EPL scheme, institutions for administration of charge (both monitoring and collection), and division of charge revenue between CEA, NWSDB, and NDB.

6 Advantages of charge as outlined.

The objectives of the charge are recommended to be that the charge should act as an incentive to industry to reduce wastewater discharge by installing and operating pollution abatement equipment and by increasing water recycling. The latter will have the additional benefit of reducing groundwater draw down, which is currently unregulated. In the case of common wastewater treatment, the charge should encourage firms to swiftly install pretreatment and then join up with the common wastewater plant.

Thus the charge would be in addition to the current EPL scheme and the proposed user fee for common wastewater treatment. It would be a "non-compliance" fee levied on those industries who either fail to comply with EPL standards and do not utilize the common waste water treatment, once they become available.

While any level of charge will have an effect of increasing incentives to recycle, the main decision by firms as set out in chapter 2 will be the relative charge level versus the costs of pollution reduction. The cost of pollution reduction will either be individual treatment costs, or pretreatment costs and the user fee for the common wastewater treatment plant.

For individual treatment, the capital costs of installing pollution are large, but these are currently being mitigated by the Pollution Control and Abatement Fund (PCAF). In the first 5 months since the PCAF was made operational in April 1993, over 15 firms have applied for funds and up to 10 loans have been formally agreed.

In addition the CEA is beginning to take tougher legal action against those industries who do not have treatment plants and this is beginning to have an effect. Effluent charges will have an added effect, but they would have to be prohibitively high to match the capital costs of treatment. Thus it is recommended that the level of the effluent charge is set to cover the operating cost of waste water treatment.

To comply with these objectives, the recommended charge will be:

1. Effluent charge according to COD load set at 25 Rs per kg COD.

2. This charge will levied on high polluting industries if they do not comply with CEA concentration based standards.

3. Non compliance will be determined as
   - those industries who fail to pretreat and join up to common waste water if such an option is available,
   - fail to meet EPL by installing a "recognized" wastewater treatment plant.

The above system combines a load based effluent charge with a cut off point based on those who fail to meet the existing concentration-based EPL standards. The advantage of this is that no new load based standards are required. This means that the scheme can be implemented much more quickly.

The level of the charge is recommended to be a minimum initial level of 25 Rs in order to come close to operating costs of the average large scale biological or physical-chemical plant. Such a charge will have a less than 1% effect on the profits of most firms. If the charge is considered too high, the fault lies with the EPL scheme not with the charge.

The effect of the charge would be to improve water quality and improve compliance. The revenue raised from the charge will be substantial and is estimated to be in the region of Rs 620 million per year (assuming industry COD load stays fixed). As the charge creates an incentive for treatment, load and hence revenue will decline. The revenue of Rs.620 million per year compares with the size of the Pollution Control and Abatement Fund of Rs 260 million, and the annual billing revenue of the NWSDB of Rs.6 billion per year from the 1500 major consumers.

The power to administer the charge should be vested in the CEA. Monitoring the operation of waste water treatment will be the responsibility of CEA, based on data provided by industry. It is strongly recommended that the CEA devolve the power for collecting the charge to the NWSDB. This is for three reasons: the NWSDB has experience in large scale billing, it will be controlling the new common wastewater plants and in the event of non-payment it can resort to the cutting off of domestic water supply.

The revenue for the charge should be divided between the CEA, the NWSDB and the Pollution Control and Abatement Fund. The NDB should receive 75% of funds. The NWSDB should receive the cost of billing for the charge. The CEA should receive the remainder of the funds.

CEA/DCA/4.7.11

Introduction

The focus of this report is to test the feasibility of introducing an effluent charge scheme in Sri Lanka.[1] Thus the report provides a set of concrete recommendations for a charge scheme. These recommendations have emerged after a series of detailed meetings with key participants (listed in Appendix 1) during the five weeks available for this report. It is hoped that this report faithfully reflects the views of those consulted.

Traditionally, environmental policy in Sri Lanka has focused on regulations and standards, but there is growing interest in using economic incentives to complement such regulations (Steele and Pearce, 1994). Two key constraints to effective environmental policy in Sri Lanka are weak enforcement and limited funds. It is hoped that effluent charges, by providing revenue for pollution control, and by providing for tougher enforcement will help to overcome these two constraints.

The report is divided into two sections: a section on the broader policy framework and then the details of the charge. Part I introduces the policy framework for the introduction of effluent charges. This is to ensure that effluent charges are seen as one possible policy instrument in the total regulatory and incentive structure for controlling industrial water pollution. This policy overview is also needed as there are currently a number of new regulations and incentives being discussed or about to be initiated in the area of industrial pollution. It is important that these different policies are made consistent and complimentary.

Part I begins with a review in chapter 1 of water pollution in Sri Lanka, as controlling water pollution is the ultimate objective of the charge scheme. Chapter 2 briefly presents the conceptual framework for balancing the costs of pollution control with the benefits of such control, and how charges can be used to ensure this. Chapter 3 reviews the current regulatory structure for industrial water pollution, focusing on the Environmental Protection License Scheme. Chapter 4 examines the set of economic incentives influencing firms decisions to invest in reducing water pollution, of which effluent charges would be one part.

Part II contains the detailed recommendations for the effluent charge scheme. Chapter 5 provides a brief summary of the recommendations for effluent charges given by the ERM report, which form the basis for this report. Chapter 6 examines international experience with effluent charges, covering both developing and developed countries. This is to ensure that Sri Lanka's charge scheme is based on lessons learned elsewhere. Chapter 7 provides the main recommendations for Sri Lanka's charge scheme, drawing on the ERM Report, the experience of other countries and the discussions had with key participants. Chapter 8 presents conclusions with a outline for what work remains to be done if the recommendations in this report are to be implemented by the Central Environment Authority and other key agencies.

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[1] The authors of this report wish to acknowledge the assistance of the CEA staff, Samantha Abeyratne and Asuntha Paul.

Part I. Policy framework

Chapter 1 : Water Pollution in Sri Lanka

Water quality in surface and groundwater in Sri Lanka is an issue of growing concern. The untreated discharge of both domestic sewage and industrial effluent has led to the deterioration of the quality of many water sources. In principle, some water pollution is inevitable since adding any foreign substances other than purified water to a water body is an act of water pollution. However, present trends in the growth of discharges has made water pollution the number one environmental priority for the island.

1.1 Extent of water pollution

Comprehensive data on the extent of water pollution in Sri Lanka is scarce. There are a number of reports on selected water bodies. National estimates are included in the reports by NARESA (1991), bkh (1992) and the Institute of Fundamental Studies (IFS, forthcoming). These suggest that the three main problems are:

1. excess biodegradable matter and nutrients in urban areas (Kelani River, Beira Lake, Kandy Lake, and canals in the Colombo area)
2. heavy metals in some areas (Kelani River and downstream of tanneries)
3. some pesticide concentrations are exceeding safe levels for aquatic ecosystems (bkh, 1992).

While there are areas of localised pollution throughout the island (eg near rubber or coconut processing plants), water pollution is most severe in the Colombo Urban Area (CUA), where all surface water and much of the groundwater is now polluted. This applies particularly to the slow moving canals, and smaller water bodies in the area, including the Beira Lake and Lunawa Lagoon. A survey of the San Sebastian Canal in Grandpass show high levels of BOD, oils and grease and total coliform count (Vitarana and Peter, 1992). For the Lunawa Lagoon, the evidence is that 24 fish species which used to inhabit the Lunawa Lagoon are now almost all gone and those that remain are only available in very small numbers (EFL, 1993). The two other major water bodies in the area are the Bolgoda Lake and the Kelani River. These would not yet appear to be so polluted, but there is growing concern as Kelani is the main source of Colombo's water and Bolgoda supports a major fishery. Evidence of groundwater pollution is very scarce, but seems to be a particular problem in Moratuwa/Ratmalana.

1.2 Sources of Water Pollution

Chemicals that pollute water consists of inorganic and organic substances. The main inorganic sources are heavy metals (eg. cadmium, lead and mercury), metalloids (eg arsenic), algal nutrients (eg. nitrogen and phosphorous), pollutants leading to excess alkalinity or acidity (eg. sulphuric acid) and inorganic pollutant species (eg cyanide, ammonia, hydrogen sulfide and carbon dioxide) (Manahan, 1993). In Sri Lanka the main source of inorganic pollution include pesticides and fertilizer run-off, and industrial process involving chemicals and metals.

Organic sources of pollution include sewage, detergents, biorefactory pollutants and effluent from organic based industrial processes. In Sri Lanka, such processes will include food and beverages, rubber and coconut processing and tanneries. These

organic pollutants are often the most serious pollution problem in fresh water, even though they do not involve toxic substances. This is because the organic pollutation is difficult to remove and consumes the dissolved oxygen in the water for aerobic decomposition.. Aquatic life depends on the amount of dissolved oxygen and so will compete with the pollution for the available oxygen. A dissolved oxygen level lower than 4 ppm can kill the fish in the water body.

The extent of oxygen consumption by the organic pollution is determined by two general tests called biochemical oxygen demand (BOD) for biodegradable pollution, and chemical oxygen demand (COD) which also includes non-biodegradable pollution. The BOD test measures the amount of oxygen consumed by the pollutant during a certain time period, normally set at 5 days and hence called BOD5. The COD test picks up additional non-biodegradable organic pollution. A high BOD or COD level indicates a low level of dissolved oxygen and therefore a high level of pollution.

The table below presents average BOD and COD concentrations, and heavy metal sources for untreated Sri Lankan industrial effluent (ERM, Volume 2, 1994):

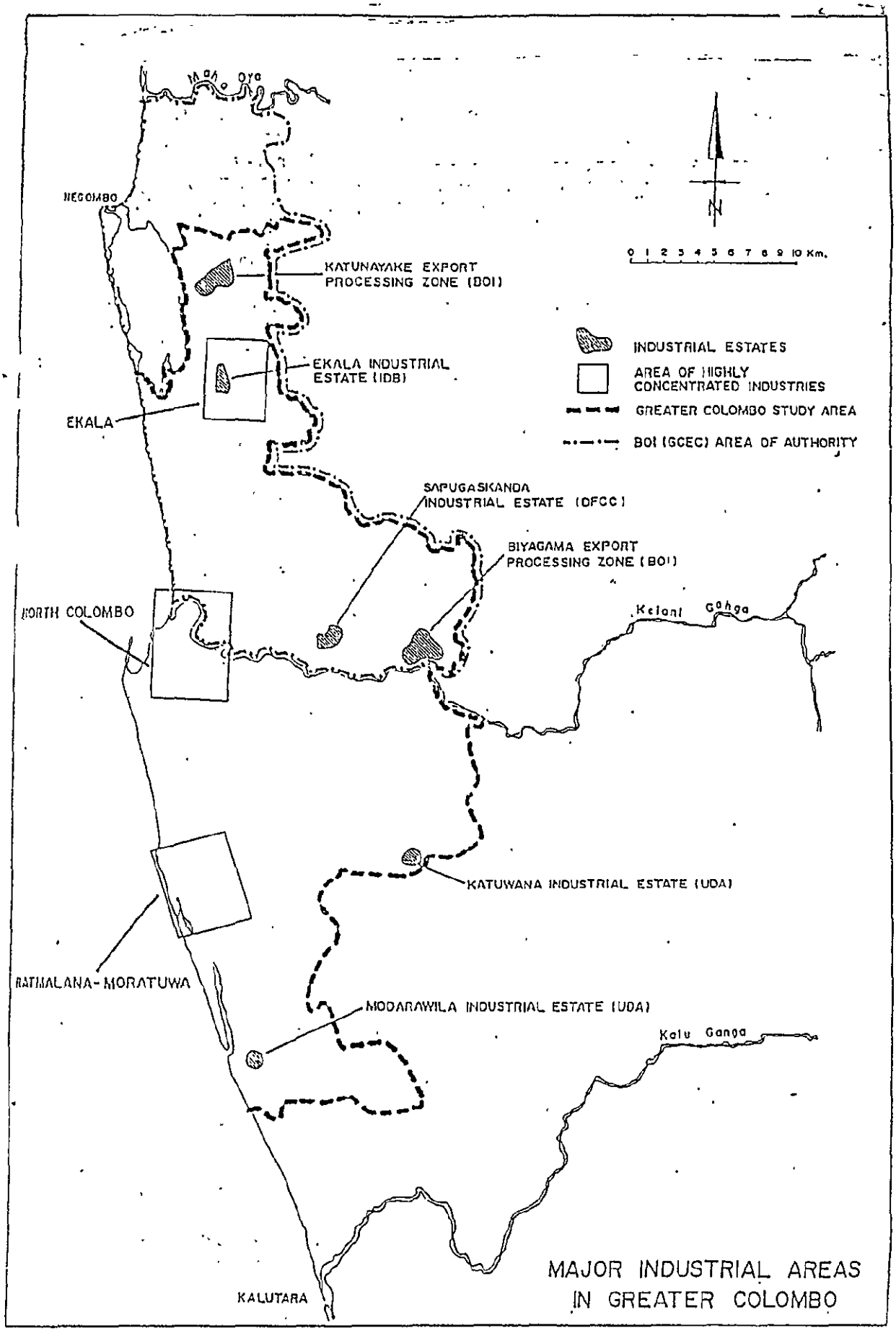
Table 1.1 : Typical Input wastewater in Sri Lanka

Industry	Heavy metals	BOD (mg per litre)	COD (mg per litre)
Textile processing (fabric preparation, washing, printing, dying and finishing)	-	700	1600
Tannery (hides and skins: soaking, dehairing, pickling, tanning, dying and finishing)	chromium	2000	5000
Food, general	-	1500	3000
(Crepe) Rubber	-	2000	6000
Concentrated latex	-	-	25,000
Metal preparation and finishing (oil and grease removal, acid pickling, electroplating, anodising and galvanising)	cadmium, chromium, nickel	-	-
Chemical formulation and repackaging including agrochemicals and paints	lead, zinc titanium	-	-

Source: ERM, 1994

Data on total effluent discharge show that the quantity of industrial effluent discharged is minor when compared to the total domestic discharge (World Bank, 1995). In the Greater Colombo area, it is estimated that major polluting industry contributes less than 5% of total pollution, although this rises to 15% in terms of COD volume (ERM, Volume 2, 1994). Even in Moratuwa/Ratmalana it is estimated that 25% of the total current wastewater generated is from industry and 75% from the residential area, the industrial workforce and from commercial establishments (Associated Engineering, 1994).

However, when considering the concentration of toxic substances and the quantity of effluents discharged from a single point source, controlling industrial pollution tends to be easier and more cost-effective. This is because the costs of industrial treatment tend to be lower than the cost of installing domestic sewage. The need for cost effective pollution control is examined further in the next chapter and is why this report focuses



MAJOR INDUSTRIAL AREAS IN GREATER COLOMBO

only on industrial emissions. Maximising the benefits of pollution control require that water is treated according to its uses. Thus water for drinking will need to be cleaner than water for irrigation. In Sri Lanka, perhaps the most sensitive water body is the Kelani River upstream of the Ambatale Intake, since this is the source of Colombo's water supply. The CEA has recently been monitoring discharges from large industries on this stretch of the Kelani, including Pure Beverages (bottling), Osprey Clothing, and Techstream (garments), Tan Lanka and Leather Corporation (tanneries) and the Ceylon Petroleum Corporation.

1.3 *Controlling water pollution: Industrial Wastewater Treatment*

Industrial water pollution could be prevented if industries took precautions to reduce the effect of their effluent on water quality. This would require shifting to less polluting industrial processes and treatment of effluents. Establishment of the Central Environmental Authority and the creation of a ministry of cabinet rank in charge of the subject of environment have been progressive steps towards reducing industrial water pollution. Issuing Environmental Protection Licenses (EPLs) to industries and requiring Environmental Impact Assessments (EIA) from each new industry have also been steps in the right direction.

According to the general effluent treatment process, waste water can undergo up to 4 treatment processes. The first stage is preliminary treatment to separate floating material and heavy settleable inorganic solids. This treatment reduces BOD by 15 to 30%. The second stage of primary treatment which consists of removing large suspended organic solids accomplished by settling basins.

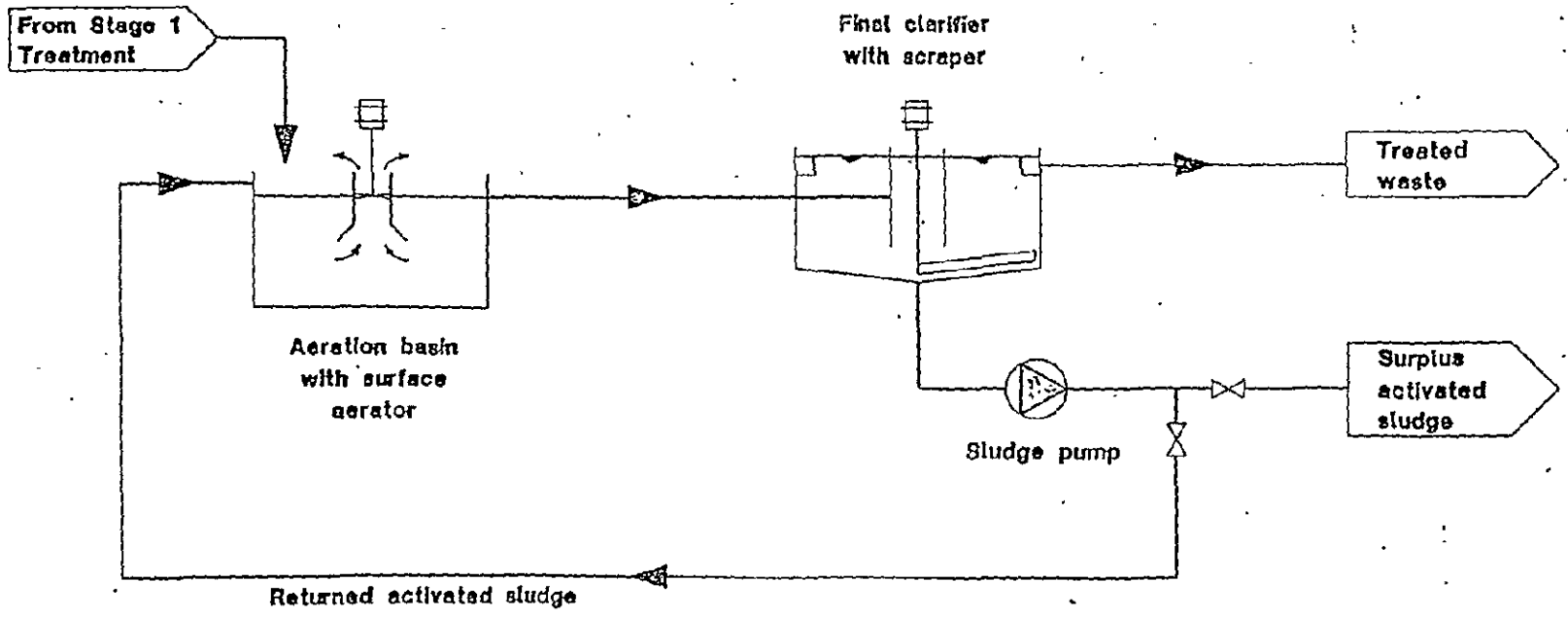
Next come the main treatment process, which cover either biological and physical-chemical treatment. or some combination. Certain types of industry only require biological treatment. These include food and beverage processing (eg desiccated coconut, meat, fish, vegetables) and rubber processing. Other plants require physical-chemical treatment, either on its own or combined with biological treatment.

In the latter cases, the physical-chemical treatment, such as the removal of heavy metals or neutralisation of extremes of pH, must be done before the biological treatment since the heavy metals or acids/alkalis will destroy the microorganisms used in the biological treatment process. For example, this applies to metal finishing and electronics industry since the heavy metals and cyanides can kill off the microorganisms. Most textile processing and dying industries, and tanneries will require chemical treatment before biological.

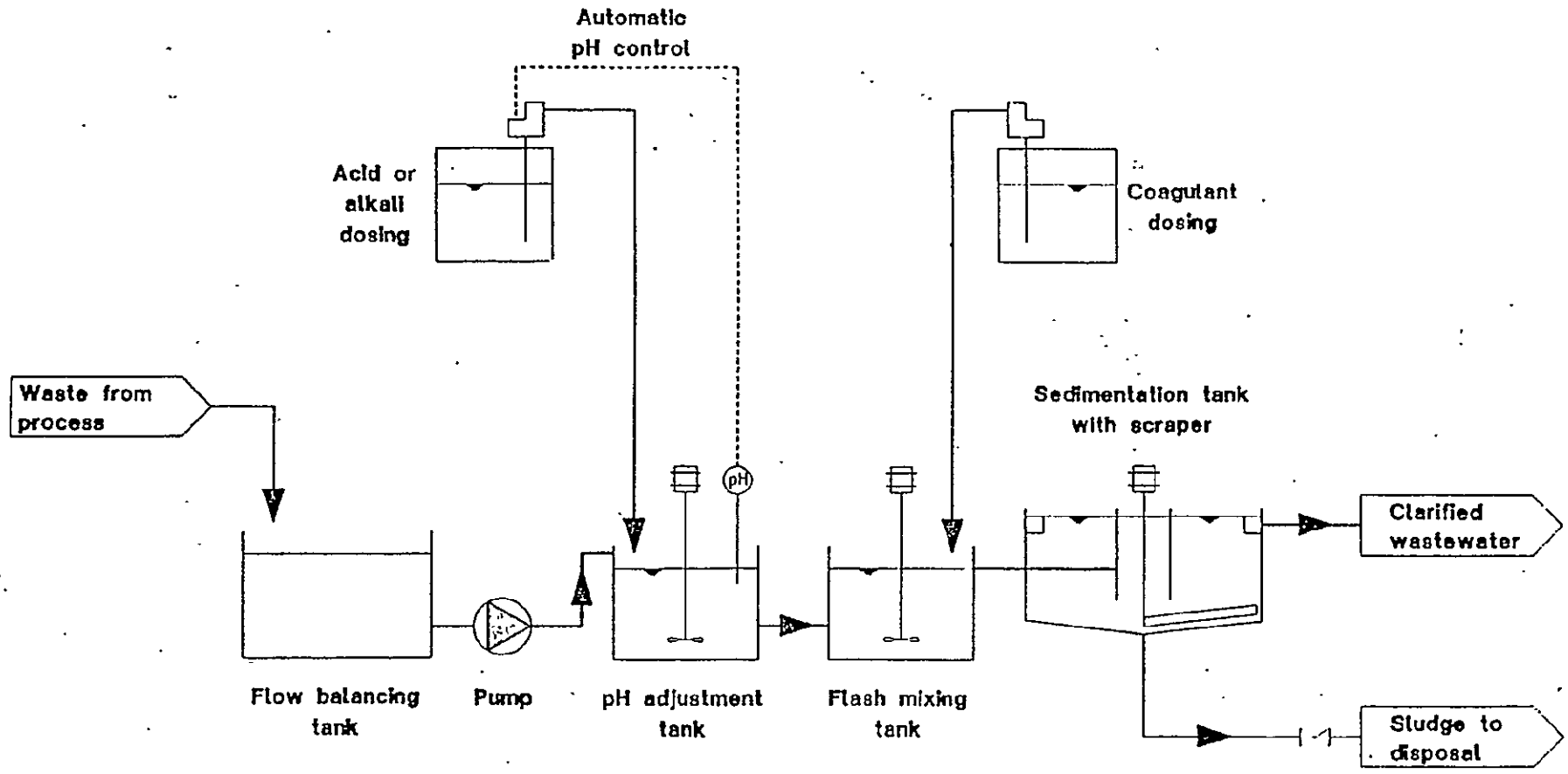
Biological treatment takes advantage of the same kind of micro processes that would otherwise consume oxygen in the water body receiving the wastewater. This is by using microorganisms under optimum conditions to degrade the organic material, until the BOD has been reduced to acceptable levels. The main types of biological treatment technology are:

- trickling filter, where the water is sprayed over rocks covered with microorganisms
- rotating biological reactors, where large plastic disks are mounted close together on a rotating shaft

Typical Second Stage Bio-chemical Treatment Plant



Typical First Stage Physico-chemical Treatment Plant



- activated sludge process, where microorganisms in the aeration tank are converted to microbial biomass and carbon dioxide. The solids settle out in a settler and part of this "hungry" sludge is recycled to "feed" on the incoming effluent. The remaining sludge is sent for anaerobic digestion (Manahan, 1994).

A typical physical chemical treatment includes:

Flow and load balancing (24 hours)
Chemical addition and pH control flocculation
Solids separated by separation
Make up and dosing plants for chemicals

Some processes also use activated carbon to transfer a substance from a solution to a solid phase (known as sorption). This is used for removing phenols and dyes, such as discharges from textile washing.

In the Sri Lankan context while some industries follow preliminary or primary treatment, less than 5% have proper physical-chemical or biological treatment, and even less consistently treat process wastewaters to the EPL standards. The most common form of treatment comprises chemical coagulation using polyvalent cationic inorganic salts such as aluminium sulphate, pH adjustment using calcium hydroxide (lime), chemical flocculation and then solids separation by gravity separation. There are also some biochemical treatment based on activated sludge and rotating biological reactors.

Chapter 2: The theory of an effluent charge: the costs and benefits of reducing Industrial water pollution

2.1 The Benefits of water pollution reduction

As the previous section has made clear water pollution is a serious problem in Sri Lanka, and reducing water pollution will have large benefits for society. These benefits include higher fish yields, improved health, improved recreational opportunities and aesthetic benefits in terms of reduced odour. In the Colombo area, the health benefits are generally not so great as most of the population has access to piped water for drinking and bathing. However in the areas, where water is from wells, it is possible that water pollution can enter the groundwater as has happened around the Lunawa Lagoon. .

In the Ratmalana/Moratuwa area, where water pollution arises in Lunawa Lagoon and Bolgoda Lake, there is some evidence of health impacts. Children have been observed bathing in the lagoon and some skin rashes have been documented as a result of lagoon water contact during floods. These benefits (which are equal to the avoidable costs) can be estimated in economic terms, in order to enable them to be compared to the costs of cleaning up pollution.

2.2 The costs of water pollution reduction

While the benefits of reducing pollution may be high, it is not free. The costs of reducing water pollution includes both:

- the costs of compliance, which are initially borne by industry in installing pollution abatement equipment, such as water treatment:
- the costs of administering the pollution control system, which are currently borne initially by the Central Environment Authority in regulating and monitoring pollution.

While the costs of reducing pollution are borne in the first instance by industry and the Central Environment Authority, ultimately these costs will be passed on to all society. To pay to install water treatment, industry may be forced to increase product prices, or cut profits so that share holders have their dividends reduced, or to cut down on labour costs. Similarly the costs of the CEA will be financed by the government, using revenue raised from taxpayers.

Another complication to a consideration of pollution costs is that costs will vary depending on the approach adopted. The two main approaches are:

- **production changes**, which are sometimes known as waste minimization. This involves changes in the production process, which reduce the waste outputs. In some cases, if these changes involve upgrading the technology of the plant, they may increase both economic efficiency and reduce pollution. In the long run, the cost of pollution abatement will be quite low and may even be zero. Example are switching from chrome plating to a less polluting process in the tannery industry.

- end of the pipe abatement. This is where the production process remain unchanged, but pollution abatement technology is installed at the "end-of-the pipe" to reduce the waste outputs. This is an add-on cost to the costs of production, with no efficiency gains, so will be much more expensive than waste minimization. Examples are installing physical-chemical or biological treatment plant to reduce water pollution.

Clearly waste minimization is the preferred options due to its lower long run cost. It requires in the short run capital and management and technical expertise to invest in changing the production process. This is possible in dynamic relatively profitable industries, such as textiles. However, in Sri Lanka, the dominant trend among existing industries is to comply to water pollution regulations by end of pipe approaches. Thus for the purposes of this report, abatement costs are taken to refer to end of pipe costs.

Even with end of pipe abatement, costs can vary. The two main causes in cost variations are the technology chosen and the scale of the plant. As the earlier chapter made clear there are a number of different technologies for controlling water pollution, which can be defined in their broadest sense as either physical chemical or biological treatment.

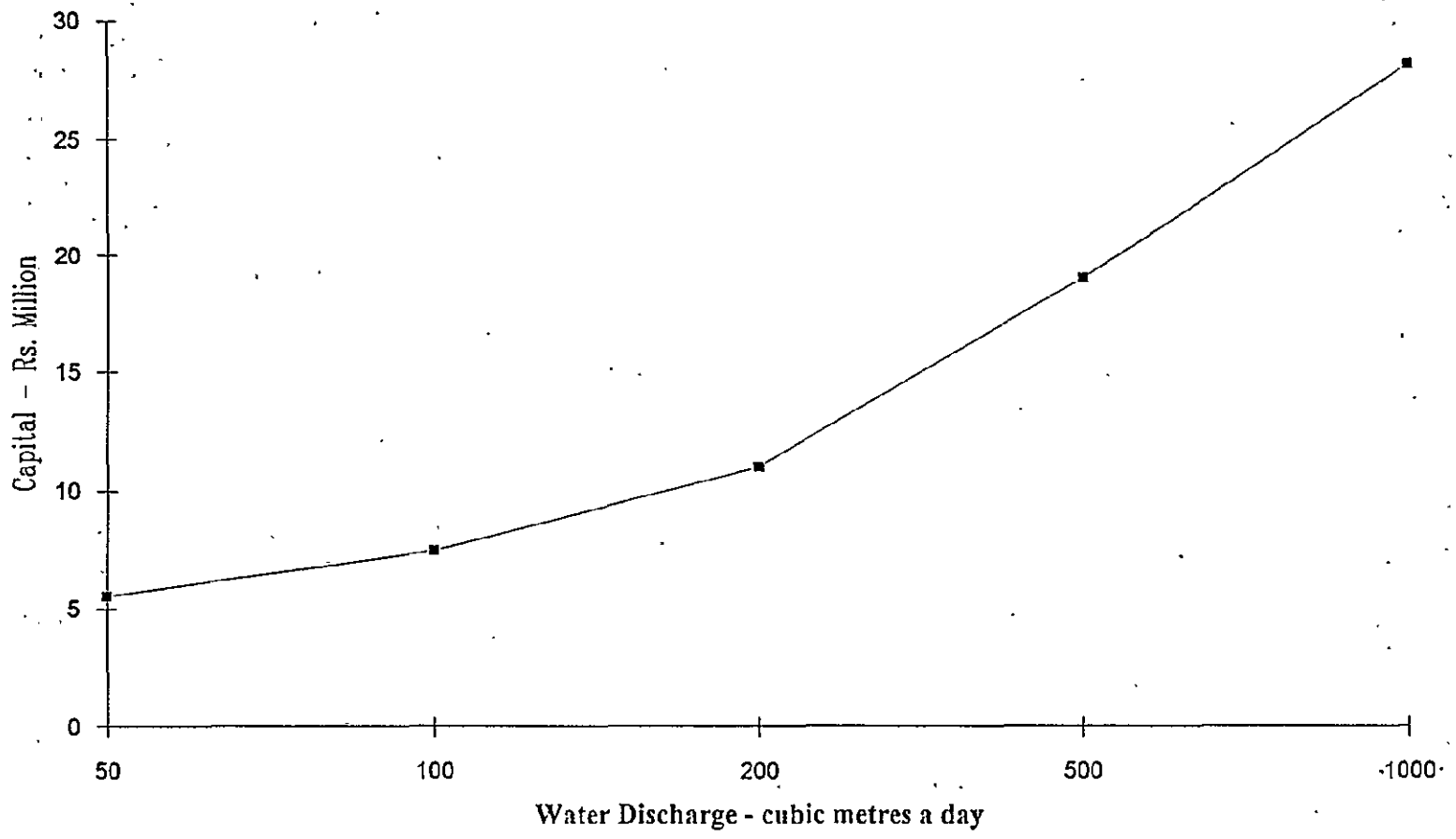
For reducing BOD and suspended solids the two technologies are substitutes. Although there is some evidence that most high polluting industries, especially in Sri Lanka will require first physical-chemical and then biological treatment to meet the national standards. This is borne out by the fact that those industries who have gone in for full treatment, such as Lever Brothers, have installed both types of treatment. As the ERM report explains: "The most likely overall reason for non-compliance (with existing standards) is that chemical treatment in isolation is not sufficient to achieve the required standards, particularly in relation to the textile dying and finishing industry and the hides and skins industry."

The main economic difference between the two technologies is that biological treatment, which relies on settling ponds with micro-organisms, requires a much larger area. These high land costs and civil engineering costs mean biological treatment generally has higher fixed or start-up costs than physical-chemical treatment.

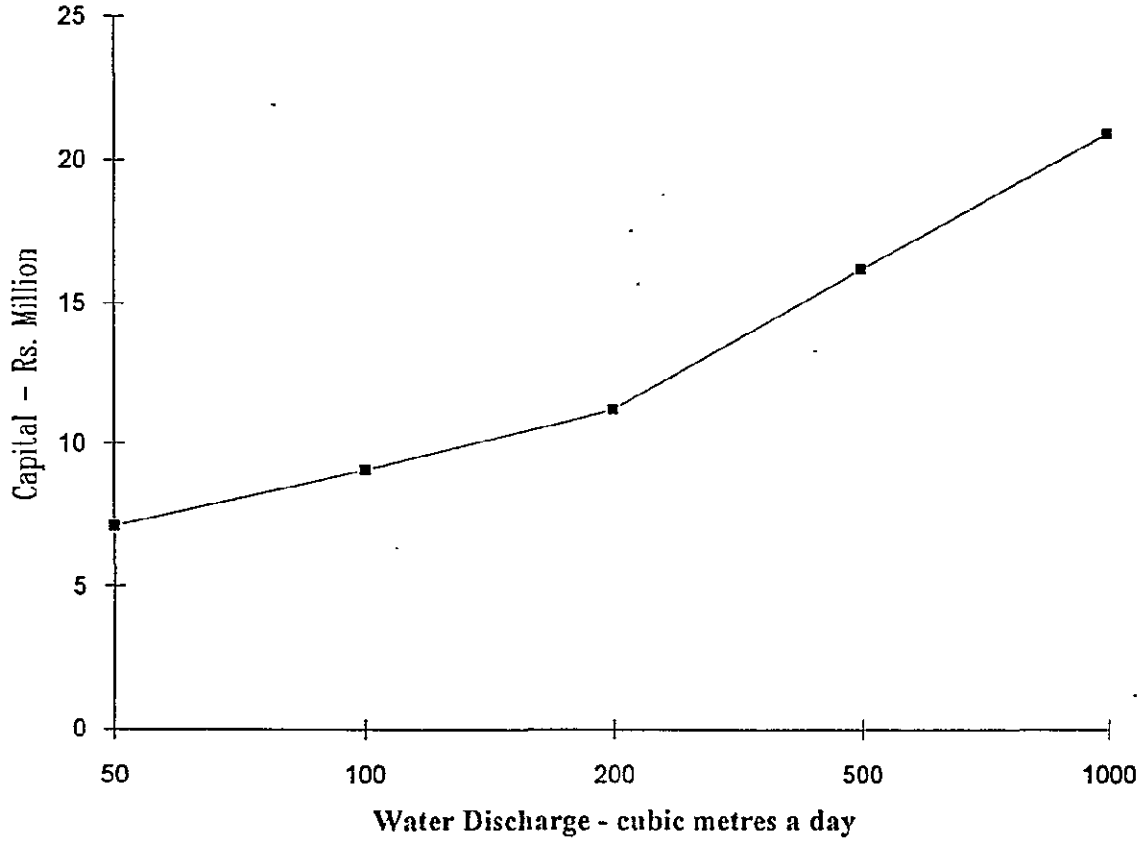
By contrast, once the biological plant has been set up, its operating costs are very low. While the operating costs of the physical-chemical treatment plant, which requires large inputs of chemicals (eg alum) and electricity, are much higher. In general, of the few existing water treatment plants in Sri Lanka, most are physical-chemical. This generally reflects the fact that most industries are concentrated around the Colombo region, where land is expensive or simply unavailable near to the factory. Thus in the very congested Moratuwa-Ratmalana area, industries do not have the space to install their own biological treatment, and sometimes have very little space even for physical-chemical treatment.

The other determinant of the cost of end-of-pipe waste water treatment is the scale of the plant. Treatment plants generally have high economies of scale, which means that the unit costs decline as more pollution is treated by the plant. This applies particularly to biological treatment, which as has been stated, have high fixed or start-up costs. This means that the more industries use the biological treatment plant, the more costs will decline. This is why the government has decided to set up common biological

ERM Estimates for Capital Outlay - Biological



ERM Estimates for Capital Outlay - Physical Chemical



wastewater treatment plants in areas of high industrial concentration such as Moratuwa/Ratmalana and Ekala/Ja-Ela.

This is supported by research by ERM which estimates that the capital cost of providing wastewater treatment for high polluting industry in the Colombo area is US$67 million if individual industries are made responsible, but US$53 million if common wastewater treatment is used. The US$15 million difference between the two options is not as high as might be expected due to the high costs of "collecting" the waste from the different industries that has to be incurred by the joint treatment plant. However, they also suggest that the operating cost of central treatment plants may be lower than individual plants because: "the greater volume and diversity of waster results in a more consistent feed. Acidic wastes from one industry will reduce alkaline wastes from another and this results in lower chemical consumption than if the wastes were treated independently".

Economies of scale have also been demonstrated in treatment plants in individual areas or for specific industries. The latter is illustrated by the fact that a project involving 10 tanneries each discharging 100 m3 per day would cost US$ 2.3 million on and individual basis, but with a combined treatment plant of physical-chemical and biochemical treatment this cost would be halved to US$ 1 million (ERM, Volume 2, 1994).

This policy of taking advantage of economies of scale has already been applied in the Board of Investment (BOI) industrial estates of Biyagama, Katunayake and Koggala. Here industry must reach set pretreatment standards, including the removal of toxic wastes, and then the BOI provides common biological wastewater treatment. The actual plants are run by the NWSDB.

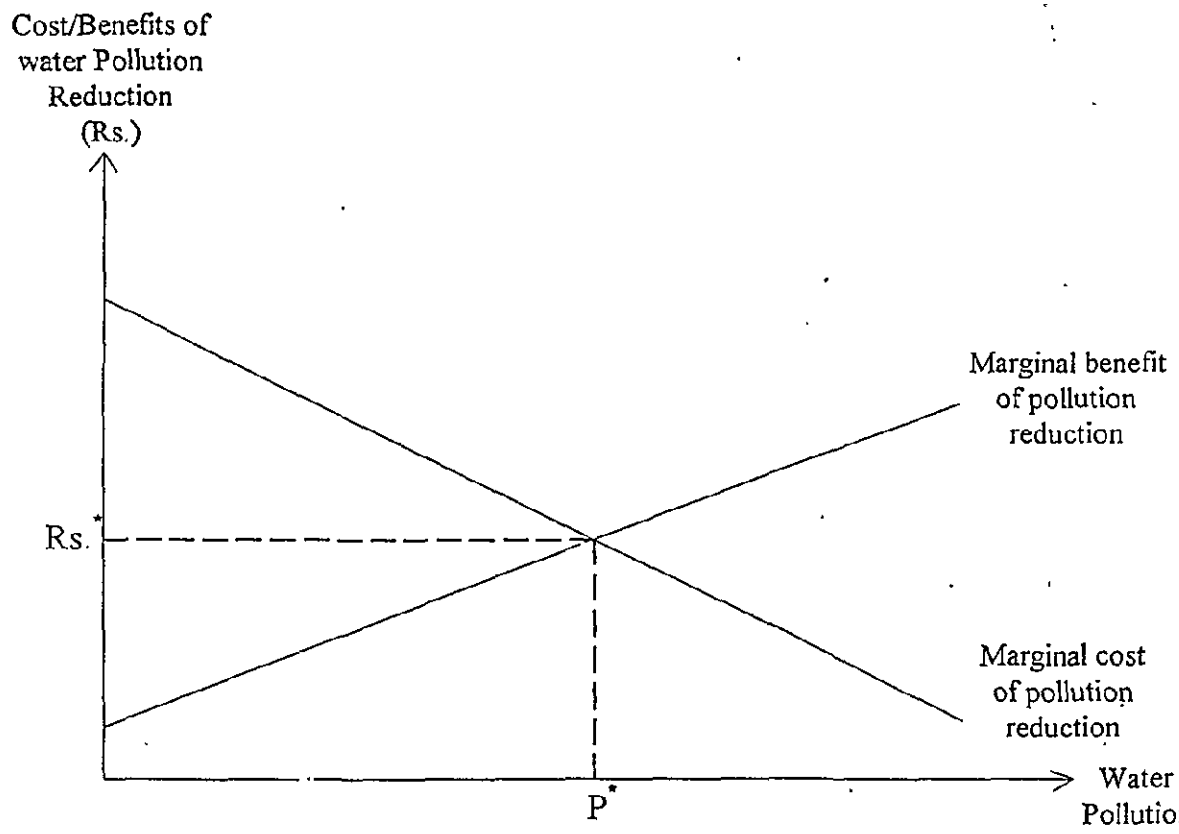
2.3 Setting costs equal to benefits: the role of standards and effluent charges

As society will gain by pollution reduction but at a certain cost, it is important that these costs and benefits roughly compare. A full understanding of economically optimal water pricing is a complex task (Munasinghe, 1990). However, for the purposes of this report the basic concepts can be presented in the diagram, which shows water pollution increasing on the horizontal axis, and costs/benefits rising on the vertical axis.

The downward sloping line is the costs of reducing pollution (in terms of what economists call marginal costs ie the costs of reducing an additional unit of pollution). Since this line slopes downwards, it shows that the costs of reducing pollution decline as pollution increases. This illustrates an important point, that reducing pollution from, for example BOD 5000 to BOD 4050, is much cheaper than reducing pollution from BOD 100 to BOD 50. This simple rule gives rise to some strong conclusions.

First of all, in terms of industries as a whole, it is cheapest to reduce pollution by focussing on those industries with the lowest marginal costs of control line. However for water pollution, the marginal control cost is generally fairly similar for different industries. Indeed the shape of the line depends more on the technology chosen (eg activated sludge versus activated carbon) than on the type of industry. **This means that it is cheapest to focus first on the high polluting industries since they will be higher up their marginal abatement cost curve.** Once, the high polluting industries have been made to comply, it is cheaper to get all the remaining medium and low polluters to reduce a moderate amount than to make some industries reduce a lot, and some reduce very little. These conclusions are to some extent reflected in the policy of the CEA, which in

: Setting Costs Equal to Benefits : the role of standards and effluent charges



January 1994 passed responsibility for enforcement for low polluting industry to local authorities and is focusing on medium and high polluting industries (CEA, 1993).

The upward sloping line shows the benefits of reducing pollution (in terms of what economists call marginal benefits ie. the benefits reducing an additional unit of pollution). Since the line slopes upwards, this illustrates that the benefits of reducing pollution are higher, the higher pollution is. This is a fairly straightforward conclusion.

Since it has been established that the benefits of reducing pollution should equal costs, the point of optimal pollution reduction is at P*. This is not zero pollution since this would be prohibitively expensive. It is the point at which the benefits of one extra unit of pollution reduction equal the costs of that extra unit of pollution reduction.

In terms of environmental policy, there are two ways of reaching the point P* (Pearce and Turner, 1990).

The most common way is to simply set a standard that stipulates that the amount of pollution reduction is P*. That is the system currently adopted for Sri Lanka, as for many other countries. However the Sri Lankan water pollution standards are based on standards originally selected for India. This reflects the logic of the diagram, since India is more likely to have similar costs and benefits of pollution control than an industrialised country like the US or Germany.

In addition, Sri Lanka has different standards for different water discharge points (eg costal waters, inland waters and irrigation water) and for different industries (eg textiles and tanneries). The different standards for different industries reflect the different costs of reducing pollution in each industry. The standards for different discharge points arise since the benefits of reducing pollution vary depending on the discharge point. For example the benefit of reducing pollution to the sea, which has a high assimilative capacity, is much lower than the benefit of reducing pollution to inland surface waters, which has a lower assimilative capacity. Thus the Sri Lankan standards for discharging to the sea are more relaxed than the standards for discharging to inland water bodies.

This principle can be taken even further with the selection of ambient water quality standards, which vary depending on the use of the water, and hence the benefits of reducing pollution. Thus water bodies used as a drinking water source will clearly derive higher benefits and hence need tougher standards than water used for fishing only. These standards are discussed in greater detail in the next chapter.

The second way of reaching P*, is to use prices or economic incentives. At its most simple, this would involve setting a tax equal to Rs*. The industry would then compare this tax with the cost of pollution abatement, and reduce pollution down to P*. In the context of water pollution, this is known as an effluent charge, since it is levied on the effluent of the industry. This technique is not yet used in Sri Lanka, however it is being used by a number of other countries (Gunnar and

Jimenez, 1992). The subject of this report is how to implement this approach in Sri Lanka.

In principle, as the above explanation has made clear, the standard P*, and the effluent charge Rs* can be used to give the same result.

Chapter 3: Current Effluent Regulations and Standards

3.1 Environmental Protection License Scheme

The basis for current regulations on industrial effluents is the Environmental Protection License scheme, which was introduced by the National Environment Act Amendment of 1988:

"Part IV A, Environmental Protection (NEA, 1980 and 1988)

23A. With effect from such date as many be appointed by the Minister by Order published in the Gazette (herein) referred to as the relevant date) no person shall discharge, deposit, or emit waste into the environment which will cause pollution except
(a) under the authority of license issued by the Authority; and
(b) in accordance with such standards and other criteria as may be prescribed under this Act".

The EPL sets limits for emission to different media. This has been set out most explicitly for water emissions, with a series of national standards for discharges to different media gazetted in the National Environmental (Protection and quality) Regulations No 1 of 1990, and some more relaxed standards for specific industries. These are set out in Tables 3.1 and 3.2.

Table 3.1: EPL Tolerance Limits (for selected pollutants)

Determinant	Effluent into inland surface water	Effluent into marine coastal water	Effluents discharged on land for irrigation purposes
Total suspended solids (mg/litre)	50	150 (for process wastes)	-
pH value at ambient temperature	6 to 8.5	6 to 8,5	5.5 to 9
Biochemical oxygen demand (BOD) in 5 days at 20 degrees C (mg/litre)	30	100	250
Chemical oxygen demand (COD) (mg/litre)	250	250	-

Source: CEA

Table 3.2: Industry Specific Tolerance Limits (for selected pollutants)

Determinant	Effluent from rubber factories discharged into inland surface water		Effluent from textile industry into inland surface water	Effluents from tanning industry	
	latex concent rate	standard Lanka rubber		inland surface waters	marine coastal areas
Total suspended solids (mg/litre)	100	100	50	100	150
pH value at ambient temperature	6.5 to 8	6.5 to 8	6.5 to 8.5	5.5 to 9	5.5 to 9
Biochemical Oxygen demand (BOD) in 5 days at 20 degrees C	60	50	60	60	100
Chemical Oxygen Demand(COD) mg/litre	400	400	250	250	300

Source: CEA

In 1990, a new set of slightly more relaxed standards was proposed, known as SCOPE (Scheme for Control of Pollution from Existing Industries). SCOPE was developed by the Committee on Environment of the Industrial Commission (EC/IC) and the National Environmental Steering Committee (NESC). The scheme was approved by the NESC at its 16th meeting held on 8 October 1992, but cannot be gazetted until the NEA has been amended. The main difference is that SCOPE sets lower limits of 100 mg/1 for BOD, 350 mg/1 for COD and 100 mg/1 for ammonia, compared to the 1990 regulations which set 30 mg/1 BOD, 259 mg/1 COD and 50 mg/1 ammonia. However ERM concludes that: "In relation to the treatment of wastes from the textile and hides and skins industries in particular it is unlikely that the SCOPE standards will make a significant difference to the extent of treatment required." (ERM, Volume 2, 1994)

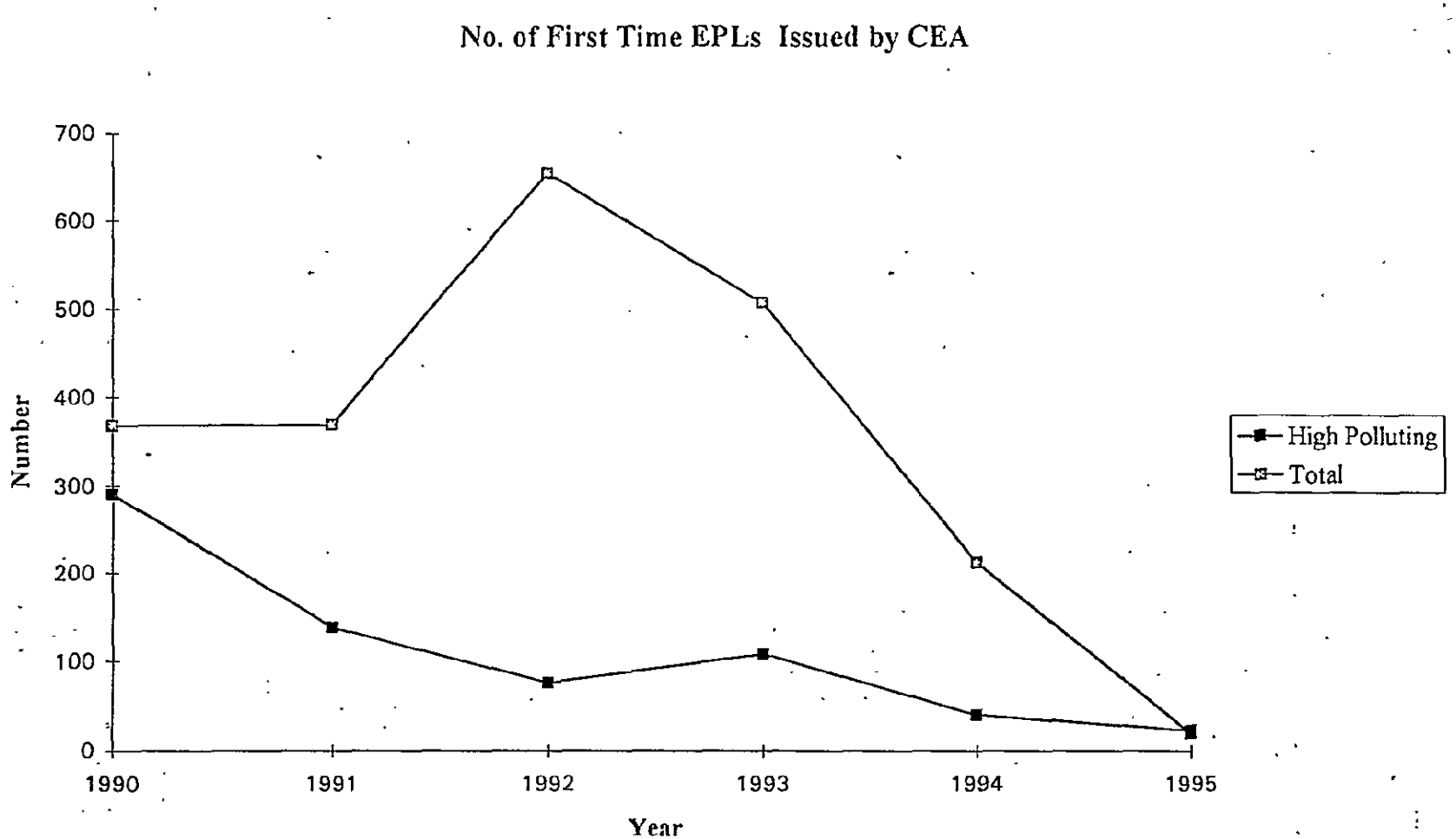
Another set of standards which is currently under discussion are standards for ambient surface water quality, which would be designated depending on the use of a particular water body (bkh, 1992).

In addition, there are currently discharge standards in the areas where the BOI operates common waste water treatment plants.

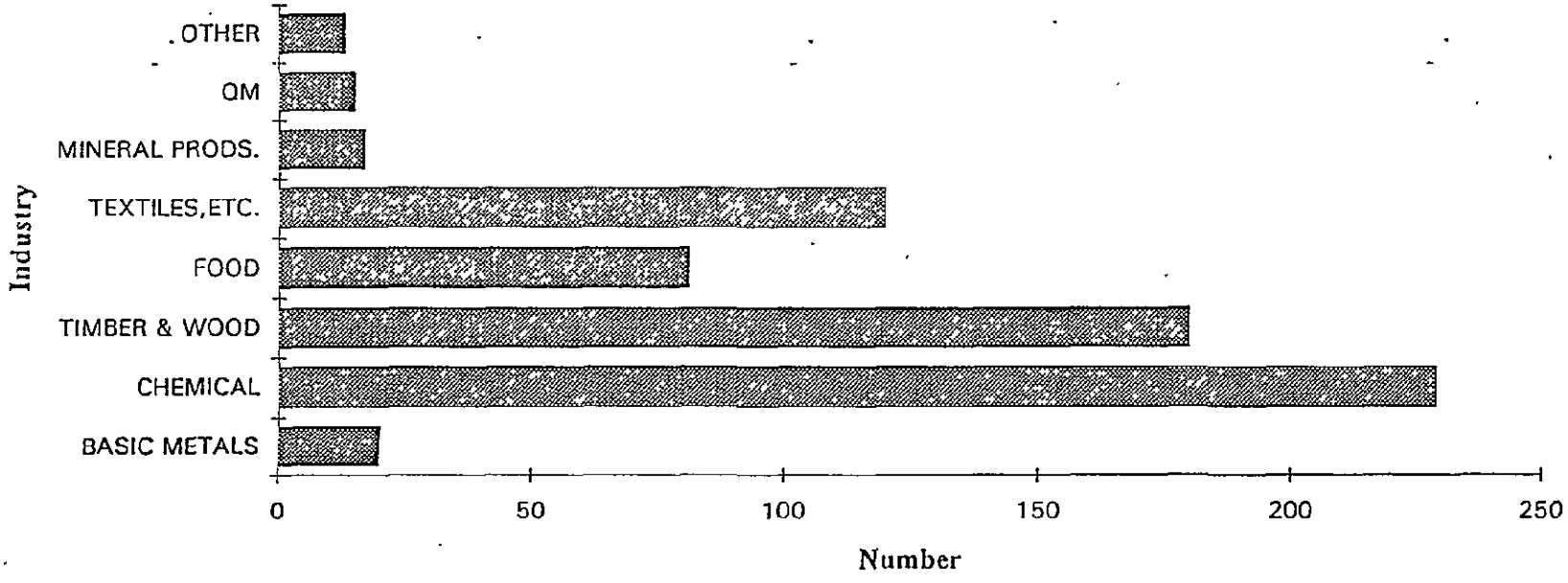
3.2 EPL Operation

The EPL scheme currently has mixed success. There are two types of application: New Site Clearance and Environmental Protection Licenses. The latter are renewable each year.

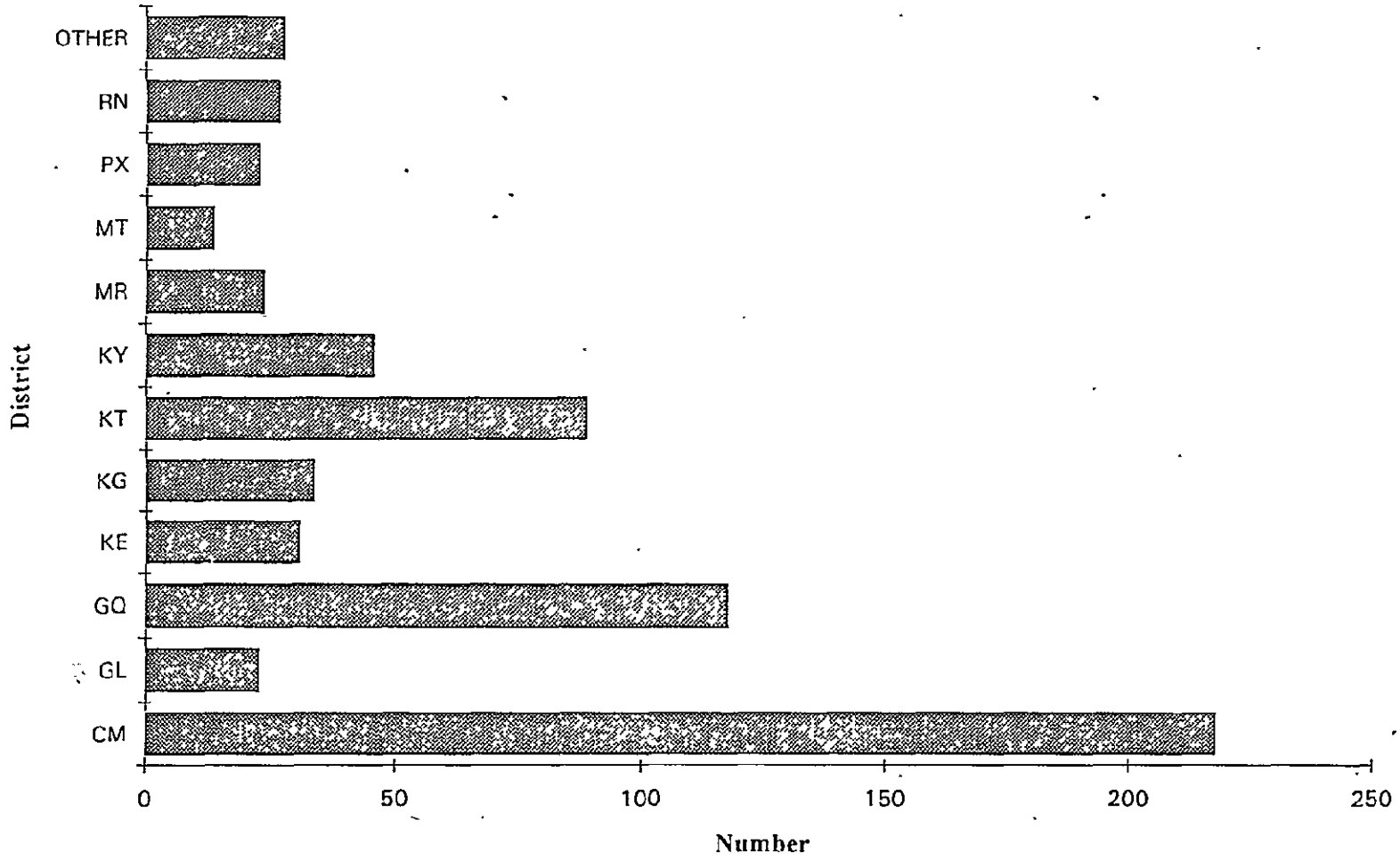
The CEA has responsibility for EPL. The CEA has delegated this power to the BOI, for industries with BOI status. When the scheme started in 1990, the CEA licensed high, medium and low polluting firms. As of January 1994, responsibility for the low polluting industries was given to local authorities.


No. of First Time EPLs Issued by CEA
700
600
500
400
300
200
100
0
Number
1990
1991
1992
1993
1994
1995
Year
High Polluting
Total

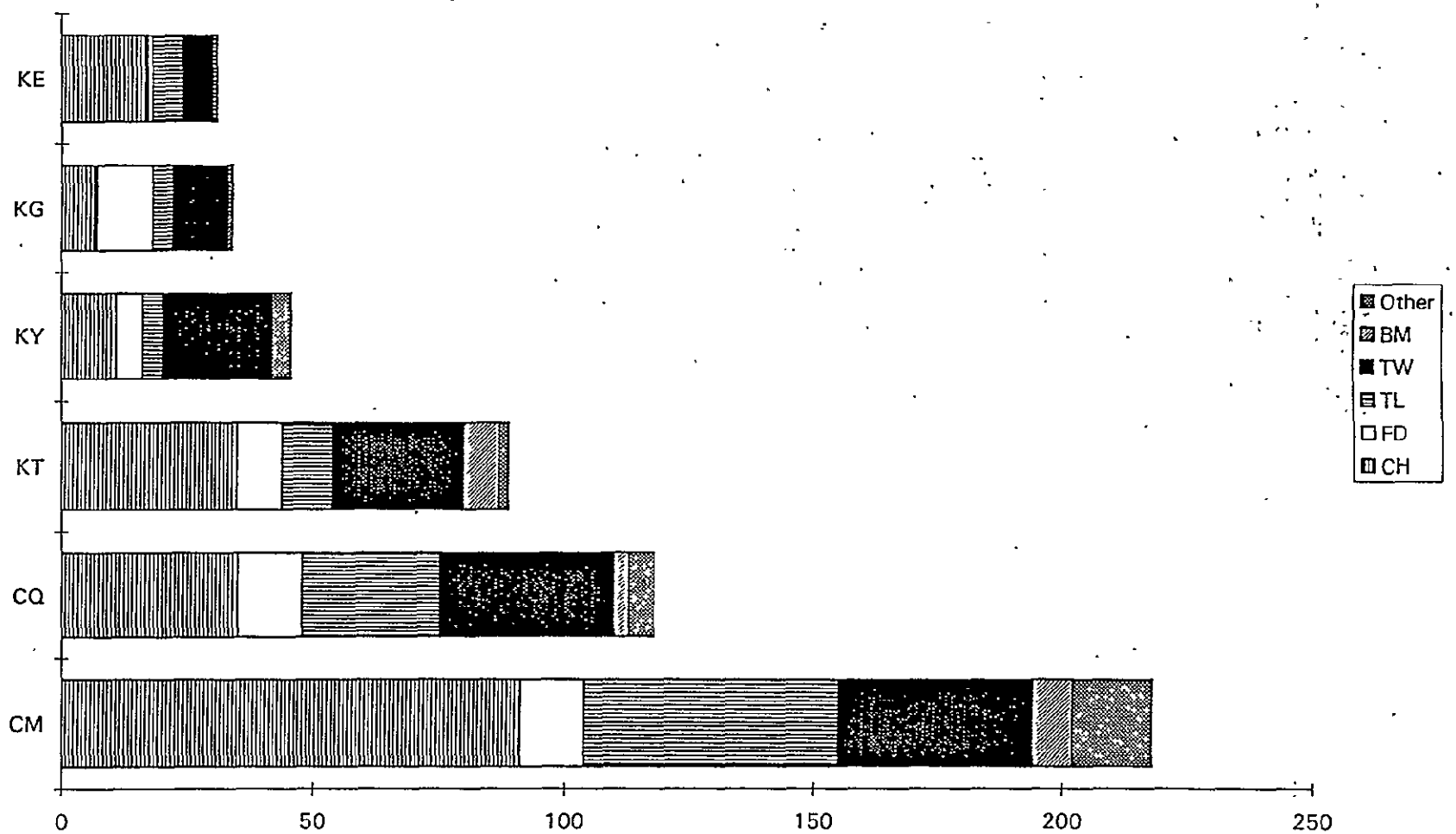
Number of First Time EPLs Issued by CEA to Industry - High Polluting



Number of High Polluting Industries by District - Administered by CEA



Type of High Polluting Industries by District 1990 - 1995: CEA Administered



The success of the EPL performance is that from the start of the scheme in 1990 to 31 June 1995, the CEA issued 2313 first time EPLs (all category of industry). This is shown in Table 3.3, which updates earlier data given in a NAREPP evaluation of EPL (Riznychok and Schmidt, 1992). EPLs were also issued by the BOI, but this data was not available. This is an impressive performance, given limited funds, relatively stringent emission standards and widespread industrial apathy and active resistance.

Table 3.3: EPL's applications and issues by CEA between 1990-1995

Year	Applied (being processed)	Issued
1990	1085	368
1991	894	370
1992	466	654
1993	871	508
1995	480	212
1995 (first six months)	470	20
Total	4266*	2313

* This covers total applications that were being processed. Actual completed applications (ie. applicant fee received by CEA) are 3878.

The problems with the EPL are that the actual installation of waste treatment facilities remains low. There is no comprehensive data available, but it is estimated that only 5% of industry has waste treatment facilities. This figure is higher for the major high profile polluters in the Colombo area, at 10% at the most. Even so there is evidence that very few of these treatment plants consistently meet the EPL emission standards. This poor operation arises through a mixture of:

1. Poor installation: due sometimes to rogue consultants or sometimes from the industry supplying incorrect information to the consultants (e.g. underestimating water use or levels of heavy metals).
2. Improper operation by the industry: lack of skilled technicians or limited funds lead to incorrect inputs (e.g. of chemical neutraliser) and lack of maintenance and repairs.
3. Deliberately turning plant off to save money.

As illustrated, the main reason for these problems of lack of proper wastewater treatment are outside the control of the CEA. They arise since the industry has overwhelming economic incentives to use the plant improperly. The next chapter sets out the existing incentive framework, before the effluent charge is considered as a way to readdress the incentives against reducing wastewater.

Chapter 4. Economic Incentive framework

The aim of this chapter is to identify both the current and future economic incentive framework that influences and will influence the decisions of firms to reduce waste water. Currently, this framework consists of four incentives which encourage wastewater treatment and one disincentive which discourages treatment.The four incentives to reduce wastewater are:

1. Low cost loans for wastewater treatment plants for existing industries
2. Common waste water treatment plants at selected industrial estates for existing industries
3. Ad-hoc fines of major polluters
4. Ad hoc tax exemption of imported wastewater treatment plants

The major disincentive to wastewater reduction is the zero price of groundwater and surface abstraction. In the future this incentive structure may change by:

1. An increase in the number of common wastewater treatment plants
2. Possible effluent charges, which are the subject of this report.

4.1 Current Incentive Framework

The main incentive in the current framework are the low interest loans available in the newly established **Pollution Abatement and Control Fund (PACF)**. This was set up at the National Development Bank with Rs.260 million funding from the German Government.

Although it was hoped that the Fund would be in operation by 1993, complications and subsequently a change of the donor country meant that industrialists were able to access the fund only from April 1995. It is important to note that the fund is available only to financially viable industries that have been in operation before the 1st of January 1994.

The Abatement fund consists of a Rs. 52 million technical component and a Rs.208 million credit component. The Technical Assistance component is to enable industrialist to cover the cost of consultancy services related to waste minimisation, preparation of designs and selection and supervision of installation and operation of treatment plants. The Fund will provide 75% of the cost subject to a maximum of Rs. 600,000. The credit component is to enable industrialists to borrow for the development of treatment plants, the improvement of worker safety measures and to assist in the relocation of highly polluting industries to special estates that are equipped with waste treatment plants. Industries can obtain a maximum of Rs.6 million with the rate of interest pegged at the official inflation rate of the country (i.e zero real rate of interest). The fund allows a maximum repayment period of seven years, inclusive of a maximum grace period of one year.

Given the short operational period of the fund, it is difficult to clearly analyse its success. By mid August, after 5 months in operation, the NDB had received 26 applications/inquiries, of which 10 of these applications are formal and 9 have received funds to develop treatment plants (Rs. 26 million has been disbursed, i.e. 10% of the total). The type of industries that have received funds to develop treatment plants

include two food processing industries, two rubber processing industries, a garment washing plant, a textile industry, a hotel, a metal finishing industry paint manufacturer and a tannery.
The NDB has also received inquiries and applications from a variety of industries requesting assistance that vary from establishment of relatively simple treatment plants to assistance for relocation of industry.

The second important current incentive is the **Common wastewater plants** which exist in the BOI industrial estates of Biyagama, Katunayaka and Koggala. These treatment plants are currently not very sophisticated and produce very little pollution reduction. As a result they require pretreatment of waste to reach normal sewage (ie 300 BOD mg/1). As ERM concludes: "This approach does not exploit the benefits of providing combined treatment on a centralised basis since individual industries are still forced to invest in and operate individual treatment plants. For some industries including the food industry and the textile processing and dying industries this is an unnecessary requirement." (ERM, Vol 2, 1994). In addition, the plants do not ensure polluter pays since the costs of the collection and treatment of wastewater are included in the BOI's ground rent. This means that the non polluting industries pay the same as less polluting industries.

The third incentive to reduce wastewater is the threat of **fines by the CEA.** This is limited by the fact that the maximum fine the CEA can legally levy is Rs 10,000, but this can be set on each Director of a Company. But until legal fines are enforced in a more uniform and widespread fashion they will remain a weak instrument.

A fourth and equally selective incentive is the ad hoc system of **tax and duty exemptions** on imported wastewater treatment technology. In some cases this can make a significant difference to the cost of treatment, since duty may be as much as 100%. Lever Brothers were exempt from duty and Business Turnover Tax (BTT) on their imported plant of over Rs.40 million, which represented a significant saving. However until such duty rebates are made uniform policy, they cannot be considered a rigorous incentive. Indeed the existence of duty may itself be considered a disincentive to install wastewater treatment.

A much more major disincentive to wastewater treatment is the **zero charge for ground and surface water abstraction.** Since over 60% of industries in the Colombo area rely on their own abstraction for water, and this water costs only the cost of pumping, there is very inefficient use of water. This high input of underpriced water reduces the incentive for water recycling and increases the volume of waste water discharged.

4.2 Future Incentive Framework

The future incentive structure should seek to increase the positive incentives of common wastewater treatment plants, and remove the negative incentive of zero abstraction charges by charging an effluent fee. Plans are now underway for a Joint Wastewater Treatment Plant in the Ratmalana/Moratuwa and Ekala-Ja Ela areas. The other future economic incentives also includes the possible introduction of an Effluent charge as proposed by the new Environment Act, and assessed in Part II of this report.

The relevant section in the proposed Environmental Act reads in the draft of April 1995:

"46. The Fee payable for an EPL may be prescribed/ or determined on the basis of one or more of the following factors:

a) class of premises
b) location of premises
c) quantity of wastes or pollutant discharged
d) production capacity
e) quantity of natural resources used
f) pollutant or class of pollutants discharged
g) potential cost of restoring the receiving environment
h) polluter pays principle
i) administration costs of processing EPL applications, and
j) other factors determined by the Minister.

47. The term "polluter pays principle" shall mean and include-

a) the principle that a person contributing the greater amount of pollution, shall bear the largest burden in paying for cleaning the environment.

b) the principle that smaller fees shall be charged for activities that reduce pollution or cause less pollution.

48. The Minister may prescribe the procedure, conditions, fees and other circumstances under which and EPL shall be transferred or traded".

The Ratmalana/Moratuwa Central Treatment Plant will be located in an area south of Colombo, which was developed as an industrial estate in the 1950s, but has now become heavily residential. This increase in the population was partly to provide labour for industry, so industry arguments that they should not have to pay to clean up as they were there before, are specious.

According to the feasibility report (Associated Engineering, 1994), the proposed wastewater management plan includes a collection system, a preliminary treatment plant, an outfall, pretreatment and waste minimisation by industries, central sludge processing and hazardous waste management. The waste water collection network consists of over 40 km of gravity sewer, linked together by 6 pumping stations. Treated effluent is to be discharge through a sea outfall, consisting of both a land section (1100m) and a marine section (2000m) The recommended standards for these pretreatment plants (as set out in the feasibility report) are much more relaxed than the current BOI pretreatment standards, allowing firms to save from the economies of scale in a joint treatment plant.

The capital cost of the plant is Rs. 141 million, and cost recovery will be ensured by a user fee on industrial and commercial users. The feasibility report set-out the following

provisional schedule fee levied on water discharge, for these consumers. The exact level will change depending on the final specification for the plant.

Table 4.1: Summary of ProposedTariffs for Ratmalana/Moratuwa central treatment plant

Description	Option A - 1	Option B - 1
Industrial / Commercial	Rupees	Rupees
Volumetric User Fee	40 per m^3	47 per m^3
Industrial Process Connection Fee	115,000	115,000
Industrial Domestic Connection Fee	37,000	37,000
Commercial Connection Fee	26,000	26,000

Source: Associated Engineering, 1994

The Ekala-Ja Ela Central Treatment Plant will be located at Ekala in Ja-Ela AGA Division about 20 km north of Colombo, and 3 km from Ja Ela town. It includes dense industry in the Ekala Industrial Estate and as much industry again outside the estate. The proposed central treatment plant is to serve the total of 140 industrial facilities in and around the Estate. (Soil and Water Limited, 1993)

The Industrial Estate was established in 1963 by the Industrial Development Board with basic infrastructure facilities, which includes a domestic sewerage network and treatment plant. Out of the 64 effluent generating industries, only 13 (20%) have constructed any kind of facility for wastewater treatment. Of these only three have comprehensive treatment plants, with the other 11 industries possessing only basic collection and sedimentation tanks prior to discharge.

The feasibility report for the establishment of the treatment plant proposes three options to tackle water pollution in the area:

1) Individual on-site treatment plant
2) Ocean outfall system
3) Joint collection with treatment

The first option requires all industries develop individual treatment plant to meet present standards set by the CEA. The second option is to discharge industrial effluent into the Colombo north sea outfall at Madampitiya. This would require only a collection network and thus represents the cheapest option. The option also has the added advantage of meeting the requirements of domestic users. However, the option would require substantial government participation as several institutions will be involved and the CEA has to ensure that industries meet pretreatment standards prior to discharge, which would require monitoring industries more closely.

The third option, a joint collection with a central treatment plant will aim to service a total of 102 industries, 45 from the industrial estate and the remaining 57, from the area around the estate. It is proposed that the central treatment plant be run on a cost recovery basis with tariffs based on BOD load and water flow. One possible tariff would be Rs.90 per cubic metre of discharge (Soil and Water Ltd., 1993).

4.3 Implications of the Central Water Treatment Proposals

It is clear that the success of the two central treatment plants, in the Ratmalana / Moratuwa and Ekala-Jaya Area will rest on a number of factors:

1) The number of firms with existing treatment plants,
2) The cost to industries, especially to small and medium scale industries and
3) The incentives for industries to connect.

Issue 1 is not a problem as very few industries in both the area have any treatment and almost none that conforms to CEA standards. Issues 2 may be a problem but nonetheless, accords with the polluter pays principle (i.e industries with higher discharge should pay a higher charge, irrespective of size or profits). The main problem is issue 3, since the only current threat is legal action by CEA. This is a very real problem as illustrated by the problems faced by the tannery industry in agreeing to be relocated and thus join a common wastewater treatment plant. This suggests that there may be a role for a non-compliance effluent fee to both encourage timely installation of pretreatment and joining up with the common wastewater plant. An effluent fee will also, to an extent remove the burden of monitoring from the CEA since industries will have to monitor and minimise their discharge to justify a reduction of their charge. These details are discussed further in the second part of this report.

Part II: Effluent Charge Details

Part II of this report provides detailed recommendations for an effluent charge scheme for Sri Lanka. Chapter 5 summarises the original ERM proposal for an effluent charge contained in the Industrial Pollution Management Strategy (ERM, 1994). Chapter 6 reviews the experience with economic incentives and effluent charges in other countries. Chapter 7 builds on the earlier chapters, to present recommendations for an effluent charge scheme in Sri Lanka.

Chapter 5: Summary of ERM Effluent Charge Proposal

The original proposal for the charge arises from the Industrial Pollution Management Strategy developed by ERM. The effluent charge proposal appeared in various different forms. As directed in the Terms of Reference, this report will focus on the proposal as described in the "Scheme for Introduction of Industrial Effluent Charges in Sri Lanka" MEIP/SMI-IV, Consultancy Services for Strategy, Guidelines and Institutional Strengthening for Industrial Pollution Management (ERM, 1994b).

This document gave detailed proposals for the development of an effluent charging scheme for Sri Lanka. The main conclusions were:

The effluent scheme should be phased in over 5 years.

The aim of the effluent charging scheme is in the short term to:

1. Provide an incentive to industry to reduce its wastewaters

2. to encourage them to participate in the proposed common wastewater treatment plant (initially planned for Ekala/Ja-Ela and Moratuwa/Ratmalana area).

3. to stimulate early compliance by existing industry with the SCOPE or national standards.

The longer term objective is the improvement and permanent maintenance of improved river water quality.

It is recommended that the scheme should be administered by the NWSDB as the agency that will be developing charging schemes for sewage disposal and private abstraction of water (although the latter idea has since been dropped).

It is recommended that the revenue from the charge should go to the Pollution Control Abatement Fund.

Charges must not involve undue risks with environmental quality; they must take account of transitional costs and they must be clear, transparent and understandable; and they must be consistent with the regulatory framework set up for the water industry.

Initially the charge will be based on the:

volume of effluent or water; and
load of pollutant

It can be defined for abstraction and point sources. For diffuse discharges, the charge may be best levied on particular inputs/products. The charge can be initially confined to a narrow number of emissions (eg BOD5) and subsequently broadened. It can be defined flexibly for different river classifications. The charge should be levied on net abstractions.

The charge should be a function of pollution load, volume and river quality:

Charge = River quality weighting x [(volume charge) x net volume abstracted
+ (unitary pollution charge) x load for each pollutant discharged)]

The above conclusions were discused at a Workshop to develop an Action Plan to implement the Integrated Industrial Pollution Management Strategy for Sri Lanka, held at the Lanka Oberoi on 13 January 1994. The charge scheme was considered by Working Group 2 on Economic Actions, whose comments were summarised in the ERM final report (ERM, Volume 1, 1994):

"The Group expressed very considerable support for the principle of effluent charges while recognising the difficulties in setting appropriate charging levels designed both to collect revenue and control pollution.

- It was felt that the 21 month time frame was extremely ambitious and should aim for 24 months.

- Metering of effluent volumes was not practical and volumes of effluent may have to be estimated from water consumption figures.

- An important feature of effluent charges was "selling it" to industry. This would be easier once the PCAF was in place. The Working Group stressed that:

- all effluent charge revenue must go to the PCAF and there must be clear criteria for the disbursement of funds from the PCAF."

Chapter 6: Effluent Charges in Other countries

This chapter reviews experience in other countries with incentives to reduce water discharges and groundwater pumping. The incentives reviewed include three main policy instruments:

1. **User fees** for discharging to common waste water treatment plants, or to the sewerage systems.
2. **Water abstraction charges.**
3. **Effluent charges** levied on discharges into surface or coastal water.
4. **Effluent charges** levied on input water.

While instrument 3 (and to some extent 4) are the main concern of this document, lessons can be learned from instruments 1 and 2 in terms of how the charge was levied and the practical problems of implementation.

The chapter first reviews experience with the above four instruments in Asia, then elsewhere in the developing world and finally incentives in the developed countries. The use of market based instruments is an issue which is being considered in many countries in Asia (Markandya and Panayotou, 1994).

6.1 Asian Experience

The following section is based on an Asian Development Bank review of existing economic incentives for environmental policy in the Asia - Pacific Region (Steele and Ozdemiroglu, 1994). This provides examples from Thailand, Malaysia, Philippines, China, Hong Kong and India.

Thailand's has introduced **user fees** in its first central industrial wastewater treatment, set up at the Mae Klong River for effluent from sugar mills. In 1988, the Bang Khuntien Treatment Centre was also set up with **user fees** by the Ministry of Industry to deal with heavy metal contaminated wastewater that was generated by 200 small and medium-scale electroplating factories scattered around Bangkok. Between September 1988 and May 1990, 8,300 tons of hazardous waste from 46 electroplating and 20 other factories was treated. A standard fee of 450 baht per ton of waste was charged with adjustments for type of waste and distance from treatment site (1 baht = 2.05 rupees).

A scheme for common wastewater treatment **user fees** in Samut Prakan Province proposes covering the capital cost of the plant with a fee on the volume of wastewater, and the operating cost of the plant with a fee on BOD load. The capital costs fee is estimated at 5.63 baht per m3, and the operating cost fee at 10.7 baht per kg of BOD. It is suggested that such a charge will be less than 1% for three quarters for 75% of firms, 2% for a some textile and food processing industries, and more than 2% for a few fabricated metal firms (Limvorapitak and Lathapipat, 1995).

Hong Kong is currently introducing **user fees** for waste treatment with fixed charges based on size of water connection and variable charges based on volume and composition of discharge.

Indonesia is currently considering user fees for common wastewater treatment plants. The proposal is for the fee to be levied on COD load. This is chosen instead of BOD because, as the feasibility report for common industrial wastewater plants concludes: "Although BOD is a better measure for oxygen demand in surface waters and treatment facilities, usually COD is taken as it is easier and faster to determine" (Republic of Indonesia, 1993).

India currently has pollution consent fees ranging from Rs 200 to Rs 10,000 and is planning to increase effluent fees to be above the costs of treatment (1 Indian Rupee = 100 paise = 1.63 Rs). Most Indian states currently levy water charges known as "cess". These include an **effluent charge** component since water which will be discharged as pollution is set at a higher rate. The 1992 rates of cess in the state of Tamil Nadu are four paise per m3 of process water, whereby the water gets polluted, but the pollutants are easily biodegradable and 5 paise per m3, whereby water gets polluted and the pollutants are not easily biodegradable.

The Philippines has a comprehensive set of **effluent charges** but they are currently set too low to deter polluters (Montgomery James, 1992). The levy is calculated on the number of pollution "points" which depend:

- on the extent of exceedence from standards (in terms of absolute exceedence in kg for BOD and COD, and percentage exceedence for heavy metals)
- the ambient quality set for the receiving water body

Originally the fees were intended to range up to several thousand pesos per day, but the maximum fine was set by law as up to P 5000 per day (1 peso = 2 Rs). In the case of strong industrial waste discharges, this is much lower than the cost of treatment. In a review of the scheme, it was proposed to increase the level, so that by the end of three years, the sum of the fees will be more than the capital and operating costs.

In Malaysia, since 1978, **effluent** charges have been levied on the discharge of palm oil and rubber factories. The fee was first set at M$ 100 per ton of BOD load above 500 parts per million (1 M$ = 20.81 Rs). In addition a license was introduced of M$100 per ton of BOD load. These fees could be waived if the firm implemented waste treatment. By 1984, this scheme was successful in lowering BOD effluent levels to the target of 100 mg per litre.

In China, the mainstay of environmental policy is regulation of effluent and emission standards combined with an **effluent charge** system. The latter is best described as a noncompliance fee system. Similar to the Philippines system, the levy is calculated according to exceedence of concentration based standards. The pollution parameter that exceeds the standard by the greatest amount is multiplied by a factor to give the levy. The fine is doubled if the polluter is caught lying about emissions. The levy is also increased by 5% per year from when the levy is assessed until the enterprise complies with the standards. 80% of the revenue is retained for pollution control, primarily installing individual wastewater treatment. The remaining 20% is kept by the local Environmental Protection Bureau to support monitoring and enforcement.

The fee applies to non-compliance with water, air, waste and noise standards, but the largest component is for water effluent. Thus in 1989, fee collections amounted to Y

1.4 billion, with Y 858 million for excess discharges to water. The main success of the scheme has been to generate significant funds for pollution control since the levy is set considerably below actual treatment costs. The latter problem was partially addressed in 1991 when the levy was increased by 40%.

This **effluent charge** scheme was introduced in Shanghai in December 1986 with the explicit aim " to promote conservation and minimize water use". The fee is Y 0.12 per m3 of discharge and goes up if the discharge is above the set quota or if the levy is not paid on time (1 yen = 0.06 Rs).

6.2 Examples from other developing countries

Brazil introduced in 1978 an **user fee** for discharging wastewater into the sewage network. The charge was levied on the volume of wastewater in terms of m3, weighted according to the concentration of suspended solids and BOD (Bhatia, Cestti and Winpenny, 1993).

6.3 Examples from the developed world

This review is based on a publication reviewing economic incentives for environmental policy in selected developed countries (IISD, 1994).

Netherlands has a user fee for financing the public provision of central treatment plants. Initially charges were first based on oxygen demanding materials. The charge is based on "population equivalents" (PE) which is the amount of oxygen demanding pollution that is discharged on average in a year by one individual. As of January 1, 1986, the population equivalent is fixed at 136 grams oxygen per day.

For households and small companies, the number of Population equivalents is fixed. For large companies, the number of PEs is metered. For medium sized companies, the levy is determined on a coefficient table based on data such as number of employees, production and water or raw material consumption. If a company does not agree with the amount, it can be ask to be measured. But the costs for installing a meter (up to Dfl. 150,000) and taking measurements must be borne by the company. In view of the high costs, medium sized companies are unlikely to apply for actual metering. When the scheme first started, much data was missing on volume and composition of discharge, and charges were often too low. But charges have been revised upwards as more data has been collected. The average levy rate doubled from 36 guilders in 1980 to 73 guilders in 1993 (1 guilder = 31 Rs).

As of 1993, additional charges were introduced on heavy metals. One population equivalent is taken to be equal to 100 grams of cadmium, mercury or arsenic and 1 kg of copper, nickel and lead. The levies are collected to finance common waste water treatment plants for those companies who do not have access to such scheme. The revenue are generally sufficient to cover 60% of the investment costs of biological treatment and 90% of the cost of physical-chemical treatment.

Germany has had **water abstraction** taxes since 1988. These began first at a state level in Baden-Wurttemburg and then at a city level in Hamburg and Berlin. In Baden-Wurtemburg, the tax rate for surface water is set between 0.1-0.04 DM per m3

depending on the water use (1 DM = 34 Rs). The rate for groundwater is set at a slightly high rate of between DM 0.1 - 0.01 for groundwater. Rebates of up to 90% are available for water intensive agriculture, forestry and industry whose competitive position might be affected. The rebate is conditional on taking all available measures to save surface water and to use surface water instead of ground water. This tax has raised on average of DM 140 million per year

Similar schemes have now been introduced in other German states. Hesse currently has the highest rates of 1 DM per m3 for water cooling for industry and DM 0.8 for other industrial uses.

Hamburg introduced an abstraction charge on groundwater only in 1989. This is currently set at 0.17 DM per m3 for good quality groundwater and 0.1 DM for high chloride groundwater. Berlin has applied a groundwater tax since 1989. This is generally based on metered abstraction rates, but the water management authorities may base the tax assessment on estimates. The tax is a uniform DM 0.3 per m3.

France has an effluent charge scheme levied on the input water. This principle is similar as the Indian system, but is more accurate since the level of pollution for each firm is actually measured and added to its water bill.

6.4 Conclusions from review of international experience

A summary of the incentives schemes is set out in the Table:

Table 6.1: Selected Pollution Incentives (converted to Rs)

Country	Effluent charge	User fee for Common wastewater treatment	Abstraction Charge
China	0.01 Rs/m3 (Shanghai)		
Philippines	10,000 Rs/day (maximum)		
Malaysia	2 Rs/kg BOD (above 500 BOD mg/litre)		
Thailand		1 Rs/kg of toxic waste (Bang Khuntien) 22 Rs/kg of BOD plus 12 Rs/m3 (Samut Prakan Province)	
Indonesia		Not specified	
Brazil		25 Rs/m3	
Netherlands			2263 (average levy per day)
Germany			3.4 to 10 Rs/m^3

Source: Own data

1. Many countries have some form of economic incentive to reduce water pollution. In addition, a number of countries have actual effluent charges, including China, Malaysia and the Philippines.

2. The main success of existing effluent scheme has been to generate funds for pollution control. This is particularly the case in China, where the equivalent of Rs 53 million was raised in 1989 from water effluent charges.

3. The main problem with existing effluent schemes has been that the level of the charge has been too low compared with treatment cost. This has resulted in the need to significantly raise the charge to provide an effective incentive.

4. Most fees on waste discharges tend to be based on a simple parameter, such as water volume (in m3), pollution load or concentration exceedence. Malaysia's effluent charge is based on BOD, China and Philippines effluent charge are based on concentration exceedence. User fees for common wastewater treatment are based on BOD load in Thailand and are planned to be based on COD load in Indonesia.

5. Several schemes use estimates for levying charges. This is the case in both the Netherlands and Germany. If these estimates are contested by industry, industry must bear the cost of installing a meter and monitoring.

Chapter 7: Effluent charge details

This section will develop a set of recommendations for introducing an effluent charge in Sri Lanka based on:

* The ERM conclusions as endorsed by the Working Group (chapter 5)
* The review of other countries experience (chapter 6)
* Discussions held during the course of the project (See Appendix 1, for individuals contacted)

The recommendations will be developed under five main sections:

7.1. Objectives of charge

7.2. Type of charge: unit of charge, cut-off point of charge, industries to be charged.

7.3 Level of charge (including industrial treatment costs).

7.4. Effects of charge: effect on water quality, size of revenue raised and costs of charge (including industrial compliance costs, charge collection costs and monitoring costs).

7.5. Institutional issues: charge and EPL scheme, institutions for administration of charge (both monitoring and collection), and division of charge revenue between CEA, NWSDB and NDB.

7.6 Advantages of charge as outlined.

7.1. Objectives of charge

The basic principle for the charge has been that the charge should act as an incentive to industry to reduce wastewater discharge by installing and operating pollution abatement equipment and by increasing water recycling. The latter will have the additional benefit of reducing groundwater draw down, which is currently unregulated. In the case of common wastewater treatment, the charge should encourage firms to swiftly install pretreatment and then join up with the common wastewater plant, as discussed in chapter 4.

Thus the charge would be in addition to the current EPL scheme and the proposed user fee for common wastewater treatment. It would be a "non-compliance" fee levied on those industries who either fail to comply with EPL standards and do not utilize the common waste water treatment, once they become available.

While any level of charge will have an effect of increasing incentives to recycle, the main decision by firms as set out in chapter 2 will be the relative charge level versus the costs of pollution reduction. The cost of pollution reduction will either be individual treatment costs, or pretreatment costs and the user fee for the common wastewater treatment plant.

For individual treatment, the capital costs of installing pollution are large, but these are currently being mitigated by the Pollution Control and Abatement Fund (PCAF). In the first 5 months since the PCAF was made operational in April 1993, over 15 firms have applied for funds and up to 10 loans have been formally agreed.

In addition the CEA is beginning to take tougher legal action against those industries who do not have treatment plants and this is beginning to have an effect. Effluent charges will have an added effect, but they would have to be prohibitively high to match the capital costs of treatment.

The areas where the current EPL legal enforcement framework works poorly are identified below, along with how a charge scheme could correct some of these problems:

1. The current framework is not perceived by industry to be uniformly enforced. This is not so much the fault of the CEA, as it is inherent in the nature of a judicial enforcement system where the decision to prosecute may be based on legal considerations, such as extent of evidence, rather than degree of non compliance. A charge scheme which would be applied uniformly would reduce the "ad hoc" nature of policy enforcement.

2. It provides perverse incentive to dilute highly polluted water so that it complies with the current concentration based standards. While this is now not so widely practised, partly due to weak enforcement of current regulations, as the CEA takes tougher action, this dilution will become more attractive to firms. A charge scheme based on pollution load could remove this loophole.

3. The current regulations have no effect on the reduction of groundwater, that is currently unregulated. In fact, given the above issues of dilution there are incentives to increase use of groundwater. A charge scheme by making wastewater outputs more expensive, would also provide incentives to reduce water inputs.

4. The current scheme cannot ensure that industry will install pretreatment and hook up to the common wastewater treatment plant once it becomes available. This is imperative to make the BOT viable for a private sector investor. The charge scheme by punishing those who fail to hook up or install their own individual treatment, would increase the pressure to hook up.

5. The current scheme works poorly at ensuring that once treatment plants are installed they are operated properly. In some cases treatment plants are deliberately turned off, while in other cases they are poorly maintained, are overloaded in terms of pollution load, or do not have the correct chemicals added at the correct times.

The reasons for this are economic. The avoidable operating cost of an average plant range from Rs 50,000 to 500,000 a month (see Table 7.3). Such avoidable costs

include electricity, chemicals, proper maintenance and trained skilled operators (other variable costs such as depreciation on the machinery cannot be avoided). The costs are higher for physical-chemical treatment and arise as a result of high energy usage (for pumps, aerators etc) and high chemical costs. So within a year, operating costs can be as much if not more than installation costs. Thus even once firms install waste treatment plants, they have an overwhelming incentive to use them incorrectly or not at all.

The current EPL scheme tries to tackle the latter problems by monitoring, with industry supposed to provide monitoring data once a quarter. The industry either does not bother to comply, or generally ensures that when these samples are taken the plant is working properly. Given limited resources, the CEA generally itself inspects each enterprise at most once every year. The limited results available show a large variance between the sampling data supplied by the industry (from respected laboratories) and that of the CEA.

Thus the current scheme shows some limited success in getting firms to install pollution plats. But it is much less effective at ensuring that these plants are used in such a way to comply with standards. In this case an effluent charge system would be most effective and would fill an existing gap in the regulatory/incentive structure.

As the focus is on ensuring that plants are actually operated, the appropriate charge level would be to be above the cost of operating a wastewater treatment plant. In areas, where common wastewater treatment is planned this can be pegged at the cost of pretreatment plus connection to the common treatment. A consideration of both the most important parameters in influencing pollution costs, plus the absolute level, will guide consideration of the appropriate unit and level of the charge. This is considered in the following section.

7.2. Type of charge

This section works from the objectives of the charge outlined above to examine three issues:

1. unit of charge
2. cut-off point for charge
3. which industries to face charge

7.2.1 Unit of charge and cut-off point

These are two inter-related decisions on what unit the charge should be levied, and what should be the charge cut off point (ie who should pay it). Taking both issues together, the possibilities are set out below:

1. **Water discharge (in m^3):** so the charge would be based on water flow discharges, and cut-off based on the those who discharge a certain amount of wastewater.

2. **Concentration exceedence:** so charge would be based on some exceedence of the existing concentration standards, and cut-off based on those who do not meet concentration guidelines. This is the system currently used in the Philippines effluent charge scheme (see chapter 6).

3. **Pollution load (which is a function of water flow and pollution concentration):** so charge could be levied on pollution load with cut- off determined according to some load based standards. This is similar to the approach used in the Malaysian effluent charge scheme (see chapter 6).

4. Some combination of the above (as recommended by ERM). This may appear beneficial, but care must be taken not to make the scheme too complex. All other existing charge schemes (see chapter 6) started simple.

The difference in approaches is illustrated by the bar chart of selected industries ranked according to concentration, water discharge or pollution load.

Water discharge (option 1) is very unfair on high water use industries with low concentrations and does not comply with the polluter pays principle.

Concentration criteria (option 2) is the basis for the current EPL, so it seems the easiest approach. The problem with this approach is that it is possible to evade the standards with dilution. This loophole can be avoided by stating that the standard can only be reached by the installation of a recognized waste treatment system, not by dilution of waste. In discussion with industry it was proposed that the authorities should set out the recognized waste water treatment options. This is the approach used in the UK and US where standards are based on technology. In the UK, the standard is set according to "best practicable means" and in the US standards are stipulated according to "best available technology" for a particular production process. In Sri Lanka these technology guidelines already exist in the form of the bkh guidelines (1992). In principle, the main job would be to increase knowledge of these standards through industry association and research institutes (eg Rubber Research Institute).

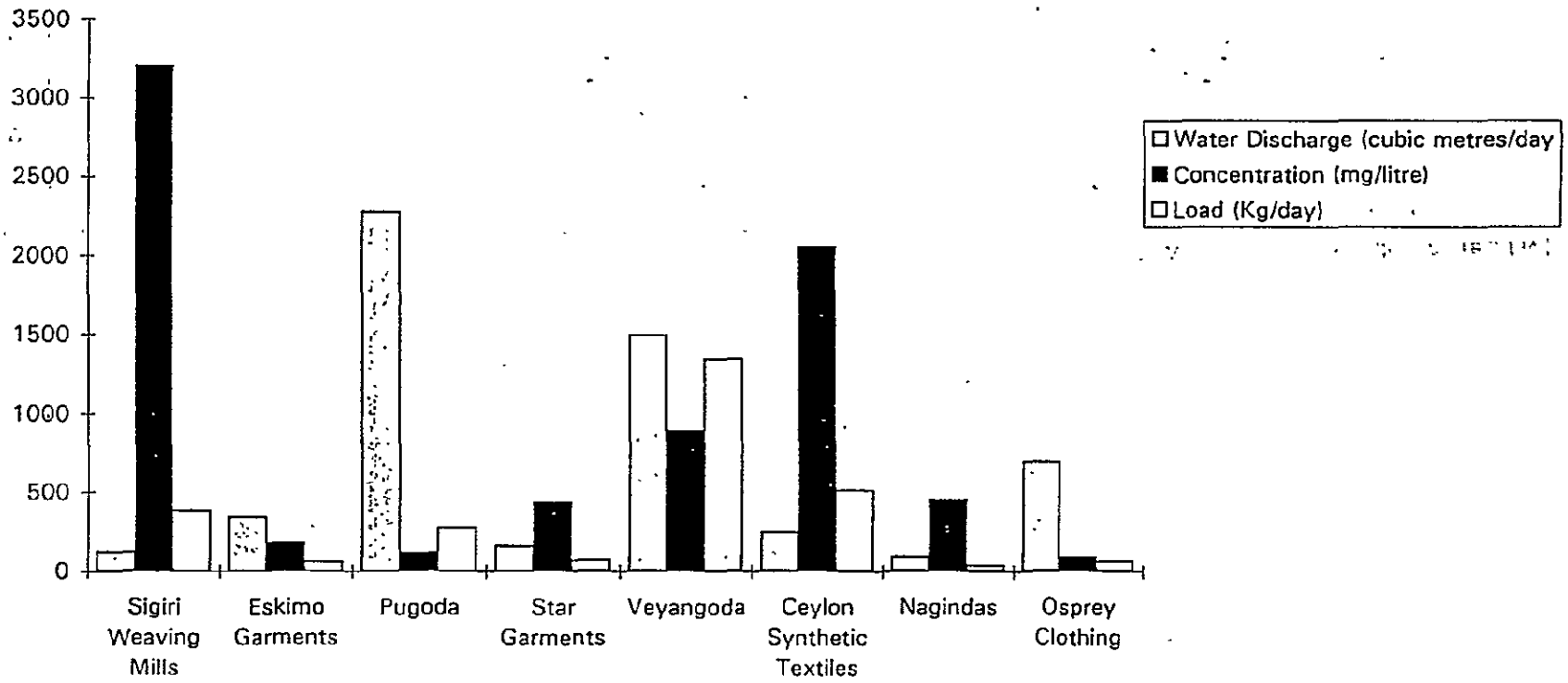
Pollution load criteria is the most commonly used criteria elsewhere and also the most accurate reflection of the polluter pays principle. In this case, to decide who should pay the charge requires some decision about the acceptable load. Since current standards are concentration based, this would require new load standards. These are generally set according to the allowable load per unit of raw material input or product output. The problem with the load measure is that being dependent on the flow, it requires composite sampling for industries such as tanneries, which are batch dependent.

Weighing up the options

In order to compare the different strengths and weaknesses of the options above, these three options will be assessed in terms of effectiveness, enforceability and compatibility with existing policy.

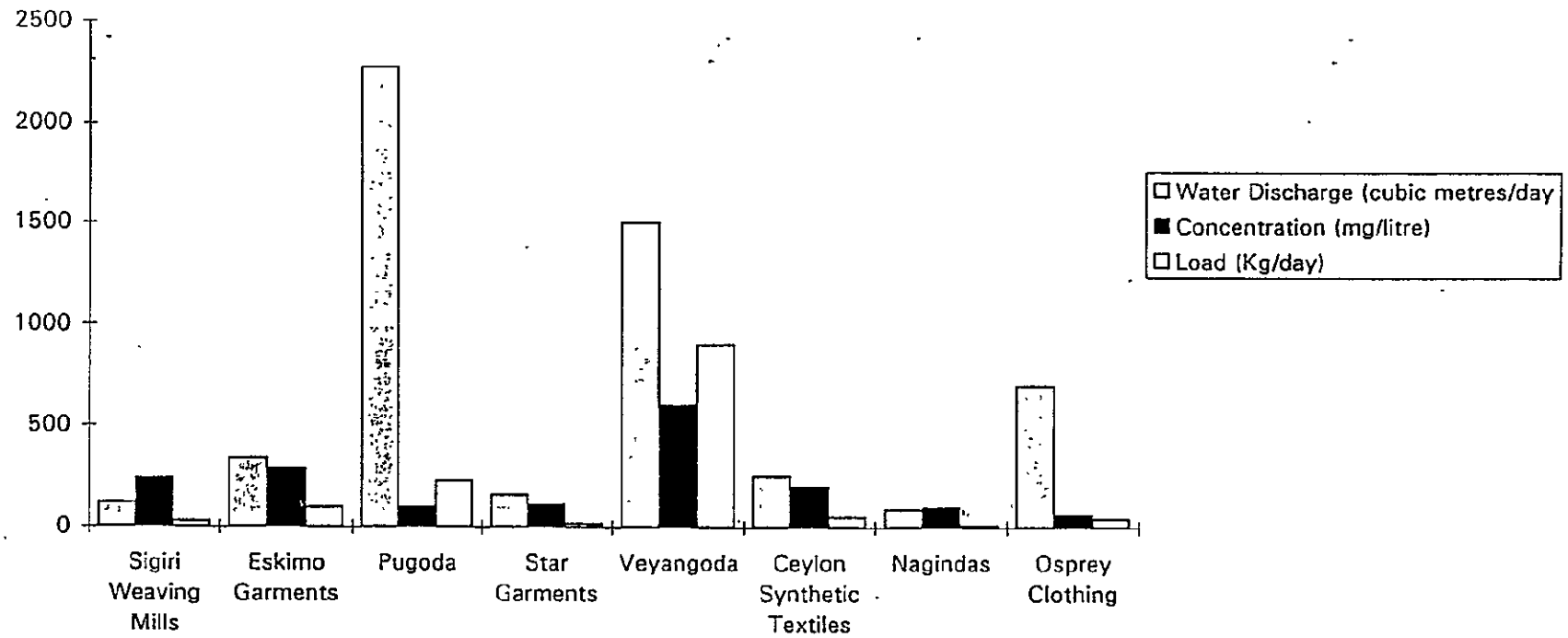
Ranking Selected Textile Industries According to Different Pollution Indicators - COD

(Source: CEA and Own Calculations)

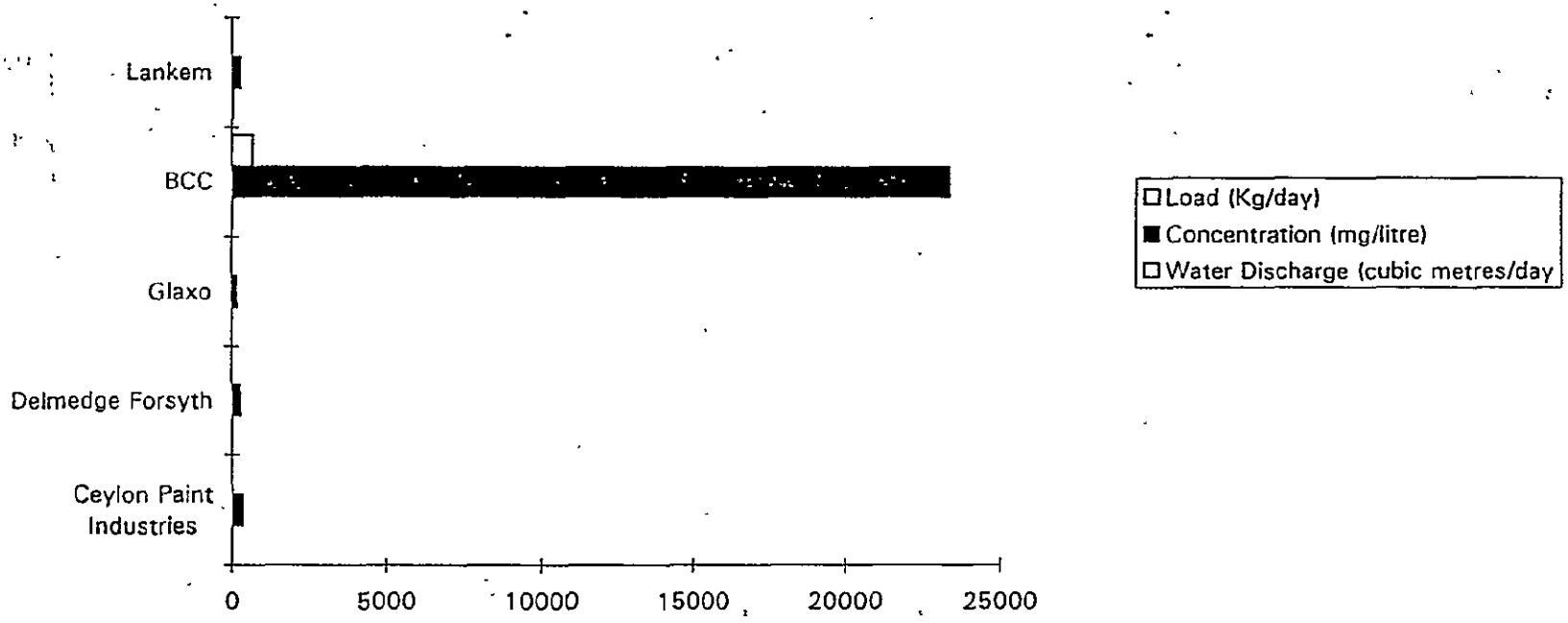


Ranking Textile Industries According to Different Pollution Indicators - BOD

(Sorce: CEA and Own Calculations)

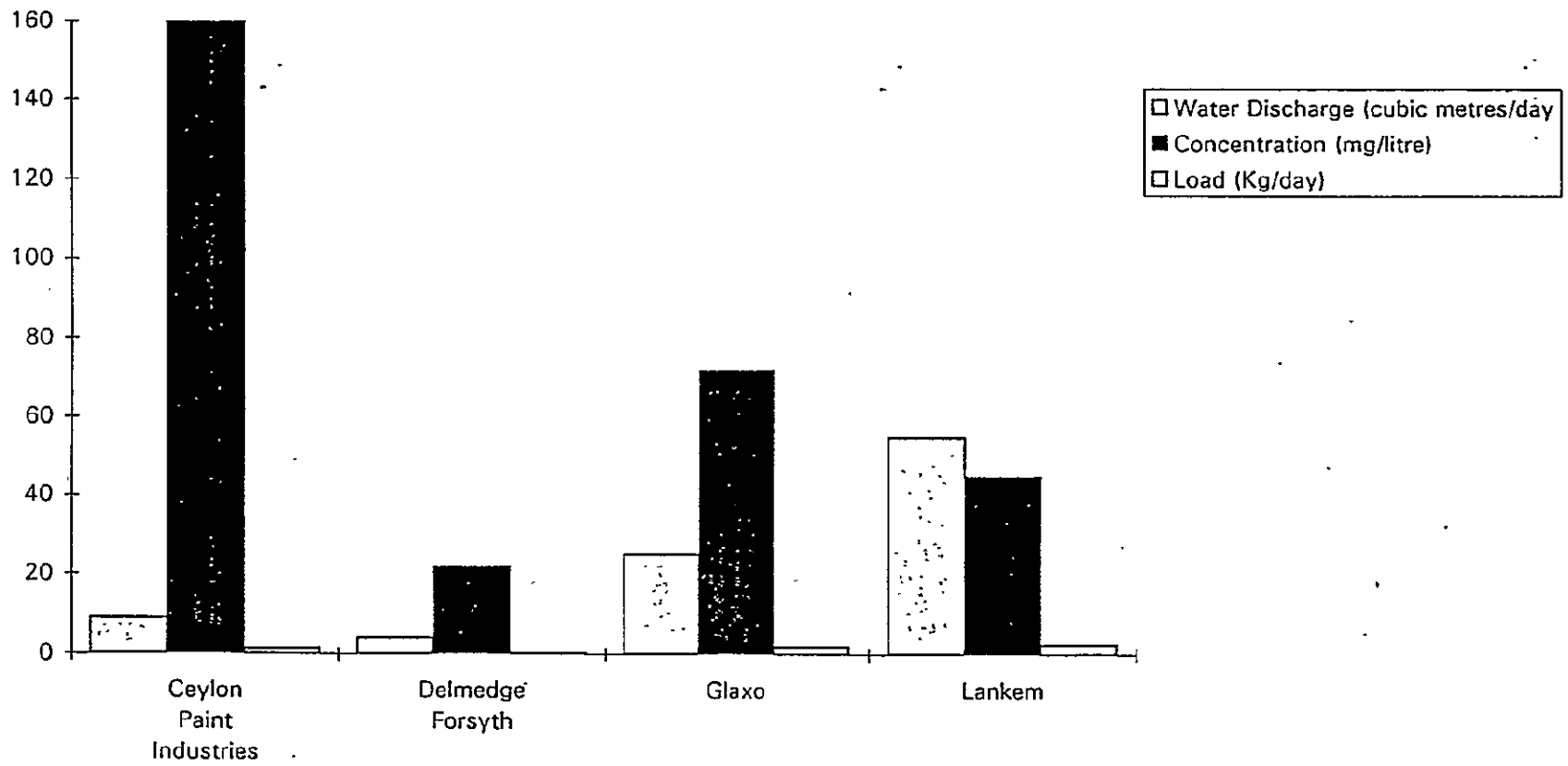


Ranking Selected Chemical, Paint & Pharmaceutical Industries According to Different Pollution Indicators - COD
(Source CEA and Own Calculations)

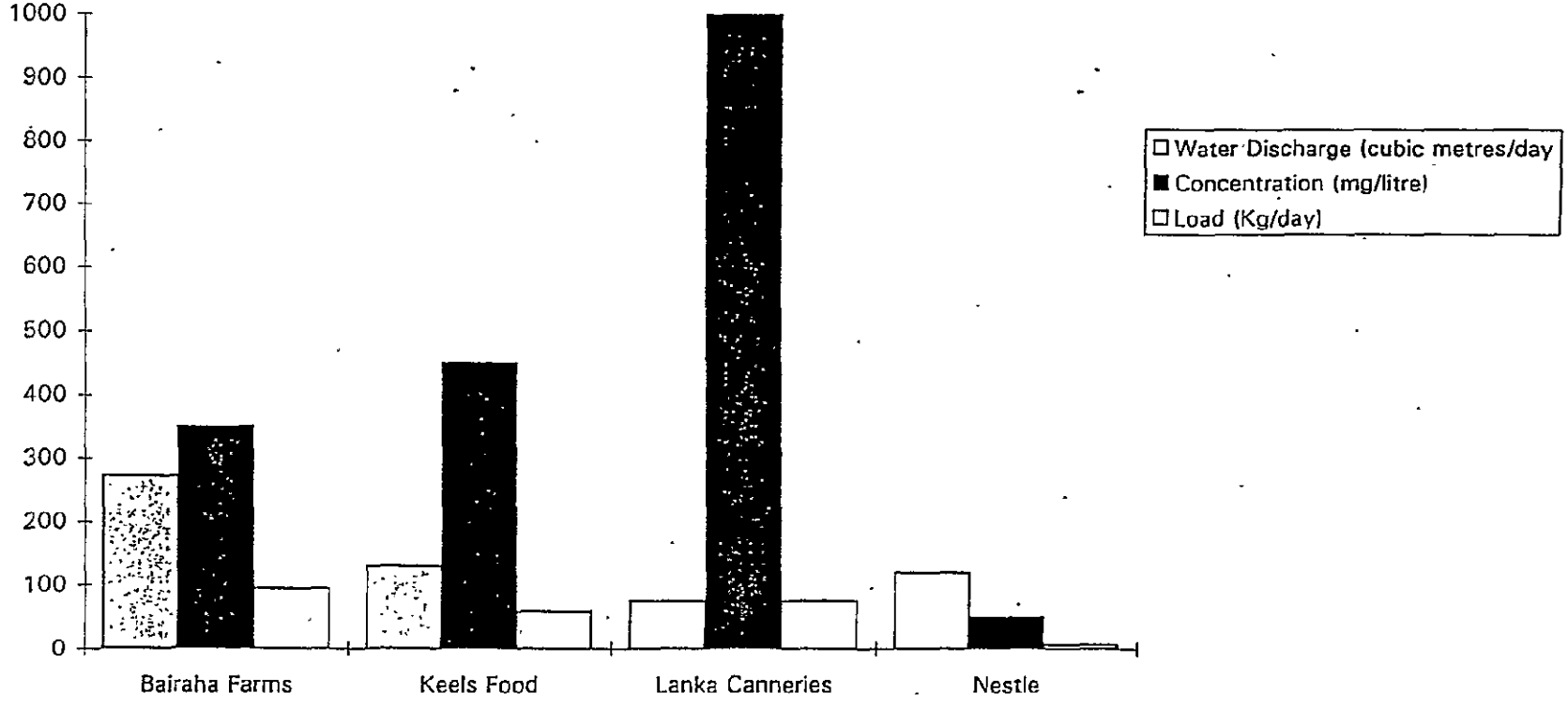


Ranking Selected Chemical, Paints & Pharmaceutical Industries According to Different Pollution Indicators - BOD

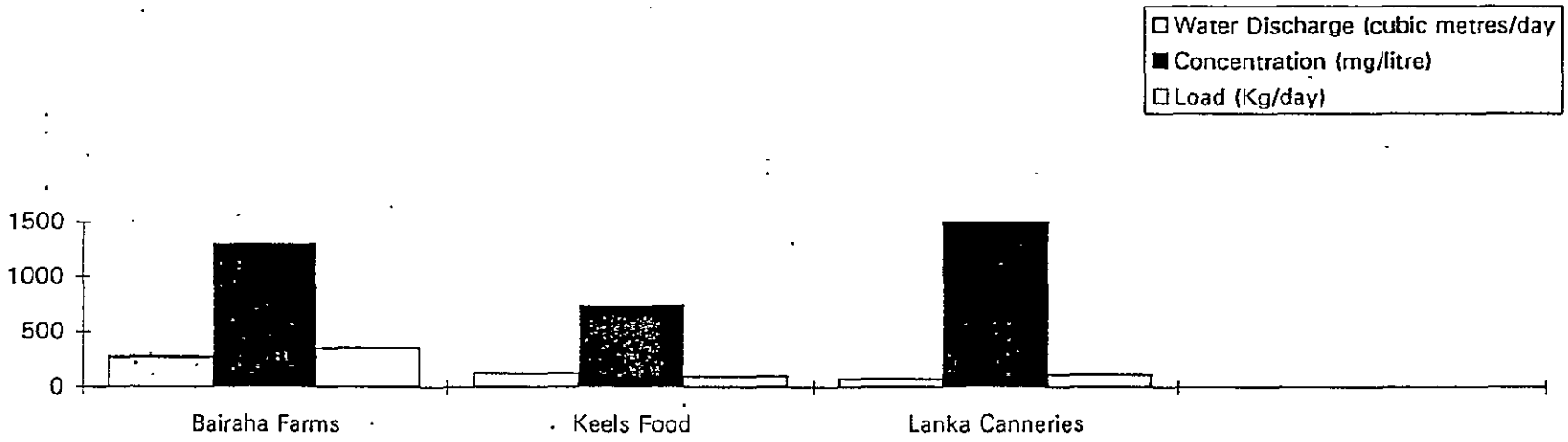
(Source CEA and Own Calculations)



Ranking Selected Food Industries According to Different Pollution Indicators - BOD
(Source: CEA and Own Calculations)



Ranking Selected Food Industries According Different Pollution Indicators - COD
(Source: CEA and Own Calculations)



In terms of effectiveness - defined as the objective of setting the charge above the waste water treatment operating cost - concentration exceedence (option 2) is the least acceptable. Operating treatment cost, is a function of both pollution load and water flow. However at low levels of water flow, such as those in Sri Lanka, water flow seems to be more of a determinant of cost than BOD or COD load.

Enforceability is defined in a technical sense to mean ability to monitor, and in a political sense in terms of perceived fairness and transparency. This is defined as accordance with the Polluter Pays Principle. In the technical sense - defined as measurement - concentration exceedence (option 2) is the easiest, since it requires concentration data which is already required by the CEA. Concentration exceedence (option 2) is also the most flexible since it allows the charge to cover different parameters, such as BOD, COD and pH. This is the option used in the Philippines.

The other options will clearly need additional information in the form of waste water flow data. Load can be found by multiplying flow times average concentration. Flow data will be hard to estimate as industry may conceal their true discharges and the assumption that discharge will be roughly 80% of water intake cannot be used since intake is mostly from unmetered groundwater. As far as political enforceability, load and concentration exceedence are preferable since they conform most with the polluter pays principle.

As far as comparability with existing policy, concentration exceedence (option 2) is the best since it compares most directly with the EPL scheme. However both water flow and pollution load are under discussion as the basis for the charge levied by the new common wastewater treatment plants.

Table 7.1 illustrates the three option weighted according to the different criteria (the higher the score the better the option).

Table 7.1: Criteria for deciding unit and cut-off point for effluent charge

	Effectiveness	Enforceability		Compatibility
		Technical	Political	
Flow	1	0	0	1
Load	1	0	1	1
Concentration exceedence	0	1	1	1

Weighted according to effectiveness, enforceability (technical and political) and compatibility, then load and concentration exceedence emerge as the best options. It is therefore proposed to combine them and make the charge load based, with a cut off point based on exceedence of concentration standards (through failing to install "recognized waste treatment"). This is very similar to the Malaysian effluent charge system.

A load based effluent charges with a cut off point based on those who fail to meet the existing concentration-based CEA standards, provides the best option. In particular, no new load based standards are required. This means that the scheme can be

implemented much more quickly. If in the future load based standards are introduced, then it will be easy to switch the cut-off point of the load based charge to the new load based standards.

The establishment of recognized wastewater treatment plants will have four advantages:

- it will encourage openness and transparency by ensuring that industry knows what the regulator expects (which has been an industry complaint).
- it will provide some cover to industry against rogue or "cowboy" consultants (another persistent industry complaint).
- it will save industry money since research is to some extent a public good and for similar industries, there are economies of scale in designing treatment plants for their requirements rather than each separately employing a consultant.
- By stipulating "recognized" waste water treatment plants, the current loophole allowing industry to meet CEA standards by simply diluting wastewater would be blocked.

7.2.2: Choosing the Load Parameter

Pollution load can be determined according to a number of different parameter, with the main parameters identified in the EPL standards as:

Chemicals Oxygen Demand (COD)
Biochemical Oxygen Demand (BOD)
pH
Suspended Solids (SS)
Selected heavy metals

The three main load parameters used elsewhere in the world are BOD, COD and toxics. Generally toxics are quite complexs to control and in Sri Lanka they come from the smaller industries, such as metal finishing. Therefore it is proposed not to include toxic in the initial phase of the charge scheme, although they can later be brought into the scheme as they were in Thailand. Suspended solids and pH are not generally used in effluent schemes. Thus the focus must be on BOD and COD load.

Both BOD and COD have advantages. BOD is the best measure of the effect of organic pollution on microorganisms, which is the process that occurs in rivers and is simulated in biological waste water treatment. For this reason a number of user fees for common wastewater treatment, such Thailand, focus on BOD.

However the test for BOD5 is less reliable than the test for COD. Also as its name implies the BOD5 test takes five days. This BOD5 test at 20 degrees Centigrade is also commonly done in Sri Lanka as a three day test at room temperature, which is assumed to be 25 degrees. Contrary to the popular view these tests give quite different results.

For these reasons, this report, follows the approach of Indonesia as selecting COD as the most reliable and simple pollution load test. The need for a reliable and simple test is crucial to making the effluent charge feasible.

This recommendation has one proviso in that it is also important that the load parameter adopted for the effluent charge is the same as the load parameter used in the common wastewater treatment plant in order to ensure consistency. Thus it is proposed that the common wastewater user fee should also include COD, although so far only BOD and water volume have been mentioned as possible parameters. If this is the case, then there may be some consideration given to the need to switch the effluent charge also to BOD.

7.2.3 Choosing the category of industry to face the charge

The charge scheme is initially proposed to cover only the high water polluting industries. This is because they are the main polluters and will generally have the lowest costs of abatement. Thus according to the theory set out in chapter 2 they should provide the initial focus.

There is no agreed data for the number and location of high polluting industries in Sri Lanka. The main reason is that there is no agreed definition of high polluters. This issues was addressed by ERM in Volume 3 (Annex E). The first initial report was done by NBRO in 1988 classifying industry according to light, general and special (with special being the most polluting). This was followed by a report by Resource Development Consultants Ltd classifying industries into low, medium and low on a simple points system (Resource Development Consultants, 1989). High polluting industries were assigned according to pollution potential and size of industry. In total they identify 291 high polluting industries.

The problem is that the classification used by the CEA was different to these earlier reports. According to the CEA database, there are 675 high polluting industries on the CEA database. However it is recognized by the CEA that the high category is not defined correctly.

The ERM report recommends a new classification according to A, B and C, which gives similar results to the NBRO results. Category A is defined as industries which generate a high volume and unit concentration of gaseous, solid and liquid pollutants, which result in a high pollution load.

It is recommended that those activities in Category C which have a high water load face the charge if they have not installed "recognized" wastewater treatment.

7.3: Level of charge and treatment costs

The objectives set out above require that the level of the charge should be above the operating cost of individual treatment plants, level of charge (based on industrial treatment costs)which will in turn be above the cost of individual pretreatment and the common wastewater fee.

This requires two pieces of data:

1. First data must be collected on the cost of individual treatment and of connection to the common wastewater treatment plant.
2. Secondly data must be collected on the load discharge from selected firms to find what level of monthly charge is required to be above their monthly operating cost of treatment.

7.3.1: Calculating Cost of Treatment

Table 7. 2 below sets out the current actual and proposed costs for common wastewater treatment. Table 7.3 sets out some selected cost for individual operating costs per month. The data in Table 7.3 is based on empirical data of actual plants. These results are generally cheaper than similar estimates made by ERM. The ERM data was based on UK costs adjusted for Sir Lanka. ERM left Sri Lanka mechanical and equipment costs the same as the UK - this may appear a fair assumption since most equipment is imported, but many companies have imported cheaper plants from India. For civil and construction costs, ERM have simply halved the UK costs - this seems to be a major over-estimate given the difference in per capita incomes.

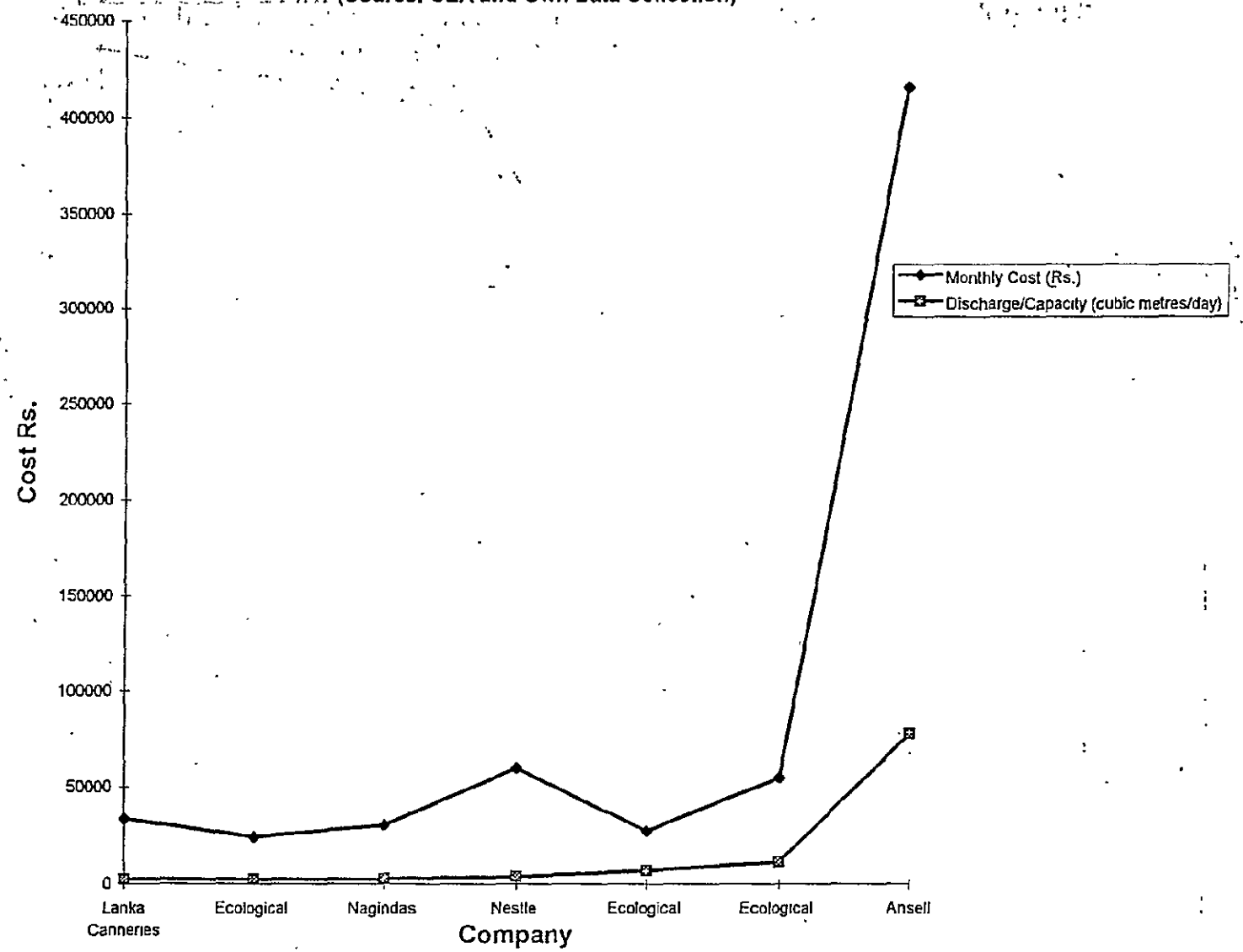
Table 7.2: Selected Industrial Use Fees for Common Wastewater Treatment

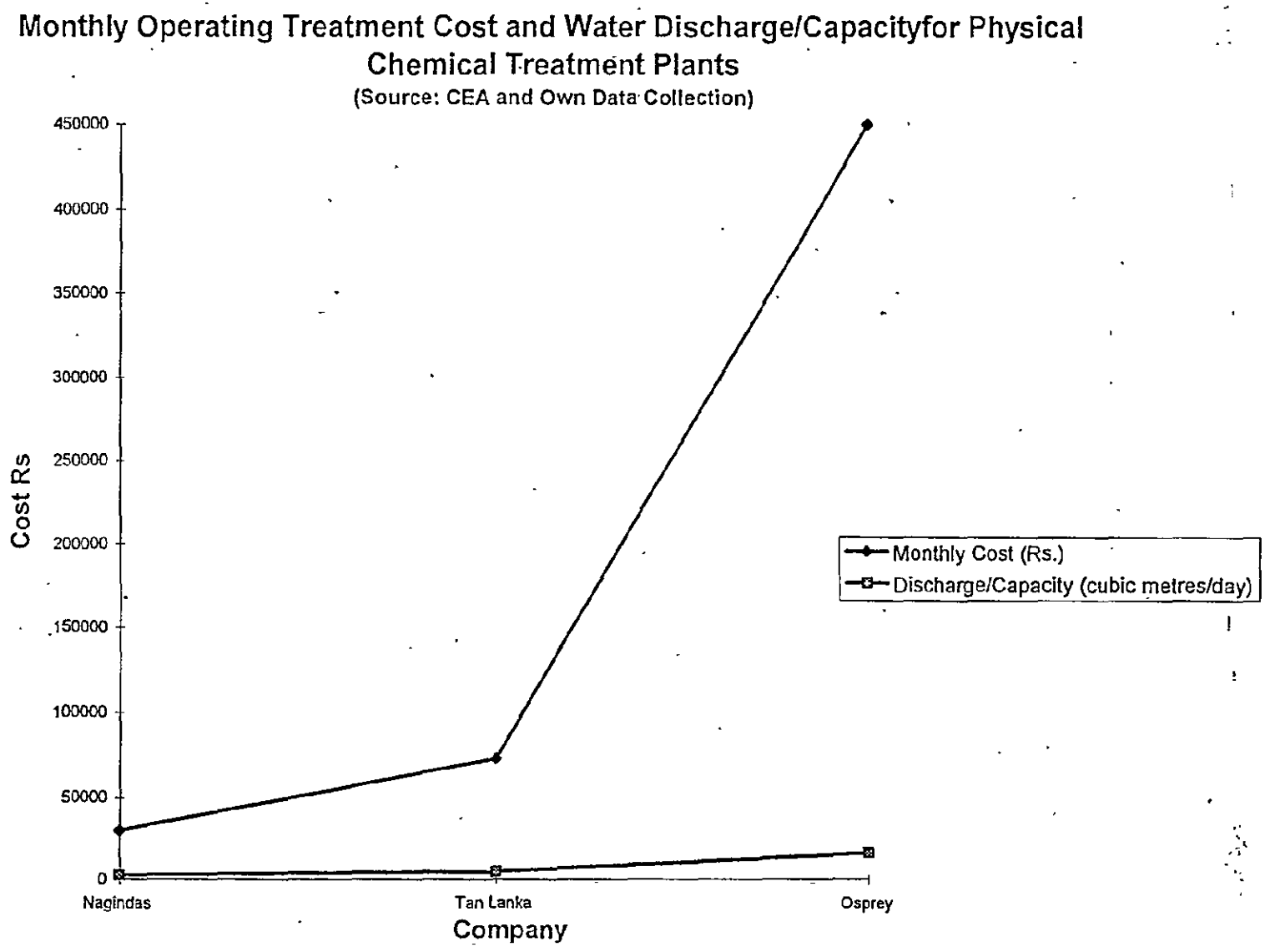
	User fee (industry) (Rs/m^3)	Capacity (m^3 per day)	Capital (Rs million)	Operating costs (Rs per month)
Katunayaka	land rent	9,000	-	350,000
Biyagama	land rent	10,000	-	275,000
Koggala	land rent	700	61 million	-
Ekala and Ja- ela	90	2,150 (initial)	90 million	20,000 (1998)
Moratuwa/ Ratmalana	40-46	45,000 (ultimate)	140 million	108,00-140,000 (1998)

Source: BOI data, Water treatment feasibility reports

Monthly Operating Treatment Cost and Water Discharge/Capacity for Biological Treatment Plants

(Source: CEA and Own Data Collection)




Monthly Operating Treatment Cost and Water Discharge/Capacityfor Physical Chemical Treatment Plants
(Source: CEA and Own Data Collection)
Cost Rs
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Nagindas
Tan Lanka
Osprey
Company
Monthly Cost (Rs.)
Discharge/Capacity (cubic metres/day)

Monthly Operating Treatment Cost and Water Discharge.Capacity for Biological & Physical Chemical Treatment Plants

(Source: CEA and Own Data Collection)

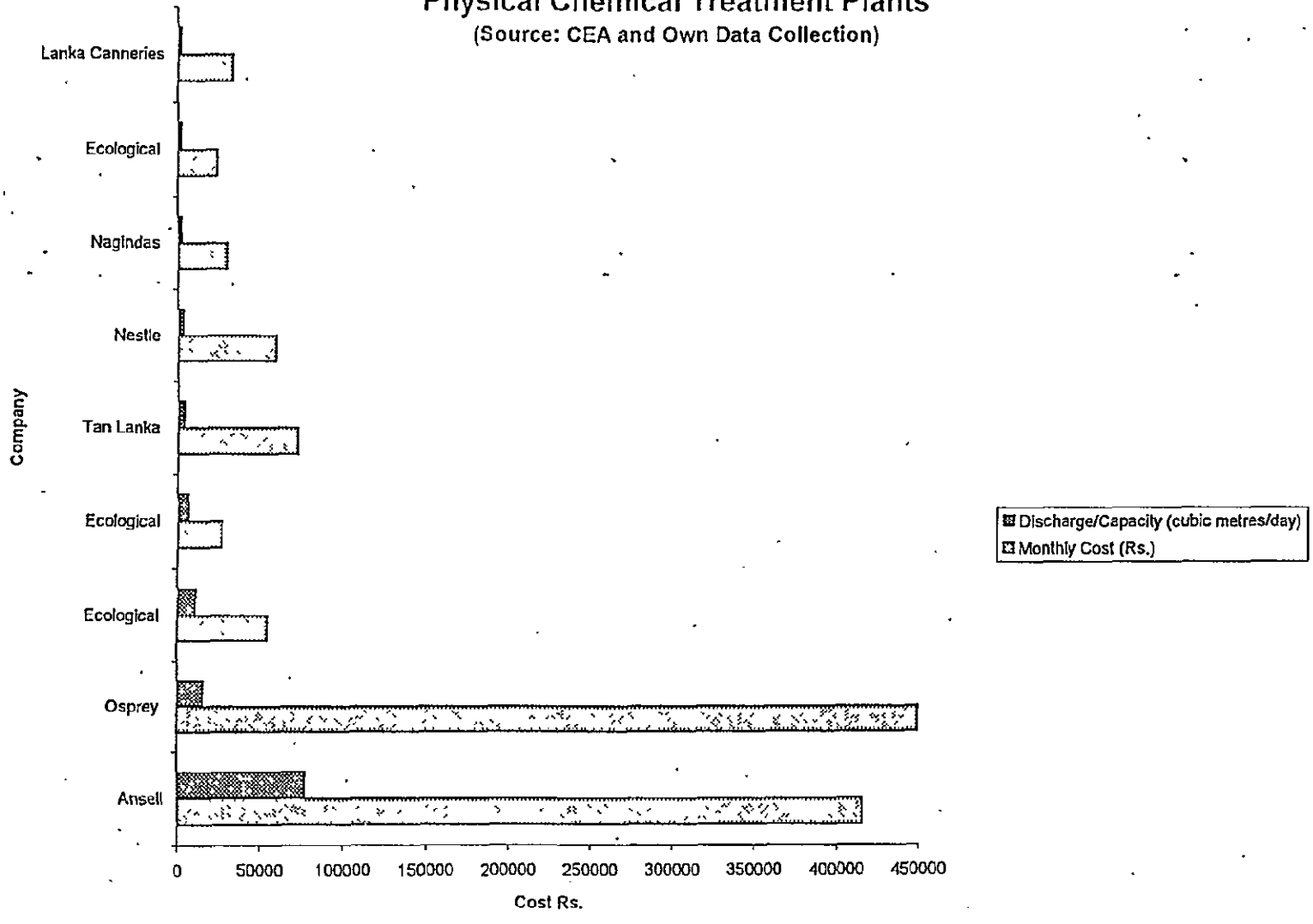


Table 7.3: Individual Wastewater Treatment Monthly Operating costs - For Selected Industries

Industry	Plant size (m^3)	chemicals Rs/month	energy Rs/month	labour Rs/month	sludge dumping Rs/month	mainte-nance Rs/month	Total Rs/month	Cost Rs/m^3
Ansell	2,600	340,000	16,000	25,000	20,000	15,000	416,000	5.3
Lanka Cannerie	75	-	11,418	18,000	-	4,267	33,685	14.8
Nagindas	90	4,400	2,600	15,000	-	8,333	30,333	11.2
Tan Lanka	150	40,000	5,000	-	20,000	8,333	73,333	16.0
Ceylon Leather Corp	150	-	20,417	6,700	-	16,667	43,784	9.7
Eskimo	340	392,945	34,911	17,800	-	99,161	644,817	63.2
Nestle	120	-	-	-	-	-	60,000	27.5
Osprey	545	-	-	-	-	-	450,000	27.5
Gil Garments	90	-		-	-	-	84,000	31.1
Lever Brothers	200	-		-	-	-	300,000	50.0
Milco	100	-		-	-	-	300,000	100.0
Average							221,000	32.0

Source: Our data collection

This table is based on actual empirical data from existing or planned treatment plants in Sri Lan following assumptions:

Lime is 17 Rs per kilo
Energy: 3.2 Rs per Kilowatt hour, and machinery operates for 24 hours per day.
Labour: labourer: Rs.5,000 per month, manager: Rs.10,000 per month
Maintenance: 2% of capital costs, unless actual data is available

The table gives an average monthly treatment operating cost of Rs. 221,000.

7.3.2 Calculation load discharges

To compare monthly cost of treatment with monthly cost of charge, it was necessary to calculate the monthly pollution load for selected industries. This was done by three methods to arrive at some consistent results:

1. Data on pollution load can be found by multiplying average concentration by water volume. Concentration data were available from the CEA files, as this monitoring data are required as part of the EPL. However these samples are not true composite samples and so may not be accurate. They are also not available for the same time period, although most were taken some time over the last year.

   Water volume were found from CEA data, and data from the Greater Colombo Wastewater and Sanitation Masterplan - GCWSMP - (Engineering Science, 1993), bkh (1991) and ERM reports (which based its volume data largely on the GCWSMP). It was found that in some cases the GCWSMP data was inaccurate (for example some plants listed as having pollution treatment did not in fact have any). For this reason the CEA water data was generally preferred.

While the flow data from the CEA were from industry and hence may be subject to error, the same problem applies to all other studies including the bkh data, the GCWSMP data and ERM data (which used the GCWSMP data). Indeed as ERM concludes: "The data held by CEA is reasonably accurate in that it represents the best data that is actually available from industry".

The only empirically collected flow data currently available for Sri Lanka are being collected by the University of Moratuwa in conjunction with bkh, for a study of water quality on the Kelani River. This data is still being collected and is not yet available.

2. Data on pollution load can be found by multiplying production data by production load factors. Production data were available for selected industries from annual reports held at the Chamber of Commerce. Load factors are generally available using WHO load data per product, and other load estimates.

3. Data on pollution load were found from existing data given in ERM (1994) and bKh (1991).

Generally there was less than one order of magnitude found between the three pollution load results set out above. Table 7.4 below presents data found using method 1 above. In order to keep consistent, the rest of the report uses the load data generated by method 1, unless otherwise specified.

Table 7.4: Pollution loads for Selected Industries

Industry.	Water discharge (m3/day)	BOD Concentration (mg/l)	COD Concentration (mg/l)	BOD load kg/day	COD Load kg/day
Sigiri Weaving Mills	120	240	3200	28,800	384,000
Eskimo Garments	340	290	180	98,600	61,200
Pugoda	2275	100	120	227,500	273,000
Star Garments	159	110	442	17,490	70,278
Veyangoda	1500	600	900	900,000	1350,000
Ceylon Synthetic	250	200	2060	50,000	515,000
Nagindas	90	100	454	9000	40,860
Glaxo	25	72	181	1,800	4,525
British Ceylon Corp	30	n.a.	23,400	n.a.	702,000
Delmedge Forsyth	4	22	290	88	1160
Ceylon Paint Industries	9	160	360	1,440	3,240
Lankem	55	45	300	2,475	16,500
Baihara Farms	272	350	1300	95,200	35,3600
Keels Food	130	450	741	58,500	96,330
Hanwella Rubber	50	3,600	n.a.	180,000	n.a.
Lalan Rubber	98	2462	4347	241,276	426,000
Osprey Clothing	700	60	90	420,000	63,000
Nestle	120	50	120	6000	14,400
Riverina	150	200	500	3000	75000
MILCO	100	560	1400	56000	140,000
Ceylon Leather Corp	150	310	1000	46,500	150,000

Source: Own calculations based on CEA data

Comparing treatment cost and charge level

Using the data already presented it is possible to examine how much COD or BOD load needs to be multiplied by to equal the estimated average operating costs of a treatment plant. Since treatment operating costs are generally presented on a monthly basis, it is easiest to present charges on a monthly basis. This is done in Table 7.5 (using the same data as Table 7.4 above). Only two industries comply with current CEA standards (Osprey and Nestle) - all the rest would face a charge.

Table 7.5 : Monthly Charge on COD Load at different charge rates for selected industries

Industry	Rs/kg of COD					
	2.5	5	10	15	20	25
Sigiri Weaving Mills	28,800	57,600	115,200	172,800	230,400	288,000
Eskimo Garments	4,590	9,180	18,360	27,540	36,720	45,900
Pugoda	20,475	40,950	81,900	122,850	163,800	204,750
Star Garments	5,271	10,542	21,083	31,625	42,167	52,709
Veyangoda	101,250	202,500	405,000	607,500	810,000	1,012,500
Ceylon Synthetic	38,625	77,250	154,500	231,750	309,000	386,250
Nagindas	3,065	6,129	12,258	18,387	24,516	30,645
British Ceylon Corporation	52,650	105,300	210,315	315,900	421,200	526,500
Delmedge Forsyth	87	174	348	522	696	870
Ceylon Paint Industries	243	486	972	1,458	1,944	2,430
Lankem	1,238	2,475	4,950	7,425	9,900	12,375
Baihara Farms	26,520	53,040	106,080	159,120	212,160	265,200
Keels Food	7,225	14,450	28,899	43,349	57,798	72,248
Lalan Rubber	31,950	63,901	127,802	191,703	255,604	319,505
MILCO						
Lanka Canneries	8,527	17,055	34,110	51,165	68,220	85,275
Ceylon Leather Corporation	11,250	22,500	45,000	67,500	90,000	112,500
Average	18,940	37,880	75,761	113,642	151,523	189,404

Source: Own calculations

By comparing Table 7.3 and Table 7.5 it is possible to determine the appropriate charge to approximate avoidable treatment costs. By "avoidable", this includes all the operating costs which would be saved by not using the plant. Thus depreciation of the plant and interest on loans are not included since these would be incurred whether the plant is used or not. This comparison is made easier by Table 7.6 below. This presents the monthly average treatment cost given by Table 7.3 and the monthly average charge rates on COD load for different rates from Table 7.5.

Table 7.6: Comparing monthly average treatment cost with monthly average charge (at different charge rates)

Monthly average treatment cost	221,000 Rs/month
Monthly average charge on COD load (with charge rate of Rs.2.5)	18,940 Rs/month
Monthly average charge on COD load (with charge rate of Rs.5)	37,881 Rs/month
Monthly average charge on COD load (with charge rate of Rs.10)	75,762 Rs/month
Monthly average charge on COD load (with charge rate of Rs.15)	113,643 Rs/month
Monthly average charge on COD load (with charge rate of Rs.20)	151,524 Rs/month
Monthly average charge on COD load (with charge rate of Rs.25)	189,405 Rs/month

Source: Own calculations

The charge that most closely seems to approximate monthly treatment. plant operating costs of Rs.221,000 is a charge of about 25 Rs per kilogram of COD.

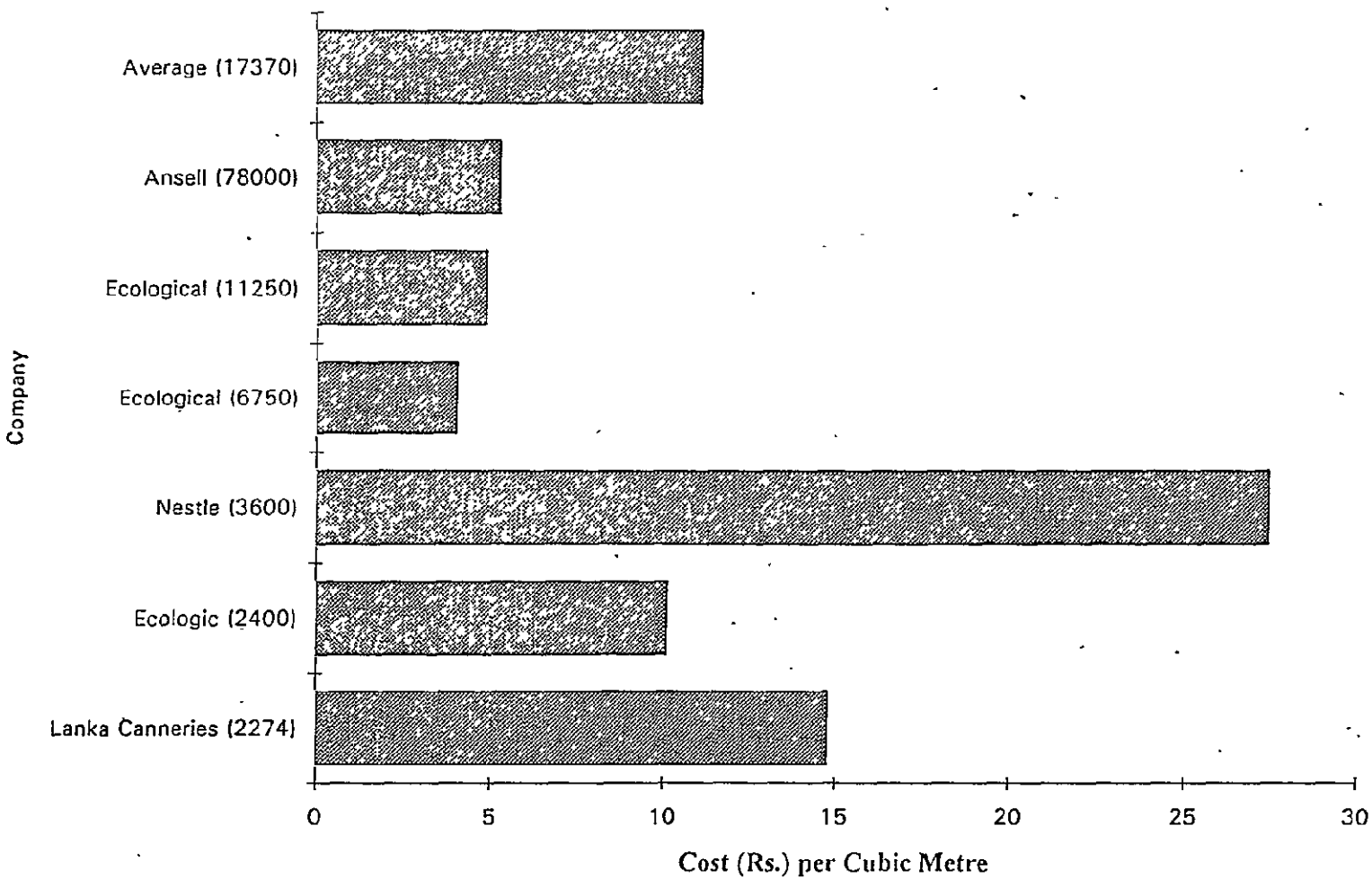
There are two other issues to be considered in setting charge levels:

1. The charge can be introduced at a lower level to ensure that initially all the high polluting industries are "on the books". It is then assumed that the charge can be ratcheted upwards. This approach is however much harder than it appears since opposition will build up to keep the low charge level in place. This has been the downfall of many charge scheme currently in place in other countries, such as China. If the charge level is not close to the actual charge level there is no incentive to use waste water treatment, since the firm will just pay the charge and keep polluting. For this reason a middle path is suggested with a charge that is not prohibitively high, but neither so low as to be just symbolic.

2. It is important that the charge rises automatically in line with inflation since with inflation levels in Sri Lanka at about 10%, the level of the charge can be swiftly eroded by inflation.

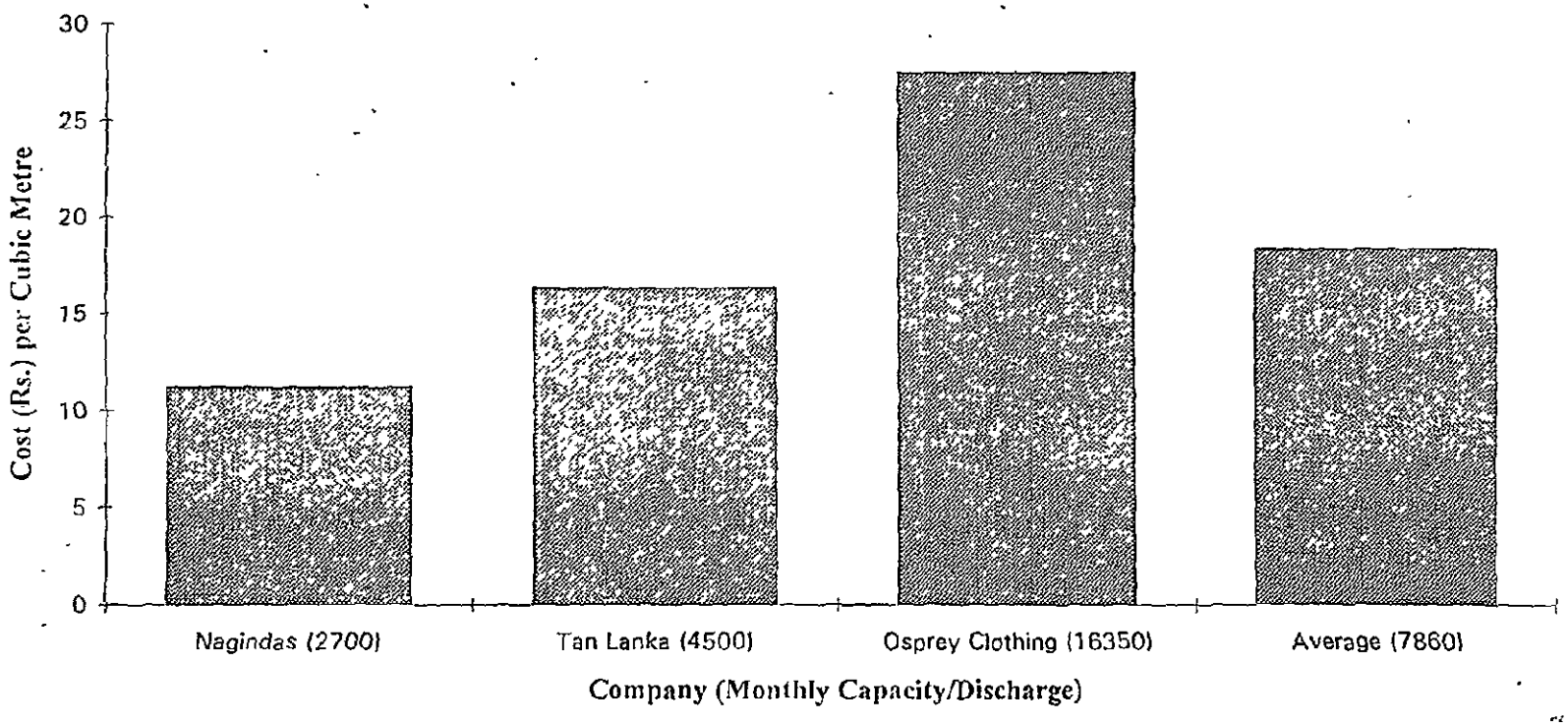
Operating Treatment Cost per Cubic Water Discharge - Biological

(Source: CEA and Own Data Collection)



Operating Treatment Cost per Cubic Metre Water Discharge - Physical Chemical

(Source: CEA and Own Data Collection)



7.3.3. Conclusion: Recommended charge

The recommended charge will be:

1. Effluent charge according to COD load set at 25 Rs per kg COD.

2. This charge will levied on high polluting industries if they do not non-comply with CEA concentration based standards.

3. Non compliance will be determined as

   - those industries who fail to pretreat and join up to common waste water if such an option is available,

   - fail to meet EPL by installing a "recognized" wastewater treatment plant.

7.4 Effects of charge

This section will consider the effect of the best option charge (load based charge with concentration based cut-off point) on water quality, revenue raised, and costs of charge: industrial compliance costs, collection costs and monitoring costs.

7.4.1 Effect of charge on water quality

The effect on water quality is assumed to be positive and significant. As stated in chapter 1, water bodies in the Colombo Urban Area and a few hot spots outside, are severely polluted. While domestic pollution is the main cause, industrial pollution is easier and cheaper to control. However to date very few industries have treatment plants. If the charge system leads to an increase in the number of individual treatment plants and their more consistent operation, as well as encouraging firms to join up to common treatment, then there will be clear and significant effects on water quality.

A quantitative estimate of the possible impact of the charge can be obtained in the following fashion. According to the bkh and ERM Reports, potential reduction in wastewater flows and pollution loads as a result of a charge range from a maximum of 40% to an average of 25%. (ERM, Vol 2, 1994). The total COD industrial load from the five most polluting sectors is given in ERM as 68,000 kg/COD per day. If it is assumed that this were to decline by a full 25% as a result of the effluent charge, then COD load would decline by 17,000 kg/day. Even assuming just a 10% decline in load, there would be a decline in COD load of 6,800 kg/day.

7.4.2 Revenue raised by charge

As the charge is load based, the revenue raised depends on the load. If we assume that industrial COD load stays at its current level (estimated at 68,000 kg/day), for a charge of just 2.5 Rs per kg, ERM estimates that 48 million Rs per year will be raised. With a charge of 5 Rs per kg, 97 Rs million will be raised. With a charge of Rs 10,

194 Rs million will be raised. With a charge of Rs.25, the revenue will be Rs.620 million per year, assuming COD load stays constant. However, as explained in the previous paragraph, it is expected that industry will install and operate treatment and pollution load and hence charge revenue will decline.

These figures may be an overestimate as they assume that all industry will pay the charge, while our report focuses only on high polluting industry. However there is also evidence from bkH that the ERM load calculations are under-estimates. ERM estimate total load from the rubber industry to be 29,000 kg COD/day, while bkH suggests that the natural rubber industry generates 45,000 kg COD/day. ERM estimates the textile industry as generating 11,300 kg COD/day, while bkh estimates it as at least 13,300 kg/day (Bkh, Guidelines 6; 1992). Our empirical data confirms the view that the ERM load figures are on the low side.

The size of this revenue can be compared with other sources of funds for the three agencies who will be recipients of this revenue:

1. Current total NWSDB billings for the whole island are about Rs 1 billion per month, or Rs.12 billion per year. Half of this is made up of the 1500 major consumers, many of whom are industry.

2. The Pollution Control and Abatement Fund is currently set at Rs.260 million, and Rs.26 million has already been dispersed.

7.4.3 Cost of charge

The costs of the charge include compliance costs for industry, and administrative costs of the charge, including costs of collection and monitoring cost.

7.4.4 Compliance costs for industry

The cost of the charge is pegged at the treatment costs for industry of complying with the EPL scheme. If the charge is considered too high, the fault lies with the EPL scheme, not with the charge.

Table 7.7. below gives the costs of the charge as a percentage of industry profits. As this table illustrates, the charge is less than 1% of profits for most high polluting industries. For some very significant polluters, such as Veyangoda or Ceylon Synthetic, the charge will be 10% or more of profits. But this is in accordance with the EPL scheme and the Pollution Pays Principle.

The charge can also be compared with the costs that industry currently pays for water as an input. Major industrial consumers pay a charge of Rs.25 per m3. Thus large water users are currently paying charges of several thousands per month. For example, the water bill of the Ceylon Petroleum Corporation is about Rs.500,000 per month, JB Textiles spays about Rs.300,000 per month and Nagindas pays about Rs.200,000 per month for water as an input. This is generally more than the proposed monthly effluent charge cost.

Table 7.7: Effluent charge as percentage of profits

Industry	Annual profit	Annual Charge as a percentage of Profits			
		2.5 Rs/kg COD	5 Rs/kg COD	10 Rs/kg COD	25 Rs/kg COD
Veyangoda	10,000,000	1	2	4	10
Ceylon Synthetic	2,284,000	1.7	3	7	17
Lankem	19,136,000	0.006	0.01	0.03	0.06
Bairaha	49,329,043	0.054	0.108	0.215	0.54
Keels	5,943,865	0.122	0.243	0.486	1.2
Riverina	51,689,000	0.01	0.02	0.04	0.1

Source: Annual Reports and Own calculations

Table 7.7.confirms results found in other Asian countries. An article reviewing treatment costs in Thailand, explains: "The operating cost of even a relatively costly in-house treatment amount to only a tiny fraction of gross sales revenue and are often less than one percent of total operating costs. The evidence also suggests that capital costs are likely to be a small fraction of total investment costs, except in a few heavily polluting industries with special treatment requirement" (Limvorapitak and Lathapipat, 1995).
Another study of treatment cost in the Philippines declares: "Evaluation of the annualized costs of capital, operations and maintenance for the various charges surveyed in the IEPC study indicated that the incremental costs of upgrading wastewater treatment facilities, would not, for most of the larger establishments, excessively reduce their net profits" (Republic of Indonesia, 1993).

There may be assertions that the charge will be anti-competitive, but this is not convincing given the range of other Asian countries, including the so-called Newly Industrialised Countries, who are forcing industry to spend on wastewater treatment. In addition, what industry seems to find most problematic about environmental policy is not spending on pollution per se, as the ad hoc way in which the EPL scheme is policed. By creating a more level playing field, a charge scheme should ensure that the costs of reducing pollution are borne equally by all the large polluters.

7.4.5 Collection costs

It is likely that the costs of the charge scheme will be proportional to the current EPL scheme. The need to develop more comprehensive monitoring data may require more resources, but these should be more than matched by more effective enforcement.

The cost of large scale billing is currently being gathered from the NWSDB as they have data for the cost of collecting water charges. The different components of collection costs include in their case:

- meter reading
- computer generated bills
- personnel and other operating costs
- notices for non payment of bills

disconnection (including vehicle and personnel)
legal action in selected cases

Similar cost components would apply to the collection of effluent charges.

7.4.6 Monitoring Costs

At present, the CEA already charges inspection fees to industry based on the initial investment of the industry. The charges range from 250 Rs to 5000 Rs. The actual license fee is then issued with a fee of Rs. 7 (CEA, 1993):

These charges are clearly too low and will need to be revised upwards. It is proposed that the burden for monitoring is borne by the industry if they want to apply for a downward revision of the charge. This is intended to stimulate private laboratories by creating more demand, and will save the scarce resources of the CEA. Increasing demand for laboratory services, particular private sector laboratories will lead to monitoring being charged at a more realistic rate.

This approach is similar to that described for the proposed Ratmalana/Moratuwa common wastewater treatment plant: "Once in effect spot checks could be carried out by the NWSDB to confirm the flow. This would require an industry to be targeted, say once per year (the actual frequency would likely depend on the industrial type, flow category and other factors) and the flow measured several times over a day or week. It the flows are higher than the limit, the industry would be questioned for an explanation and would be required to pay the additional cost of monitoring if required and would be assigned the higher category flow rate. In addition the onus would be on industry to inform the NWSDB if the flows are less than the specified amount due to process changes (Associated Engineering, 1994)". The exact way this would work is discussed more in the following section on institutional issues.

7.5. Institutional issues

The main principle here has been to introduce the charge in the most efficient, effective fashion. This has meant that the charge should be introduced with as little disruption to the existing institutional setup, and where changes are needed this has been done after considering the comparative advantage of different institutions.

The scheme is designed to complement the existing Environmental Protection Licensing (EPL). As set out earlier, the proposed COD charge would be levied uniformly on all high polluting industries who currently fail to meet the CEA standards.

The two diagrams 7.1 and 7.1 illustrate what institutional changes are proposed. 7.1 provides a simplified version of the current EPL framework and 7.2 provides a simplified version of the proposed institutional framework combining EPL with effluent charges.

Diagram 7.2 illustrates a number of key institutional issues. First of all it is proposed that the charge scheme is the responsibility of the CEA. Thus the strategic control of the charge is that of the CEA. However the CEA will need to cooperate with both

Diagram 7.1: Environmental Protection Licence (EPL) Scheme

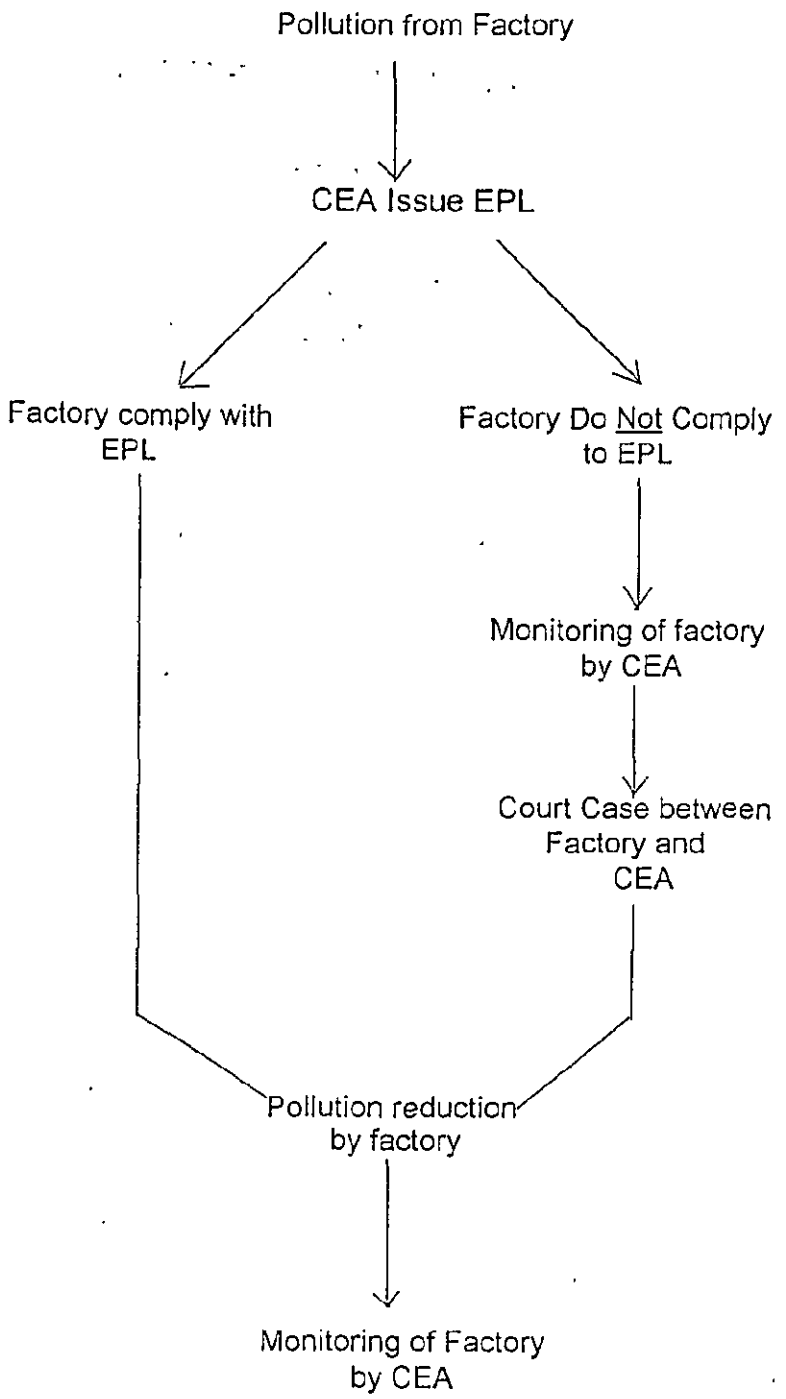
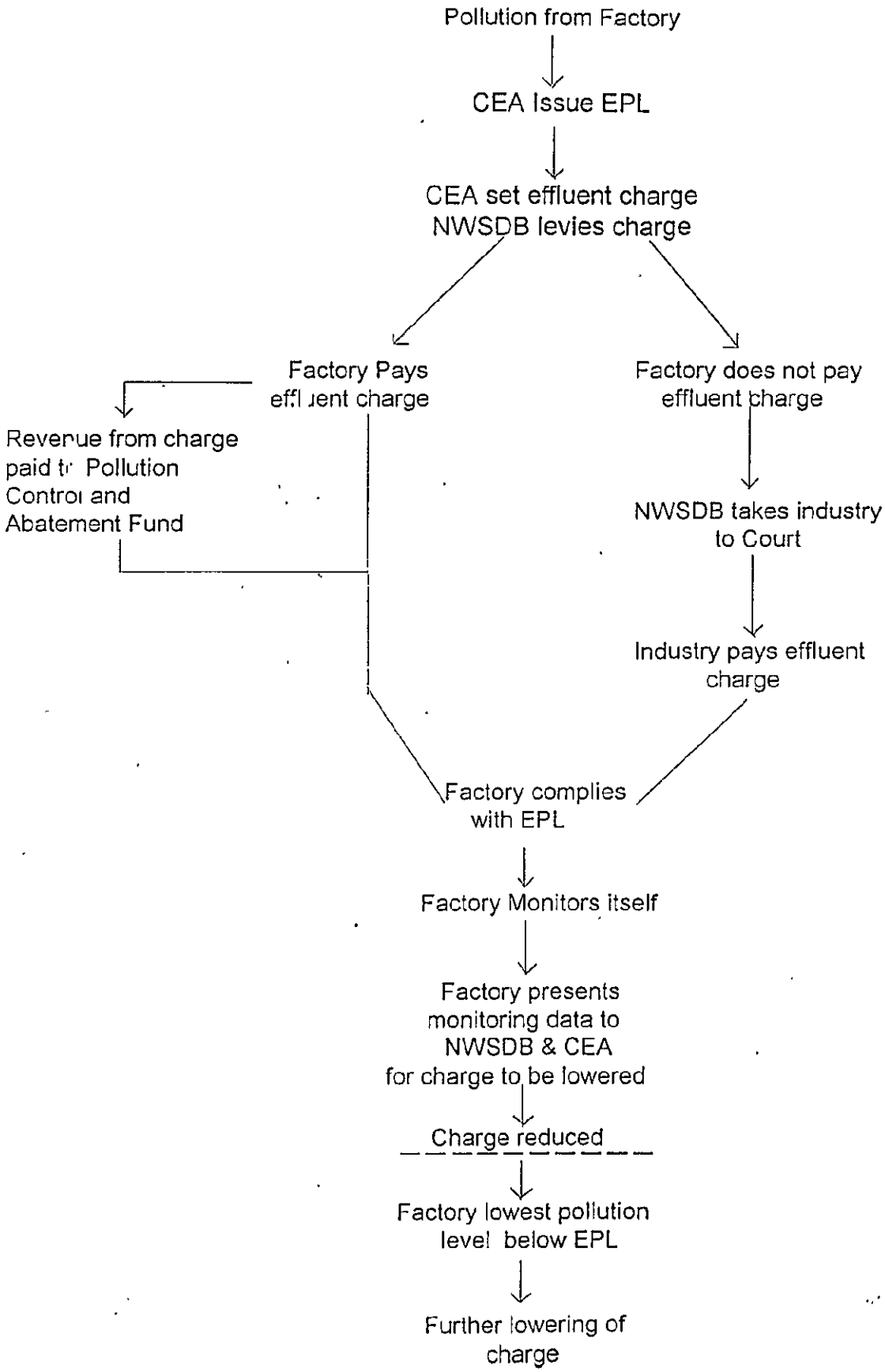


Diagram 7.2: Environmental Protection Licence (EPL) With Effluent Charge



the NWSDB and the NDB in ensuring the scheme's feasibility. The following section develops proposals for setting the charge, collecting the charge, and sharing the revenue from the charge.

7.5.1 Setting and monitoring the effluent charge levels

CEA will have the responsibility for setting the overall charge level, identifying the high water polluting industries and identifying "recognized" wastewater treatment.

Based on this information, the CEA will have the responsibility for determining each industry's individual COD load and hence the monthly charge for each high polluting industry. It may want to work together with NWSDB to develop such a database, since NWSDB already has some water flow data for major consumers.

ERM proposes three types of charge, and recommends option 3:

1. Industry monitors itself, with outside checks

   Discharges could project the level of emissions expected for a 12 month period and the charge could be computed on this basis. Actual emission levels would be audited periodically.

2. Monitoring based on historic pattern

   Discharge could be charged on the basis of the previous three, quarterly submitted analyses.

3. CEA sets charge and industry can contest

   Discharges could be charged on the basis of CEA estimates of discharges using internationally accepted pollution load factors and based on production figures, wastewater volume and water consumption figures, or any combination of these.

To accomplish this, the CEA should be empowered through regulations to determine the BOD5 or COD levels based on "pollution factors" from published literature. It would be beholden on industry to contest the figures if they so wished and to submit actual loads, based on measurements taken at accredited laboratories within a specified time period (eg. 6 weeks).

This report also agrees with ERM that option 3 is the best since using estimates, at least initially, has been standard practice in other countries that have had pollution charges, such as Netherlands and Germany.

An industry may dispute its charge level for two reasons:

1. It may claim that the charge level is calculated on incorrect data (on either water flow or concentration).
2. It may increase water recycling, install wastewater treatment or start to operate its plant correctly which lowers its charge.

As diagram 7.2 shows the burden of proof for contesting the charge level must lie with the industry. Evidence will need to be presented from an accredited laboratory, once the Accreditation Scheme for Testing Laboratories (ASTI) comes into place at the Sri Lankan Standards Institution.

The industry will also be charged a realistic fee by the CEA for contesting its charge, such as Rs 10,000. This will both deter spurious claims and cover the CEA costs of checking. This is the scheme used in the Netherlands if abstraction charges are contested, and is applicable to Sri Lanka since here the data will also be based on estimates.

In return the CEA will have to provide industry with a timetable for retesting its charge level, possibly of 6 weeks as ERM propose. In the event of a dispute, the decision of the CEA will have to be final.

7.5.2 Collecting the charge

This responsibility is also proposed to lie with CEA. However it is strongly recommended that the task of actually collecting the charge should be devolved by the CEA to the NWSDB. This is for the following three major reasons:

- the NWSDB already has experience of large scale billing of industrial customers. Thus it has experience of water metering, computer generated bills and other administrative skills. It also has proved its toughness in enforcing water charges with major industrial consumers, by disconnecting large customers such as Nagindas and Mira Garments. In addition, the NWSDB offers a 5% rebate for customers who pay on time. This explains why for most of the 1500 major consumers, arrears are less than one month.

- Many of the large industrial wastewater polluters are already NWSDB customers. These come under the 1500 major consumers, which provide the Water Board with half its Rs one billion monthly revenue. Although many industrial customers in the Colombo area depend on groundwater, most also use some surface water either for domestic purposes or if the groundwater is too polluted. This gives the NWSDB a number of advantages: it already has these industries "on its books", it already holds some data on water inputs which can be used to estimate wastewater outputs, and in the event of non-payment of the effluent charge it can use disconnection of input water as a final threat.

- the NWSDB currently runs the three BOI common wastewater treatment plants and has been given responsibility for the common wastewater treatment plants to be set up in Ratmalana/Moratuwa and Ekala/Ja-Ela. The latter will involve monitoring water discharges and pollution loads, which will involve the same information and personnel required for the effluent charge scheme.

The NWSDB would be provided with data on charge levels and pollution load by CEA and would then send out the bills accordingly. These bills levels could only be revised on the instruction of the CEA.

Both the CEA and NWSDB have legal power for charging. In the case of CEA this is part of the National Environment Act:

Section 32(2), National Environment Act
"The Ministry may make regulations in respect of all or any of the following matters:

(a) Levy of fees for:
  (i) examining plans, specifications and information relating to installations or proposed installations;
  (ii) the issue of licenses under this Act
  (iii) carrying out necessary monitoring duties;"

As explained in chapter 4, these charging powers are expanded in the new draft Environmental Protection Act.

In the case of NWSDB, this is part of the National Water Supply and Drainage Board Law No. 2 of 1974 and Amendment Act No.13 of 1992. Section 85 of the Act allows for the NWSDB to " provide for charging of different prices for water services supplied for different services."

7.5.3 Sharing the revenue from the charge

The revenue from the charge will need to be divided between the CEA, NWSDB and the NDB. It is proposed that this division be on a percentage basis. The bulk of the revenue should go to the NDB as proposed by ERM and endorsed by the Working Group on Economic Actions.

Clearly the exact percentages will need to be agreed by the three institutions, however as instructed in the Terms of reference, this report will suggest a proposed allocation.

It is proposed that 75% of the charge go to the NDB. In return the NDB will have to make releasing water volume and load data to the CEA, a condition for receiving a loan.

The NWSDB should make the CEA an offer of how much it will cost to levy the charge, and then calculate what percentage it will require of the charge. A percentage based approach is recommended as an incentive for the NWSDB to keep its costs down.
The remainder of the charge (ie 75% of the total minus the NWSDB costs) should go to the CEA.

7.6. Advantages of charge

This final section summarises the main advantages of a charge scheme as proposed in this document.

1. The court case against industry with effluent charges only requires non-payment of charge as proof. Thus there is less need for delays currently experienced, in getting environmental monitoring as evidence. So prosecution is quick and simple compared with the current legal procedure used by the CEA.

2. Collection of effluent charge can be given to institution such as NWSDB which has experience in collection of water fees and of court action in the event of non-payment.

3. Monitoring is done by industry in order to appeal for effluent reduction. Evidence is provided by accredited labs. This will create money for the improvement of both public and private laboratories.

4. The charge will allow more efficient use of the limited manpower of the CEA. Its role will become to set the EPL, set effluent charges and check data provided by industry that their load has been reduced.

5. At the moment CEA focuses on installation of treatment plant, which is the main concern in the granting of the EPL. However there is evidence that even once installed, treatment plants are operated poorly. As the ERM Report concludes: "There is often a reluctance to use the correct amount of chemical required to achieve effective coagulation and flocculating (probably because of the high cost of the chemicals and subsequent problems of sludge disposal)." In addition, there is a failure to invest in proper training and supervision of the treatment plants. As ERM conclude that: "During the validation survey the consultants noted that many of the biological systems in place were not producing effluents which met existing limits. It is suspected that this is due, at least in part, to a failure to segregate hazardous wastes from the effluent prior to treatment, or to balance the input effectively." By setting a charge equal to treatment operating costs, the current disincentives to use plants improperly, would be removed.

6. At the moment the EPL by focusing on concentration based standards allows firms to dilute their wastewater. This is confirmed by the ERM report: "When compliance is achieved it is sometimes aided by the addition of dilution water because there is nothing in the regulations to prevent such use and, if groundwater is used, there is no incentive not to do so." This would be stopped by an effluent charge based on installation of a recognised treatment plant.

7. An effluent charge by reducing wastewater discharge will also focus on reducing water intake and increase recycling. This will reduce the drawdown of groundwater, which is already causing lowering of wells in some areas and exacerbates salt water intrusion. Groundwater currently supplies up to 60%

of industrial water in the Colombo region and much larger amounts in areas such as Moratuwa/Ratmalana. This has gone completely unregulated.

8. The charge could be used a a way to encourage firms to connect up to common wastewater treatment after installing pretreatment equipment. At the moment, the only threat that firms face is legal action by the CEA. While this will eventually be effective, it is a long and expensive process.

9. The charge can be used as an incentive to get industry to move to industrial estates. For example if tanneries move out, the charge can be waived.

8. Conclusion: Recommendations for Introducing Effluent Charges

This report has set out proposals for an effluent charge scheme for Sri Lanka. It is our opinion and that of relevant private and public sector officials that this charge scheme would be feasible and effective.

This section sets out recommendations for the introduction and implementation of the charge scheme proposed in this report. The consultation and preparations required for introducing the charge are estimated realistically to take one year. By the end of one year, it is then intended that all the high polluting industries will be facing an effluent charge if they have fail to comply with the EPL standards or to install the necessary pretreatment in areas of proposed common wastewater treatment.

It is proposed to introduce charges on all high polluting industries at the same time, as the total number is only around 300, and this will avoid accusations of unfair treatment.

In order for the charge scheme to be introduced as proposed, further consultation would be needed based on this report. It is proposed that this be done in the form of two workshops. These could be joint CEA/IPS/NAREPP workshops.

The first "Consultative" workshop would be by the IPS team to introduce the findings of this report and the outstanding issues which remain to be resolved. This workshop would be to ensure that the report findings are acceptable to all relevant parties, including those who the IPS has not yet had the opportunity to consult. It is proposed that this workshop would be held as soon as possible.

The workshop will highlight the outstanding issues for discussion:

1. Decide appropriate institutional arrangement between CEA, NWSDB and NDB, including division of effluent charge revenue.

2. Identify possible legal procedures for effluent charge including compatibility with the National Environment Act and the Water Board Act. It would also require coordination with the regulations governing the Pollution Abatement Control Fund and the Terms of Reference drawn up for the BOT common wastewater treatment plants.

3. Publish lists of "recognized" wastewater treatment plants, which would have to be installed and operating in compliance with CEA standards in order to be exempt from the effluent charge. This could build on the bkh Guidelines published by the CEA for the following industries: metal finishing textile processing, pesticide formulation, dairy industry, leather industry, desiccated coconut industry, concentrated latex industry and natural rubber industry. These guidelines would need to be presented to industry at a series of round tables. It is proposed that these be coordinated by the CEA in conjunction with the Chamber of Commerce and industry associations.

4. Set up technical database: Identify all "high" polluting industries and determine COD loads for all high polluting industries to be used in charge

formula. This will require estimates of flow data and COD concentration, which are currently held on CEA files. This should build on the existing database currently held at the CEA on polluting industry, and held at NWSDB on major water consumers.

5. Agree an appeal procedure for those industries who query their charge level according to load or concentration. This would be at a proposed charge of Rs 10,000 per appeal to cover the CEA costs of re-sampling and reduce false claims. In the event of conflict it is proposed that industry could provide concentration data from accredited laboratories, which would need to be coordinated with the Sri Lanka Standards Institution programme of Laboratory Accreditation. In the event of conflict the CEA decision would have to be final.

6. Set up effluent charge collection unit. As set out in the report it is suggested that this be located at the NWSDB.

7. Set up effluent charge monitoring unit. As set out in this report it is recommended that this be located at the CEA. This will require agreement on procedure for industry to present evidence that they are complying with EPL.

8. Prepare invoicing procedures and billing arrangements, and appeal procedure for industries who reach CEA standards . This would require coordination between CEA and NWSDB.

The second "Progress Review" workshop, to be held three months after the first, would review the progress made on the outstanding issues above. This would involve presentations by relevant participants in the effluent charge scheme, including among others the CEA, NWSDB, NDB. This workshop would agree on the modalities of the scheme and draw up a more detailed set of technical issues to be resolved.

For the second workshop it is proposed to invite resource persons from other Asian countries who have an effluent charge scheme to present the success and problems of their scheme. The most relevant schemes in the region identified by this report are China, Malaysia and Philippines.

It is proposed that following the second workshop, 9 months be allowed to resolve outstanding technical issues. According to this timetable, the effluent charge scheme would then be ready for introduction by the end of one year. While it is important to ensure that the scheme is introduced properly, any delays will lead to increasing water pollution.

In order to ensure that the institutions involved are kept in contact and that the schedule set out above is adhered to it is suggested that the CEA and NAREPP Project each nominate a contact person to coordinate the introduction of the charge.

Table 8.1: Proposed Implementation Timetable for introducing effluent charge on all non-complying, high polluting industry

Actions	Responsible authorities	Proposed time frame (from publication of this report)
Consultative workshop	IPS/CEA/NAREPP	1 month
Progress Review Workshop	CEA/NWSDB/NAREPP	3 months
Technical component 1. Sharing revenue	CEA/NWSDB/NDB	3 months
2. Legal procedure	CEA/NWSDB/NDB	6 months
3. Publish recognised wastewater treatment plants	CEA Chambers/Industrial Research Units/CISIR	3 months
4. Technical database	CEA/NWSDB	6 months
5. Appeal procedure	CEA/Industry	3 months
6. Effluent charge collection unit	CEA/NWSDB	9 months
7. Effluent charge monitoring unit	CEA/NWSDB	9 months
8. Income and billing procedure	CEA/NWSDB	9 months

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Appendix 1: Organisations and individuals contacted

CEA:	G. K. Amaratunga, Chairman V.U. Ratnayaka, Director General K.G.D. Bandarathilake, Deputy Director General (Technical) R. Ellepola, Director, Environmental Protection S. Manoharan, Senior Environmental Officer S.S. Samaratunga, Environmental Officer K.E.S. Jayawardana, Environmental Officer K.H. Muthukuda Arachchi, Environmental Officer
NWSDB:	S. Fernando, Deputy General Manager, IDA M. Mediwake, Deputy General Manager (Commercial) C. de Silva, Accountant Priority
NDB:	R. Ganapala, Manager, SMI Department D. Pieris, Senior Executive - Project Engineering (Environmental) G. Herath, Executive - Project Engineering (Environmental)
NAREPP:	S. Ranawana, Environmental Economist
MEIP:	R. Perara, National Coordinator
MEIP Consultant:	M. Robertson, Grayson Laboratories
Chamber of Commerce:	C. Silva, Assistant Secretary D. Wijesinghe, Executive Assistant
Industry Representatives:	
Ceylon Trading Corporation:	W. Ellawala, Director and Chairman Colombo Rubber Traders Association
Agalawatte Plantations Limited:	R. Sylva, Chief Executive Officer
Horana Plantations Limited:	L. Fernando, Director
Ansell:	S. Amarasekara, Technical Manager
BOI:	T. Fernando, Senior Manager, Environment A. Beling, Biyagama Laboratory
University of Moratuwa:	S. Bhuvendralingham
World Bank:	S. Pilapitiya

Appendix 2: Industry Database

Textiles

Industry Location Type	Profit Rsmillion (year)	Waste water (m3/day)	Load - kg/day		Treatment	Capital cost (Rs)	Operating cost (Rs/month)
			BOD	COD			
Osprey Kelani	177.8	545			Physical chemical (proposed doubling and activated carbon	20 million (8.9 million)	450,000/
Nagindas Dehiwala		90			Physical chemical	5 million	
Eskimo Negombo		340			Chemical and Biological	35 million (from Germany)	
Gil Garments		90			Proposed physical chemical		84,000
Veyangoda Veyangoda	10 (1991)	1500			Being built: Physical chemical	12 million	
Pugoda Pugoda	12.9 (1993)	2275			Biological (activated sludge)		
Bakson Ratmalana		225			None		
JB Textiles Wellampitiya		70			None Proposed physical-chemical	2.1 million (M/E only)	
Ceylon Synthetic	2.28 million	250			None Proposed physical-chemical (activated carbon)	2.5-3 million	
Sigiri Katubedda		120			None		
Fairline Mt Lavinia		130			None Proposed: Biological (RBC)		
Asian Cotton Mills, Mt Lavinia	23 (1991)	256					
Kabool Lanka, Thulhiriya		2500			Biological (activated sludge)		15 million
Velona Silks Katubedda		120			None		
Hybro Industries Ratmalana		67			None		
Swastik Dehiwala		67			None		
Techstream Kelani		520			Partial biological (RBC)		
Favourite Moratuwa		36			None		
Star Katana		159			Physical chemical	1.55 million	
Kundanmals Ratmalana		180			None		
Tharanga		36			Partial biological		

Data: CEA files, Bol. Bkh textile survey, Annual Reports and Colombo Stock Exchange

Rubber, Food and Beverages

Industry Location Type	Profit Rs million (year)	Wastewater (m3/ day)	Load	Treatment	Capital cost	Operating cost
RUBBER						
Baeaeng Celatex Pvt		5		Biological (activated sludge)	216,000	
Hanwella Rubber latex		50		None Proposed Biological	6.6 million	
Lalan Rubber latex		98		None Proposed Biological (activated sludge)	11.2 million	
Richard Pieris and Co	1.54 billion	250		Biological (RBC)		
Ansell Biyagama		2600		Biological		1 million $AU
Kegalle Plantations Ltd Latex				None Proposed Biological (anaerobic)	3.85 million	
FOOD AND BEVERAGES						
Keels	5.94	130		Biological (Proposed new floatation tank)	(1.4 million for new tank)	
Lanka Canneries		77			2.4 million	90,000
Nestle Pannala	177.8 million	120		Biological - Activated Sludge	5.6	60,000
MILCO					5 million	300,000 (chemicalo nly)
Ceylon Cold Stores (Elephant House)		50-60		Two oil traps		
Pure Beverages	57 million	600		Biological (activated sludge)		
Sikatha DC Mills, Kuttawa Desiccated coconut		14.5		Biological (anaerobic) and oil trap		
Baihara Farms Ltd Poultry		273		Pretreatment and oil separator (Proposed biological)	(4.4 million)	
Mcullum Brewery Megoda		21		None		

Chemicals (Paint, Soaps and Pharmaceuticals)

Industry Location Type	Profit Rs million (year)	Wastewater (m3/ day)	Load	Treatment	Capital cost	Operating cost
SOAPS ETC						
Lever Brothers		200		Biological and Physical- chemical	40 million	300,000
BCC		30		None Proposed oil and grease removal and biological	1.25 million	314,000
Reckitt and Colman	174 million	10		None		
CHEMICALS						
Chemanex	122 million	1.5		None		
Chemical Industries Colombo		15		Physical- chemical		
Lankem (Agrochem- icals)		55		None		
PHARMACEUTIC AL S						
Glaxo		25		None		
State Pharmaceut- ical Corp		9		Biological		
PAINTS						
Ceylon Paint Industries		9		Partial		
Delmedge Forsyth		4		Pretreatment		

Metal Finishing and Tanneries

Industry Location Type	Profit Rs million (year)	Wastewater (m3/ day)	Load	Treatment	Capital cost	Operating cost
St Anthonys'					6.3 million	
Tannery						
Ceylon Leather Product Limited		150		Primary sedimentation proposed biological - oxidation ditch system	5.3	66200