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**Identification of Opportunities Incorporating Economic Incentives  
into Proposed Environmental Legislation  
for the People's Republic of Bangladesh**

**Volume 1 of 2**

**Bangladesh  
September 26 to October 7, 1994**

**Prepared for:**

**US - ASIA ENVIRONMENTAL PARTNERSHIP**



**WORLD ENVIRONMENT CENTER**

## **DISCLAIMER**

This project was sponsored by the U.S. Agency for International Development (USAID) through the World Environment Center's (WEC) Cooperative Agreement in support of the U.S.-Asia Environmental Partnership (US-AEP). The opinions expressed herein are the professional opinions of the author and do not represent the official position of the Government of the United States of America or the World Environment Center.

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## I. EXECUTIVE SUMMARY

From September 26 to October 7, 1994, Mr. Lawrence Barber and Mr. Mark Pfefferle participated in an Environmental Business Exchange (EBE) as WEC Experts in the field of tanning. The WEC Experts conducted interviews and waste minimization assessments at six tanneries located in the Hazaribagh area of Dhaka City in Bangladesh.

Volume One of this report concentrates on the results of the interviews and waste minimization assessments at the six tanneries. The tanneries' site-specific information is also included. Volume Two identifies opportunities to incorporate economic incentives into the proposed environmental statute for the People's Republic of Bangladesh. Further, Volume Two presents the major issues that impeded environmental protection and improvement in Bangladesh and how environmental laws can control pollution through a mix of strategies.

## II. INTRODUCTION

From September 26 to October 7, 1994, Mr. Lawrence Barber, Tanning Industry Consultant, and Mr. Mark Pfefferle, Economist, Science Applications International, (SAIC) conducted interviews and waste minimization assessments at six tanneries located in the Hazaribagh area of Dhaka City in Bangladesh which have created a discharge of untreated wastewater into the local environment. Tanneries clustered in the Hazaribagh area discharge effluent into a nearby lagoon impoundment behind a flood control embankment with no continuous provision for outlet. This discharge of effluent has resulted in the creation of a very septic, and odiferous body of water. The odor from this impoundment is reported to be detectable in other areas of the city. In addition to the odor, it has been established by Abdul Motaleb, 1993 (See References) that seepage may be occurring toward the ground water aquifer from which fresh water for drinking, as well as other purposes, is drawn. It is predicted that within a relatively few years the aquifer will be completely polluted, thus creating a serious water source crisis for the residents of the area. This problem is further aggravated by the fact that domestic wastewater is directed into the same drainage system as the tannery effluent. Some of the tannery effluent discharge also reaches the River Buriganga and contributes to the degradation of that water as well. Casual disposition of discarded tannery offal into the lagoon and into the streets of the Hazaribagh section is likewise problematic.

This part of the report (Volume 1) includes assessment of the current practices in the tanneries, recommendations for in-plant waste minimization possibilities. Statements on the aspects of no/low cost remediation, a possible plan for alleviation of the problems, and further economic considerations are addressed in Volume 2 of this report.

### **III. WASTE MINIMIZATION TECHNIQUES**

A number of water and tanning material waste minimization techniques are available to tanners. Techniques range from recycling of wash water to chemical precipitations for concentration and reclamation. Most of these conservation measures do not accomplish substantial monetary savings but they do tend to reduce volumes and chemical loadings. One procedure for minimizing objectionable offal is also described.

#### **A. Chemical Offerings**

It is important that proper amounts of ingredient materials are employed in the process steps. This may seem obvious on the surface since in Bangladesh most materials are imported, but it is crucial to perform an in-plant audit from time to time to eliminate any instances of over-use of chemicals and tanning materials. Excess increase in tanning costs tend to magnify the problems of effluent disposition.

#### **B. Conservation of Water - Reduction of Total Volume**

Instead of being continuously added to washing drums or paddles, wash waters may be utilized in batches. The initial wash is offered for a relatively short period and discarded. Subsequent washes are pumped to storage after use and used for first offerings for succeeding hide lots. This does not reduce contaminant loadings, but total volumes of effluent can be reduced.

A somewhat less effective water conservation technique can be accomplished by replacing continuous washing to completion with batches of water used and discarded.

#### **C. Reduction in Use of Hydrated Lime**

Lime liquors used for hair removal may be re-used after screening out gross solids and hair remnants and re-strengthening. Simple chemical control is needed for this process, including alkaline strength measurement. As in any conservation scheme close supervision is a necessity to ensure the proper treatment of the lime liquor.

#### **D. Deliming with Carbon Dioxide**

Some tanners reduce the nitrate loading of the waste stream by using carbon dioxide in place of ammonium sulfate in the deliming step of the tanning process. The substitution is accomplished by injecting gaseous CO<sub>2</sub> into the drum until the required deliming has been reached. This process is particularly effective in situations where nitrification in receiving waters or streams is high and must be minimized.

### **E. Chromium Recycling**

Chrome in so-called, "spent liquors" can be reclaimed by capturing and pumping spent solutions to holding tanks. The chromium complex is precipitated by alkalization, and the solids are allowed to settle. The clear supernatant liquor is discarded and the chrome bearing precipitate is redissolved by acidification. Precipitates are then combined with new chrome for a succeeding pack, or used as a first offering, or perhaps made up as a pickle liquor. While recovery has been practiced at some locations in the U.S. and Brazil, it has not received widespread acceptance in tanneries worldwide since careful laboratory control is required.

### **F. Fleshings Disposal**

Particularly in Hazaribagh, where some tanneries are rather small, there may be a tendency to simply place fleshings out in the street along with other offal without much regard for their disposition. It is evident that this is a poor practice. Fleshings can first be very simply liquefied through a water steaming process, then subsequently disposed of with wastewater. Grease will float and become a by-product which can be reclaimed for further use or sale.

### **G. Effluent Screening**

It is general practice in almost all tanneries to pass the wastewater through some sort of a solids removal device as it leaves the facility. In some cases simple bar screens are used and cleaned manually. Other plants utilize more sophisticated rotary, wedgewire, or mechanically cleaned screens. It is important to remove gross solids before they gather in the drainage system and cause flooding problems.

The WEC Experts have provided a suggested procedure for reclamation of chromium sulphate in Appendix B of this report. All of the above conservation measures require sumps, pumps, piping, and vessels, as well as a large space. It is then notable that in the Hazaribagh district, where a number of small tanneries are in close proximity, one or more of the above suggestions could be practiced on a cooperative basis, with a single receiving and treating facility or perhaps several serving a number of participants. It is suggested in the conclusions and recommendations of this report that such a facility could be operated by a separate entity set up solely for this purpose, or could conceivably be operated as an activity under the same management as the wastewater treatment facility when organized.

## IV. FINDINGS

The WEC Experts visited a total of six tanneries, one of which could be classified as small, three could be classified as medium size and rather typical of those operating in the Hazaribagh District, and two, Apex Tannery and Dhaka Hides and Skins are large.

To follow is a recapitulation of information acquired during interviews with Manufacturing Technologists at the tannery sites.

### A. Reliance Tannery

48/2/k, Moneshwar Road  
Hazaribagh, Dhaka - 1209  
Tel: 501483

Located near the southern perimeter of the tannery cluster

Ownership - Management: Mr. Shaheen

Leathers produced: Cows only. 600 per day. Full Chrome, Semi  
Chrome - Veg Retan Whites

Employees: Supervisory - 6

Labor - 120

Markets: Europe

South Asia

Hong Kong

USA

Discharges: Liquid

Lime Liquors

Chrome Liquors

Retanning and Fat Liquors

15000 L per day

Analyses - None. No sampling

Discharges: Atmospheric - none

No finishing but equipment being prepared.

Discharges: Semi-solid and Solid

Placed at street level directly in front of the tannery for

weekly removal by municipal equipment. Destination - Landfill.

Waste Treatment Systems:

Liquid: None

Solid: None

Treatment Systems Planned: None

Cost Estimates for Future Pollution Abatement Systems: None

This is medium sized tannery compared to others in the area. The premises are reasonably well maintained and the workmanship is good. The equipment is mostly of Chinese origin and includes all the items which are needed for an operation of this scope. Mr. Saheen discussed the wastewater collection system with the participants, including the fact that the surface drains converge at a number of places until there are only two discharge points to the lagoon -- a significant factor to be considered in the construction of a treatment system.

**B. Sarwar Leather Corp.**

123 Sherabanga Rd. Hazaribagh  
Located on the eastern periphery of the tannery cluster  
Ownership - Management: Mr. S. K. Lala.  
This is a family owned business, according to Mr. Lala, started in 1954.  
The family occupies living quarters in the tannery building.  
Leathers Produced: Cow or Buffalo - 400 per day  
Goat - 4-5000 per day  
Chrome, Vegetable, and Semi-chrome.  
Employees: Supervisory - 6  
Labor: 66  
Markets: Local - Bata Shoe  
Europe, Japan, Southeast Asia.  
One of Mr. Lala's sons is presently in Paris attending the Semaine du Cuir, an annual international leather show and market. They have a cutting and sewing operation on the premises where they convert some of their production into bomber type jackets and small leather goods.  
Discharges - Liquid  
All the usual - Lime, Chrome, Combination, Retan, etc.  
13,000 to 15,000 Gallons per day.  
Water source - Tube well on property. Depth 520 ft.  
Discharges - To Atmosphere  
Quite a bit of hand finishing is done, both padding and spray. The equipment is all primitive with no containment whatsoever.  
Discharges - Solid and Semi-solid.  
Fleshings to renderer - remainder to landfill.  
Waste Treatment Systems: None.  
Treatment Systems Planned: None. Affordability: None, according to Mr. Lala

This is another medium sized tannery similar to Reliance Tannery, Inc. The leathers are of good quality and the finishing is good as well. Management is interested in the value-added concept which appears to be the thrust of all of the tanners interviewed.

### **C. Pragati Leather Complex**

Al-Madina Tannery

55/1 Hazaribagh

Located in the North Central part of the Hazaribagh tannery area.

Operating Manager:

Leather Technologist - A. M. Khorshed Alam

Mr. Kalam received his training as a leather technologist in Russia.

Leathers Produced: All Cows. 300 per day

70% vegetable tan.

30 % semi-chrome and full chrome

Employees: Supervisory - 3

Labor - 40

Markets: Italy. Full Vegetable.

China - Chrome and Semi-Chrome.

Some Veg.

Discharges: Liquid - 10,000 (about) GPD

Lime liquors and veg tan liquors, some chrome, chrome retan, and fat liquor solutions.

Water source - Tube well on property.

Discharges: Atmospheric - None

Solid and Semi-solid to Landfill.

Fleshings to renderer.

Waste Treatment Systems: None

Treatment Systems Planned: None

This tannery could be considered small, although a considerable expansion program is under way, which Mr. Alam hopes to have completed by the end of this year. A new building is under construction and new equipment is either already in place, being installed, or on order. Some of the items there now are of late Italian origin. New drums are being built for liming and tanning, and finishing equipment is scheduled for end-of-the-year delivery.

### **D. Dhaka Hides and Skins, Ltd.**

147 Hazaribagh. Tannery Area, Dhaka 1209.

Located South of Center in the Tannery Cluster.

Management - Karam Ali Ahmed, Ph.D.

Technical Director

Leathers Produced:

3,000 Cows per day twice yearly at sacrifice times

15,000 Goats per day twice yearly at sacrifice times

Normally - 1,000 hides, 5,000 goats, 30% Veg, 70%  
Chrome and Semi-Chrome.  
Employees: Supervisory - 10 Technicians, 6 Engineers and Maintenance  
Labor - 500  
Markets: Europe, Brazil, Italy  
Local - None  
Discharges: Wastewater - 35Kg./1 Kg Hide  
3,000HPD = 105,000 kg wastewater = 27,000 GPD  
Analytical Data - None  
Atmospheric - Some -- No suppression.  
Treatment Systems - None  
Planned - None  
Working Conditions - Good.

Dhaka Hides and Skins, Ltd. is a large operation consisting of beamhouse and tanning facilities adjacent to the impoundment lagoon mentioned elsewhere in this report - 36 conventional size tannery drums in one row, and further processing at the above address, a city block or so away.

Dr. Ahmed has broad experience in the leather field, having been principal until recently of the Bangladesh College of Leather Technology. The company is either making money or getting substantial support from a financial source for it has some very modern equipment and is installing more, particularly toward producing finished leathers instead of crust. They are well along on starting up a shoe manufacturing division on their own property, as well as a cutting and sewing operation to produce jackets, ladies and mens leather garments, and small leather goods. They make good leathers and seem to have a strong vision for the future.

It struck the WEC Experts that Dr. Ahmed is something of a Dean in the tannery community and could be a leader as well as very valuable font of information in the development of the pollution abatement effort in the Hazaribagh district.

#### **E. Bay Tanners, Ltd.**

21 Hazaribagh.

Location: North of Center of the Tannery Cluster.

Management - Mr M. A. Qaiyyum

Leathers Produced: Cow 70%, Buffalo 30% - 1000 per day, normal  
Goat - Some - 5 to 10,000 per week

Chrome and Semi-chrome

This tannery is also a large operation with peak capacity being utilized in the period just following sacrificial days.

Employment: Supervisory - 12 Technicians - 6  
Labor - 130

Market: Hong Kong, Taiwan, USA (Boston Importer)

Discharges: Wastewater 1.5 Kg/ 1 Kg Hide

This does not fit with a figure given to WEC Experts at another tannery, nor with our experience. Actually it does not appear that there is any well developed data on this at any of the locations visited.

Atmospheric: None

Treatment Systems: None, and none planned.

#### F. Apex Tannery Ltd.

127 Hazaribagh, Dhaka City

Located in about the center of the tannery cluster.

Management: Mr. M. A. Majed, Executive Director

Leathers Produced: Normal - 2000 cows/day - 70% by weight  
8000 goats/day - 30% by weight

At sacrifice times the plant runs around the clock, pushing as many hides and goats as possible through to the blue as a form of preservation. The blues are then worked out at a normal pace.  
70% Chrome, 30% Veg.

Employees: Supervisory - 90 Incl. Foremen, Engineers, Etc.  
Labor- 525

Markets - Europe, Japan, Hong Kong  
No Local

Discharges - Liquid - No estimate - No analyses.

To atmosphere - No exhaust control for hydrocarbons.

Treatment Systems - None

This is the largest tannery in the area, perhaps in Bangladesh. It is reputed to be well run, and the appearance of the place, as well as the quality of the products would seem to bear this out. The leathers are excellent and run all the way from glazed kid and cow to nubuck. The equipment throughout, (though not all of it) is brand new, reflects the best of the specialized machinery available to tanners, and it is all well maintained.

## V. CONCLUSIONS AND RECOMMENDATIONS

The WEC Experts believe all the tanneries visited are building to expand their operating areas and are moving toward increased production. At the same time, most are installing new equipment to provide additional processing capability with which to add value to their leather production, including facilities for finishing leathers for export as well as cutting and sewing for production of garments and small leather goods for local consumption and for export. The reluctance of banks to provide capital has been mentioned as a potential problem to expansion. In fact, the Bangladesh government has imposed a ban on the export of so-called wet blue leather. This ban, however, appears to have provided a stimulus for expansion of the Bangladesh leather industry, and this could only be good for the local economy.

A no/low cost alternative to the concept of primary sedimentation and secondary biological wastewater purification currently does not exist, except perhaps in unusually arid areas where solar evaporation may be utilized. Solar techniques require shallow evaporation ponds covering large areas, high ambient temperatures with many hours of sun, and prevailing low humidity. Such areas and weather conditions are outside all possibility in Bangladesh. The shrinking of the leather tanning industry in the U.S. attests to, and is largely attributable to, the high cost of wastewater treatment and the lack of any no/low cost technique to satisfy legislated discharge-to-stream specifications. The WEC Experts discussed possible application of the minimization techniques with the tanners found that many do not have the space to adopt such measures. It was also suggested that a number of tanneries which might be in close proximity might join together in applying some of the minimization measures, but this idea did not generate any marked enthusiasm.

Since a simple solution to the degradation of the Hazaribagh community and its environs through tannery discharges does not exist, it therefore becomes incumbent upon the WEC Experts to suggest waste minimization action in some other manner. A number of factors must be considered:

### Conclusion 1.

The suggestion has been made that relocation of the tanneries might be desirable. The work by Louise Fallon - 1989 (See References) is particularly relevant to this concept. Ms. Fallon points out that population expansion is presently placing a strain upon living space and domestic food production and limited arable land must not be sacrificed for industrial purposes. The tanners, while delighted with the prospect of new facilities, would undoubtedly be demanding as to any new facilities' physical aspects, including floor area, floor drainage design, single or multiple story buildings, and customizing in any or all of a multiplicity of details. Based on conversations with tanning executives, the participants believe the tanners would like to be considered

in any way for financing such a relocation project. It would appear that it would be very difficult, if not prohibitively expensive to satisfy the tannery owners in any relocation scheme. It is also important to remember that the tanneries provide employment for a large number of unskilled and semi-skilled workers, probably several thousand, who in turn support thousands more. Any relocation would also need to consider the relocation of the workers' living arrangements, and this would compound the problem even more. Given the inherent problems of relocating tanneries out of the Hazaribagh district, the WEC Experts believed that relocation is not possible.

At the end of the tour at the one of the tanneries the participants discussed the future of the industry in Hazaribagh with the Executive Director of that tannery. He favored relocation, with the government providing funding for the move of the tanneries as well as relocation of living quarters for workers. He would expect a government loan to cover the total cost of rebuilding at a new location. The loan would be repaid over 20 years at zero interest, and the government would stand the initial cost of a treatment plant to serve the new location for all of the tanning companies involved in the move. The tanneries would be assessed for operation and maintenance of the treatment plant on the basis of a schedule of fees modified according to use of the facility.

As the WEC Experts have stated elsewhere in this report, it does not appear that such measure can be considered as a realistic approach to relocation. Many millions of dollars and years of time would be needed, and while the leather industry deserves careful consideration for its contribution and potential contribution to the Bangladesh economy there are much less costly alternatives than relocation.

### **Conclusion 2.**

As a group, the tanneries of the Hazaribagh district are discharging their effluents into a common system which converges into some two points of outfall, which because they are adjacent, can be combined rather simply. At the same time, the collection system, serves the domestic community. Wastewater from that source would not only be beneficially treated concurrently with the tannery wastewater but domestic waste actually lends enhancement to the operating efficiency of a biological treatment system.

### **Conclusion 3.**

The impoundment area between Hazaribagh and the river would, at first, seem to be a difficult place to construct anything at all. On the other hand, the flood control embankment was constructed for miles along the river's edge requiring huge quantities of fill. The fill was likely transported by barge on the river from a remote location. This indicates that additional fill could be provided in a like manner. A berm wide

enough to accommodate auto traffic now extends from a street out from the settlement to a jetty on which a tannery is located. The land side, the berm, and the jetty now form three sides of a roughly rectangular area now flooded and receiving continuous sewage flow from an outfall on the shore side. Using the end of the jetty as one terminus and the shoreside as the other, it should be possible to isolate a section of the impoundment sufficiently sizeable to accommodate a suitable wastewater treatment plant. It would be necessary to construct a temporary duct through which to divert the waste stream(s) during construction, but this would not be complicated. The contents of the isolated area could then be removed, to a large degree by pumping, then finally by mechanical excavation, until the foundations of the proposed facility could be placed. The impoundment cannot be very deep at that point given that it was river shore until the embankment system was put into place not many years ago. WEC Experts envision that the intake of the treatment plant would be at a level so as to accept gravity flow, and the surrounding area filled to grade. It would appear also that there would be gravity flow from the new facility to the river, certainly a low lift, if any. It would be wise to stabilize any residual chromium and other waste components which may have permeated subsurface earth layers by distributing a liberal application of ground limestone before backfilling the area.

The plan outlined above would require very substantial funding, but the cost would be relatively minuscule compared to a potential relocation scheme. It is also attractive from the point of view that domestic wastewater generated in the area would be additionally treated at very little cost.

## **VI. FOLLOW-UP OPPORTUNITIES**

The WEC Experts have indicated that a wastewater treatment facility in the Hazaribagh district is necessary. Over the course of this trip, the Experts have found that the tanners are willing to participate in wastewater treatment strategies, but they need assistance in support of operation and maintenance costs. Tanners were also reluctant to give financial support for design and construction of a facility. The next follow-up effort should be to acquire data on volume and analytical characteristics of the discharges at the outfall locations carrying tannery effluent. These data are a hands-on sampling and analysis procedure to be designed by a qualified engineer or engineering firm with tannery wastewater experience. The WEC Experts believe that the actual sampling and analysis might be executed by personnel (probably students) affiliated with the Bangladesh College of Leather Technology as they would seem to be the most inclined to be interested. It was also recommended that Dr. Karam Ali Ahmed, of Dhaka Hides and Skins, be encouraged to lend his knowledge to this program.

## **VII. IMPLEMENTATION PLAN AND SCHEDULE**

The WEC Experts are not in position to have knowledge of or make recommendations with respect to implementation or scheduling of the foregoing suggestion. A plan proposed for wastewater treatment is feasible, however it will require design by others and funding from sources about which the participants have no information.

## REFERENCES

- Fallon, Louise: A Conceptual Framework for Sustainable Development: An Analysis of Economic and Policy Factors Affecting Natural Resources Management in Bangladesh. US/AID Bangladesh, October, 1989
- Motaleb, Abdul: Groundwater Contamination by Industrial Wastes. Unpublished Master's Thesis, International Institute for Infrastructural, Hydraulic, and Environmental Engineering, Delft, The Netherlands, May, 1993

**APPENDIX A**  
**BUSINESS CARDS OF EXECUTIVES**

## EXHIBITS

### Exhibit A. Business Cards Of Executives

A. M. KHORSHED ALAM  
LEATHER TECHNOLOGIST

PRAGATI LEATHER COMPLEX  
AL-MADINA TANNERY

55/1, Hazaribagh, Dhaka-1209, Bangladesh.  
Telephone : Off : 505383, 504865, 861579



A. F. M. RAFIQU L ISLAM  
(Bsc. Tech In. Leather)  
Chief Leather Technologist

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OFFICE : 88, Sher-E-Bangla Road  
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Bangladesh

MAILING ADDRESS : 147, Hazaribagh Tannery Area  
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Phone : 504987, 501874, 861263  
Telex : 632153 DHS BJ  
Tele Fax : 863515



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College of Leather Technology Fax : 880-2-863515



Md. Abdur Razzak  
Chief Leather Tech.

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48/2k, Moneshour Road  
Hazaribagh, Dhaka-1209  
Tel : 501483

M. A. MAJED  
EXECUTIVE DIRECTOR (WORKS)

**APEX TANNERY LTD.**

127 HAZARIBAG TANNERY AREA  
DHAKA - 1209  
PHONE : 502030, 506119, 504983  
RES :  
TELEX : 632252 APEX BJ.  
FAX : 880-2-863429, 880-2-863559, 861167



Md. Shakeen  
~~28/2k, Moneshour Road~~  
Leather Tech.

RELIANCE TANNERY LTD.  
48/2k, Moneshour Road  
Hazaribagh, Dhaka-1209  
Tel : 501483



SK. LALA (BABU)  
Managing Director

**SARWAR LEATHER CORPORATION LTD.**

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LEATHER & ALL KINDS OF LEATHER PRODUCTS.

123, SHER-E-BANGLA ROAD, HAZARIBAGH, DHAKA-1209, BANGLADESH.  
PHONES : TANNERY-863963, 500160, 502033 W HOUSE 217056, 381519  
S. ROOM-280334, 507586, TELEX : 632170 GBSSR BJ ATTN : S.L.C.L.  
632169 ARKCL BJ. ATN : SLCL FAX:1SD. 880-2-863797, ATN SLCL  
880-2-663307 ATTN SLCL

REPRESENTED BY: \_\_\_\_\_

## APPENDIX B

### Chromic Hydroxide Precipitation from Chrome Tan Exhaust Liquor and Recovery as Chromic Sulfate

Chrome tanning liquors, at the completion of the tanning cycle still contain a significant amount of usable chromium.

Exhaust chrome tanning liquors may be drained to a sump pit, screened to remove gross solids (bits of fleshings, etc.), thence pumped to a treating tank capable of holding several hundred gallons or more. The tank may be plastic, stainless steel, or wood, but should be corrosion resistant.

After collection of the desired amount of spent liquor in the treating tank Magnesium Oxide (MgO) is added with stirring until a pH of 8.6 to 9.2 is reached. The insoluble chromium hydroxide is then allowed to settle, preferably overnight. The solids will then be dark gray-blue in color and somewhat compact. The supernatant liquid will be quite clear, thus allowing a rather easy visual separation of the two portions. The supernate is siphoned off, or preferably drained off through side-pipes, and discarded. Additional spent chrome liquor may then be added and the alkalization and settling procedure repeated until the accumulated level of precipitate is such that the tank capacity is being reached. Sulfuric acid is then added, again with stirring, until pH 2 to 2.5 is achieved, at which time the precipitated chrome will be dissolved and converted to chromium sulfate. This material, with pH adjustment to process specifications, can be used as an adjunct to pickle liquor; or as a first offering, or pretan, and discarded; or the reclaimed chrome can be combined with new chrome and used as part of the usual amount in the regular tanning step. Analytical methods for determining the chromium content of the reclaimed liquor are readily available in textbooks.

The above outline has to be recognized as a guide and a generalization, only. Each tanner will need to research and develop his own procedures to fit his own physical arrangements and formulations as appropriate.

## APPENDIX C

### PHOTOGRAPHS

A. Photograph of the septic lagoon formed between the flood control embankment and the former river shore. Surface drains for the district converge at a number of points inland, resolving into two discharge locations into the lagoon, one beneath the trees at the left center of the photo, the other beneath the palm trees at the right. The lagoon was at a low level at the time the photo was taken but reportedly rises considerably during monsoon season.

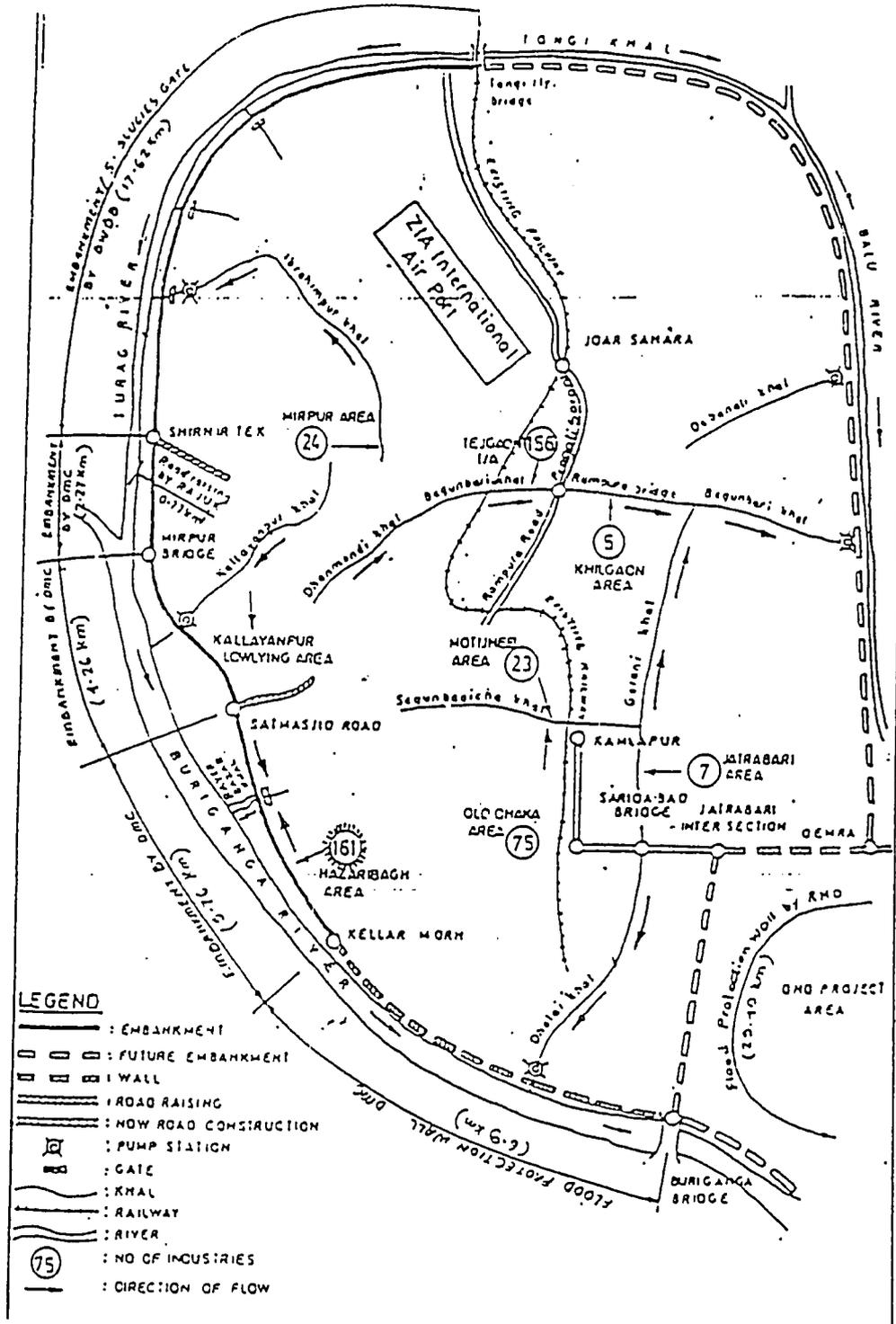


B. Photograph of the Intake for the Pumping Station - Lagoon to River. This pumping station is operated only when the level in the lagoon threatens the top of the embankment. Note weed growth in inlet.



BEST AVAILABLE COPY

A. Map of Dhaka City showing location of Hazaribagh section.  
 Map Source - Abdul Motaleb, 1993. See References



BEST AVAILABLE COPY

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## I. EXECUTIVE SUMMARY

The People's Republic of Bangladesh is taking ambitious strides to strengthen environmental protection. New environmental legislation has been proposed before the Legislative Assembly and is expected to pass during the next session. Once enacted, this law will be known as the Bangladesh Environmental Protection Act of 1994. This law will enable the Department of Environment to establish environmental quality standards and propose specific regulations to control environmental pollution in all media.

The purpose of this report is to identify opportunities to incorporate economic incentives into the proposed environmental statute for the People's Republic of Bangladesh, through the United States Agency for International Development (USAID) Mission in Dhaka, Bangladesh. To accomplish this, the proposed environmental statute and existing studies were reviewed; interviews were conducted with Bangladesh environmental officials and local businessmen; and site visits to six leather tanning operations in the Hazaribagh area of Dhaka were conducted. Preliminary findings were presented to Mr. Abdus Sobhan, Deputy Director, Bangladesh Department of Environment; Dr. Craig Anderson, Mission Environmental Officer, USAID Mission to Bangladesh; and local businessmen.

The major issues that impede environmental protection and improvement in Bangladesh are the size and density of the population in relation to land area and the resource base, and inadequate integrated planning of multiple resources. Population density throughout the country has caused deforestation, destruction of wetlands, soil depletion, and inland salinity intrusion. Floods due to storms result in severe socio-economic, environmental damages, and loss of human life. Furthermore, lack of environmental infrastructure, such as wastewater treatment facilities and landfills, degrade water quality. Lack of understanding of ecological principles and adequate alternate resources also hinder environmental management.

Environmental laws can control pollution through a mix of strategies, most of which involve command-and-control regulation of the quantity and quality of pollution allowed by individual sources or the control technology sources must use. Meanwhile, economic incentive programs create rewards for preventing or controlling one's emissions, effluents, or wastes, and penalties for increasing or keeping the releases constant. Some economic incentives establish prices, for the right to pollute, directly through market transactions. Others, such as pollution fees and various trading systems work directly by affecting market prices. Economic incentive programs should be used to supplement command-and-control standards.

Major findings and recommendations contained in this report include the following:

- The proposed statute does not include economic incentives.
- Current levels of expertise and personnel within the Bangladesh Department of Environment are inadequate resulting in a lack of enforcement of current regulations.
- The new statute should explicitly allow the Department of Environment to use economic incentives to achieve desired environmental quality levels in air emissions and wastewater discharges, and in solid waste management.
- The new statute should explicitly define "economic incentive programs" for environmental protection.
- Economic incentives will be frustrated unless other elements are present in the policy framework. Enabling conditions including legal, regulatory, and institutional reforms are necessary for economic incentives to function effectively.
- Once enacted, economic incentive programs should be based on the volume and toxicity of pollutants released.
- Existing tax codes, zoning provisions, and land use planning should be modified to include accelerated depreciation of capital equipment used for pollution control, corporate income tax deductions or credits for pollution abatement costs, and property tax waivers based on decreasing pollution releases.
- Firms, or individuals, responsible for contamination should be made financially responsible for the clean-up of contaminated sites if they are not in compliance with environmental regulations.

Funding for this project was provided through a Cooperative Agreement between the World Environment Center and the United States-Asia Environmental Partnership (US-AEP).

## II. INTRODUCTION

On September 24, 1994, Lawrence K. Barber of Waynesville, North Carolina, and Mark C. Pfefferle of Science Applications International Corporation, in Falls Church, Virginia, began a two-week assessment of selected leather tanning facilities in Dhaka, Bangladesh, and a review of the proposed environmental legislation for Bangladesh. Mr. Barber was responsible for assessing the leather tanning operations. His findings and conclusions are discussed in Volume One of this report. Mr. Pfefferle participated in the assessment of the leather tanning operations but was primarily responsible for identifying opportunities incorporating economic incentives into the proposed environmental legislation. (A complete copy of the proposed legislation can be found in Appendix A). Funding for these studies was provided by the United States Asia Environmental Partnership through a cooperative agreement with the World Environment Center.

The purpose of this report is to review the draft environmental legislation for the People's Republic of Bangladesh and to identify opportunities for the incorporation of economic incentives into the draft legislation. This report will identify different types of economic incentives used for controlling environmental pollution and include findings and recommendations.

### III. ECONOMIC INCENTIVES

Over the past five years, governments at the national and local level have implemented a variety of incentive mechanisms to supplement traditional approaches for managing the environment. Because of their inherent flexibility, economic incentives can, in some cases, be both a less costly and more effective means of controlling pollution. Payments per unit of pollution are the clearest examples of an economic incentive. Market incentives, like pollution reduction credits, are also economic incentives. Generally, market incentives are narrower than economic incentives involving only those incentives which are implemented through mechanisms having direct effects on economic markets. These incentive mechanisms operate through the ingenuity and actions of individual sources, who have an incentive to be on the alert for opportunities to make reductions in their pollution.

To bound the subject, economic incentives for the purposes of this report are defined broadly as instruments that provide continuous inducements, financial or otherwise, for pollution sources to make reductions in the pollution they release. Other common sectoral economic incentives such as ride sharing, bike paths, high occupancy vehicle lanes, and parking surcharges are not discussed in this report because the people of Bangladesh are dependent on public transportation.

The contrast between command-and-control approaches and economic incentive programs is that the former do not provide intentional incentives to reduce the quantity of releases below permitted levels. Command-and-control regulations either govern the amount of pollution that can be emitted or discharged by a single source or establish standards governing the pollution abatement technology. Typical components of this regulatory system include health-based standards for pollution levels in the environment, as well as construction and operating permits and enforcement procedures aimed at achieving these standards. Command-and-control standards do not regard the variability in different sources' costs of controlling pollution. An approach employing economic incentives may achieve the same reduction in pollution but offers companies greater flexibility. Companies have the choice of investing in different control technologies, changing manufacturing processes, or paying for unabated pollution. Moreover, by not giving companies such flexibility, the government takes on the costs of determining and imposing, for each source, emissions standards or technologies for abating pollution.

Despite limiting pollution from stationary sources, such as power plants and municipal wastewater treatment facilities, command-and-control regulations have not been effective in addressing pollution from dispersed sources, such as households, farms, and small business. Many of these sources cannot be readily addressed by the technical solutions offered by command-and-control regulation because the pollution stems from millions of economic decisions made by individuals. Even if standards

were possible, enforcement would be exceedingly difficult when so many sources are involved. Therefore, economic incentive programs are efficient means to supplement command-and-control regulations.

It must be emphasized that although this report makes careful distinction between command-and-control and economic incentive approaches, these distinctions are often difficult to apply in practice. For example, economic incentive programs, which are inherently more flexible and less prescriptive than command-and-control standards, strongly depend on monitoring, recordkeeping, and reporting, which are characteristic of command-and-control standards, to ensure compliance and to allow for adequate enforcement. In other words, the dividing line between "pure" command-and-control and "pure" economic incentives can be drawn at any number of places.

## **A. TYPES OF ECONOMIC INCENTIVES DISCUSSED IN THIS REPORT**

Environmental laws can control pollution through a mix of strategies, most of which involve command-and-control regulation of the quantity and quality of pollution allowed by individual sources or the control technology sources must use. Meanwhile, economic incentive programs create rewards for preventing or controlling one's emissions, effluents, or wastes, and penalties for increasing or keeping the releases constant. Some economic incentives establish prices, for the right to pollute, directly through market transactions. Others, such as pollution fees and various trading systems work directly by affecting market prices. The economic incentives discussed in this report have been separated into the following four categories.

- Pollution Fees, Charges, and Taxes. Payments by polluters based on the quantity and quality of pollutants emitted, or products produced.
- Deposit-refund Systems. Payments by potential polluters at the time a potentially polluting product is purchased, which are refunded if the product is disposed of or recycled in specified ways.
- Pollution Trading. The transfer of pollution credits and allowances for in-kind or financial compensation.
- Subsidies and Tax Concessions. Financial payments to polluters and tax advantages based on changes reduced in pollution discharges or in return for future pollution control actions.

Exhibit 1 shows the economic incentives discussed in this report classified according to the time the incentive becomes effective in relation to the time the pollution occurs.

### Exhibit 1. Types of Economic Incentives

<i>Incentive Type</i>	<i>Time Incentive Becomes Effective</i>		
	<i>Prior to Time of Pollution</i>	<i>At Time of or as a Direct Result of Pollution</i>	<i>After Pollution Occurred or Might Have Occurred</i>
<i>Payments for the Right to Pollute</i>		<i>Pollution Fees</i>	
<i>Deposit-refund Systems</i>	<i>Deposits</i>		<i>Refunds</i>
<i>Trading of Pollution Permits</i>	<i>Allowance Trading Systems</i>		<i>Credit Trading Systems</i>
<i>Payments from Governments for Pollution Control</i>	<i>Subsidies for Installing Pollution Control Equipment</i>		<i>Tax Advantages in Return for Reduced Pollution</i>

*Source: United States Environmental Protection Agency. July 1992. The United States Experience with Economic Incentives To Control Environmental Pollution. EPA-230-R-92-001.*

#### II.A.1. Pollution Fees, Charges, and Taxes

A fee, charge, or tax on each unit of pollution is a strategy that can provide a direct incentive for sources to reduce pollution. Ideally, fees should be set so as to result in pollution releases being reduced to the socially optimal level considering the costs of control and the benefits of the reduction. In order to motivate a change in pollution, the fees must be high enough that sources will actively seek to reduce releases. It is important to note that not all fee programs are designed to motivate sources to lower pollution. Fee programs using small fees are designed primarily to generate revenue, often to cover some of the administrative costs of a regulatory program.

Some fee programs are designed to mitigate the potentially large amount of revenue that a fee program could generate. Although more complex than a simple fee program, programs that reduce or eliminate the total revenues may be more readily adopted than a simple fee. Some programs lower the amount of total revenues generated by waiving the fee on some pollution releases. These programs reduce the total amount of revenue generated, while providing an incentive to decrease pollution. Alternatively, a program may impose higher per-unit fees on a portion of the pollution stream, providing a more powerful but targeted incentive at the same revenue levels. For example, fees could be collected on all emissions in excess of some fixed level.

The level could be set as a percentage of a baseline (e.g., fees on emissions above some percentage of historical emissions), or as the lowest emissions possible (e.g., fees on emissions in excess of the lowest demonstrated emissions from the source category).

Other fee programs are "revenue neutral," meaning that the pollution control agency does not receive any net revenues. One way to design a revenue-neutral program is to have both a fee provision and a rebate provision. Rebates must be carefully designed to avoid lessening the incentive provided by the fee. For example, a rebate based on comparing a source's actual emissions and the average emissions for the source category can be designed to be revenue neutral and not diminish the incentive.

Other types of fee programs collect a fee in relation to particular activities or types of products to encourage the use of alternatives. While these fees are not necessarily directly linked to the total amount of pollution generated from the activity or product, the relative simplicity of a usage fee may make such programs an effective way to lower pollution. Fees on raw materials to a manufacturing process can encourage product reformulation (e.g., fees on solvent sprays) or changes in work practices (e.g., fees on chemical use).

Pollution fees, charges, and taxes have not proved as popular as trading in the United States, in part because they increase the total financial outlays by polluters above the cost of pollution abatement since all potential pollution, both controlled and uncontrolled must be paid for. Economists, on the other hand, point out that fees, charges, and taxes provide incentives for pollution control while raising revenue for the government.

### **Publicly Owned Sewage Treatment Plant User Fees**

In the United States, Poland, and Russia Publicly Owned Treatment Works (POTW) impose charges on industrial facilities and households discharging into their systems. The charge for industrial sources may be based on effluent volume or the types and amounts of pollutants present. Due to high monitoring costs, pollutant-based charges are generally limited to large users. Other industrial users and households are billed based on effluent volume times a rate specific to the individual sector. Pollutant-based charges provide an incentive for large industrial facilities to reduce the volume and toxicity of effluents. Purely volume-based charges do not appear to have such an effect.

### **Municipal Solid Waste Disposal Charges**

Throughout the United States and Dhaka, Bangladesh, the community levies fixed fees for the collection of household solid waste or the costs are included property taxes.

Typically, fees are set at a fixed price per month or effectively "hidden" altogether as part of residential property taxes. In a growing number of jurisdictions charges for solid waste collection are based on volume of waste generated. Two pricing systems are commonly used. In the first system, charges are based on subscriptions for a certain number of containers and charges for stickers that must be placed on each bag left for curbside pickup. Under the second system, households pay to have the right to dispose of a set of number containers per week. If the containers are not filled, the household pays for the unused capacity.

### **Air Emission Fees**

In the past, air emission fees appeared in the form of annual permit fees and were based on emissions of air pollutants. For example, the Texas Air Control Board set fees at \$3 per ton of regulated pollutants for fiscal year 1992 and \$5 per ton in fiscal year 1993 to finance certain agency activities. This is an example of a fee that may generate revenue but is unlikely to have much incentive effect to reduce emissions.<sup>1</sup> There can be significant variations in emission fee programs. For example, potential emissions could be targeted by placing a fee on an input (e.g., a fee on the quantity and BTU content of fuel used in an industrial boiler) rather than on actual emissions. Sources paying a fee on potential emissions could be eligible for a fee waiver or rebate by demonstrating that potential emissions are not actually emitted, such as through a carbon absorber system on a coating operation.

The Clean Air Act, as amended in 1990, broadly encourages, and in some cases mandates, the use of incentive-based approaches to air pollution. The U.S. Environmental Protection Agency has taken this directive to include emission limiting strategies that directly specify limits on total mass emissions, emission related parameters, or levels of emission reductions relative to a program baseline that is required to be met by all affected sources. A marketable permits program is an example of such a program.

### **Industrial Solid and Hazardous Waste Charges**

In contrast to flat fee schedules typically faced by households, commercial and industrial generators of solid waste generally face costs that rise with increases in volume. Charges are based on the number of containers emptied and the substances contained. Across the United States, charges can vary several fold for the disposal of identical volumes of a particular substance.

### **Product Charges**

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<sup>1</sup> United States Environmental Protection Agency. July 1992. *The United States Experience with Economic Incentives To Control Environmental Pollution*. EPA-230-R-92-001. Page 3-3.

Many countries are beginning to impose special taxes on the sale of automobile tires, motor oil, fertilizer, and crude oil production. The taxes raised help pay for programs for environmental protection, environmental research, and disposal of the used tires and oil. While the incentive effects of product taxes on pollution is weak, such taxes raise revenue that can be used to finance pollution control activities.

### **Deposit-And-Refund Systems**

Under deposit-and-refund systems purchasers of products that could pollute the environment pay a surcharge, which is refunded when the purchasers return the products are returned for recycling or proper disposal. The types of containers for which deposits are used vary from country to country. In the United States, deposits are frequently used for glass and aluminum beverage containers and lead-acid batteries.

Beverage container deposits address two costs that usually are external to beverage manufacturers, distributors, and consumers, namely the costs of disposal and littering. Deposits provide a disincentive to specified types of litter and an incentive to collect such litter and reduce the volume of solid waste. Mandatory deposit legislation, in some States, has reduced the amount of roadside litter.

Some states have implemented deposit systems for lead batteries. Each state requires a deposit at the point of sale. The deposit is refunded when the battery is returned. This deposit system encourages consumers to return used batteries for recycling and proper disposal.

### **Trading Systems**

One prominent economic incentive program is based upon the creation of a market in which trading of source-specific pollutants may occur. Such programs may include traditional rate-based limits or overall limits on a source's total pollution per unit of time. The rate-based limits, which may be placed on individual units or on facilities as a whole, may decline over time. The common feature of such programs are that sources have an ongoing incentive to reduce pollution and have increased flexibility in meeting their regulatory requirements. A source may meet its own requirements either by directly preventing or controlling pollution releases or by trading or averaging with another source. Trading or averaging may occur within the same facility, within the same firm, or between different firms. Sources with lower cost abatement alternatives may provide the necessary emissions reductions to sources facing more expensive alternatives. These programs can lower the overall cost of meeting a given total level of abatement. All sources eligible to trade in a pollution market are faced with continuing incentives to find better ways of reducing pollution at the lowest possible cost, even if they are already meeting their own standards.

Programs involving emissions trading markets are particularly effective at reducing overall costs when individual sources face significantly different emissions control costs. A wider range in control costs among affected sources creates greater opportunities for cost-reducing trades. Thus, for example, areas which face relatively high stationary source control costs relative to mobile source control costs benefit most by including both stationary and mobile sources in a single emissions trading market.

Programs involving emissions trading markets have generally been designated as either emission allowance or emission reduction credit trading programs. Allowance trading programs establish emission allocations to be effective at the start of a program, at some specific time in the future, or at varying levels over time. An emission reduction credit trading program requires measurement against a pre-established emission baseline. Allowance allocations or emission baselines can be established either directly or by reference to traditional regulations. In either type of program, sources can either meet their requirements by maintaining their own emissions within the limits established by the program, or by buying surplus allowances or credits from other sources. In any case, the government will need to establish adequate enforceable procedures for certifying and tracking trades, and for monitoring and enforcing compliance with the economic incentive program.

The definition of the commodity to be traded and the design of the administrative procedures that the buyer and seller must follow to complete a trade are obvious elements that must be carefully selected to help ensure a successful trading market achieves the desired environmental goal at the lowest cost. Markets are defined as efficient if they achieve the environmental goal at the lowest possible total cost. Any feature of a program that unnecessarily increases the total cost without helping achieve the environmental goals causes market inefficiencies. Thus, the design of an emission trading program should be evaluated not only in terms of the likelihood that the program design will ensure that the environmental goals of the program will be met, but also in terms of the costs that the design imposes upon market transactions and the impact of those costs on market efficiency.

All trading markets impose some level of transaction costs. The level of transaction costs are affected by various aspects of the design of the market, such as the nature of the procedures for reviewing, approving, and recording trades, the timing of such procedures (i.e., before or after the trade is made), uncertainties in the value of the allowance or credit being traded, the legitimacy of the allowance or credit being offered for sale, and the long-term integrity of the market itself. Emissions trading programs in which every transaction is different, such as programs requiring significant consideration of the differences in the chemical properties or geographic location of the emissions, can result in higher transaction costs than programs with a standardized trading commodity and well-defined rules for acceptable trades.

While the market considerations discussed above are clearly important in designing an efficient market to minimize the transaction costs of such a program, other considerations, such as regulatory certainty, enforcement issues, and public acceptance, also clearly need to be factored into the design of any emissions trading program.

### **Subsidies and Tax Concessions**

Subsidies and tax concessions provide financial payments and tax advantages for polluters based on changes in previous pollution emissions, or in return for future pollution control actions. Many governments provide subsidies to firms needing financial assistance to acquire pollution control equipment.<sup>2</sup> The subsidy is paid either to the manufacturer of the pollution control equipment or to the firm prior at the time of purchase. Similarly, many governments provide multi-year tax concessions for firms acquiring pollution control equipment. Both subsidies and tax concession provide financial incentives for firms to implement pollution controls and improve environmental conditions.

## **B. THE ECONOMIC EFFICIENCY OF INCENTIVE SYSTEMS**

Incentive mechanisms have several properties that could make them especially well suited to environmental problems in Bangladesh. First, incentive mechanisms are inherently more economically efficient; that is, they achieve environmental goals at lower cost than direct regulation. Second, incentive mechanisms provide a greater stimulus for innovation and technical change in pollution control than does a direct regulatory approach. These properties are discussed in the next two subsections.

### **1. Greater Efficiency**

Economists suggest that the traditional command-and-control approach to environmental pollution control results in control costs that are higher than necessary to achieve a given level of environmental protection. They have suggested that costs could be reduced if economic incentives were used for command-and-control regulations. Economic incentives reduce the total cost of compliance for the regulated community by shifting greater responsibility for reducing pollutant loadings to firms with low control costs, rather than requiring all polluters to control pollution to the same level.

It is important to note, however, that one recent review of retrospective analyses of

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<sup>2</sup> Since the passage of the Tax Reform Act of 1986, the United States government is no longer able to provide Federal tax concessions to firms for the purchase of pollution control equipment. However, State and local governments are still able to provide such incentives.

emission and effluent trading systems in the United States concluded that realized cost savings fall well short of these projections.<sup>3</sup> Even if the cost savings is less than predicted, cost savings are still occurring. In appropriate circumstances, the wider use of incentive programs that are feasible in an actual policy setting will result in substantial cost savings while achieving equivalent environmental goals. In other circumstances, the cost differences between an incentive program and a well designed command-and-control program will be less,<sup>4</sup> although the incentive program will provide a stronger stimulus for innovation and technical change.

## 2. Stimulus to Innovation and Technical Change

Because most economic incentive programs base the incentive on the quantity and quality of emissions or effluents, they are more likely to provide incentives for innovation and technical change than command-and-control approaches. When emissions are used as the basis for determining either incentives or compliance with a command-and-control approach, polluters have incentives to innovate and introduce technical changes to reduce emissions to the point where the marginal cost of further reductions equals the magnitude of the incentive, or to the required levels in the case of command-and-control. When some other basis is used, particularly a technology standard, polluters usually have less of an incentive to innovate. In the case of command-and-control standards, pollution sources have a negative incentive to innovate and use improved technologies. Regulators may use new technologies as the basis for requiring even tighter control in the future since it has then been "proven". Although emission based command-and-control approaches can be used that provide incentives for innovation, they may be less effective than economic incentives approach because they only provide incentives to bring emissions down to the standard rather than zero. This may be considerably less technically challenging.

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<sup>3</sup> Atkinson, Scott, and Tom Tietenberg. 1991. "Market Failure in Incentive-Based Regulation: The Case of Emission Trading." *Journal of Environmental Economics and Management*. 21:17-32.

<sup>4</sup> Oates, Wallace E., Paul R. Portney, and Albert M. McGartland. 1989. "The Net Benefits of Incentive-Based Regulation: A Case Study of Environmental Standard Setting." *American Economic Review*, 75:1223-1242.

#### IV. FINDINGS

The People's Republic of Bangladesh is in dire need of environmental laws, regulations, and infrastructure to improve and maintain environmental quality. Many of the environmental laws were established before independence or when the country was under substantially different population and industrial development conditions. Current mechanisms for environmental assessment, regulation, and enforcement either do not exist or are ineffective.<sup>5</sup>

The major issues that impede environmental protection and improvement in Bangladesh are the size and density of the population in relation to land area and the resource base, and inadequate integrated planning of multiple resources. Population density throughout the country has caused deforestation, destruction of wetlands, soil depletion, and inland salinity intrusion. Floods due to storms result in severe socio-economic, environmental damages, and loss of human life. Furthermore, a lack of environmental infrastructure, such as wastewater treatment facilities and landfills, degrade water quality. Lack of understanding of ecological principles and adequate alternate resources also hinder environmental management.<sup>6</sup>

Given current environmental conditions in Bangladesh, there is a movement toward enhanced environmental protection. However, the current draft legislation does not provide an opportunity for the utilization of economic incentives to improve environmental quality. The only mention of economics, or finance, is found in Section 16, which allows the sale of forms and sample kits. Section 16 states<sup>7</sup>

*"The Director General may collect fees at specified rates from the person or organization receiving special services such as clearance, sale of specified forms and sample test, etc."*

This section is inadequate to sanction, or require, the inclusion of economic incentives in controlling environmental pollution.

All local entrepreneurs interviewed during this study acknowledged the existence of forthcoming environmental legislation and regulations but few acknowledged the

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<sup>5</sup> Malcolm Forbes Baldwin. October 1989. *An Assessment of Governmental Laws and Institutions Affecting Natural Resource Management in Bangladesh: Revised Draft*. An Annex of the Bangladesh Environment and Natural Resources Assessment.

<sup>6</sup> Government of the People's Republic of Bangladesh, Ministry of Environment and Forestry. October 1991. *Bangladesh Country Report for United Nations Conference on Environment & Development (UNCED) Brazil, 1992*.

<sup>7</sup> Bill for Protection of the Environment, Development of Environmental Quality and Control and Neutralization of Environmental Pollution. 1993.

potential impacts on their operations. At the same time, they admit that environmental regulations will be a good for their community. The current environmental regulation, Environmental Pollution Control Ordinance (1977) does not provide a polluter any incentive to invest in pollution control equipment. Firms in Bangladesh do not have pollution control equipment because for the most part, they are not required to comply with specific limits, and if limits are in-place, ineffective enforcement renders the limits useless.

If Bangladesh adopts regulatory a program based on economic incentives benefits will be realized more quickly than command-and-control regulations. Economic theory, as well as operators of leather tanning operations in Dhaka have both suggested that an incentive based approach would be more effective and fair.

The proposed environmental quality standards, which will become final after the environmental legislation is approved by the Legislative Assembly, are on a command-and-control path. If proposed legislation is not amended to recognize that economic incentives may be necessary to supplement the command-and-control regulations, the effectiveness of environmental quality standards may be stymied.

## V. RECOMMENDATIONS AND CONCLUSIONS

The following section presents fundamental recommendations as well as specific technical changes for the proposed environmental statute. The fundamental recommendations either address the core of the proposed statutory scheme to provide environmental protection or are suggestions that span across several proposed provisions. The specific changes focus on individual provisions. An important caveat should be placed on all of these statutory recommendations that is: attributes to the Bangladesh legal system and political conditions may warrant modification or rejection of some recommendations. Finally, recommendations are based on translation of the law from Bangla to English. Meanings may have been affected.

1. To affectively encourage pollution control, the proposed statute should include language authorizing the Ministry of Environment to use command-and-control and economic incentive programs, including fees, marketable permits, incentives, and other economic incentives to attain and maintain environmental quality standards. Economic incentives should be used, to supplement command-and-control standards and will need the support of standards and limits to be effective.
2. Under Section 2 of the proposed statute, there should be an additional category under the definitions, number 22, for "economic incentive programs". The definition should be broad so as to include a wide range of program types. First, an economic incentive program can be based on the use of marketable permits, emissions trading or tradeable allowances. Second, an economic incentive program can be based on the use of environmental charges, taxes, or fees. Third, an economic incentive program can include incentives, grants, subsidies, and rewards for early reductions or other desirable actions. In addition, the various types of the economic incentive programs can be combined into a single integrated plan.
3. The proposed statute should include broad statutory authorization allowing for imposition of a variety of environmental fees to subsidize environmental protection costs. Permitting, monitoring, inspection, and effluent fees should be collected from regulatees on a sliding scale based on the size of the firm, the magnitude of its pollutant load, and its ability to pay. These costs can be considerable, and funding shortfalls may constrain critical activities. The draft statute mandates fees under Section 16. This proposal simply expands the concept of user fees to a larger universe.
4. The proposed statute should authorize the Ministry of Environment to use fees and taxes in the regulation of emissions from baby taxis, taxis, trucks, buses, and automobiles.

5. The proposed statute should authorize the Ministry of Environment to use fees and taxes in the regulation of emissions and effluents from the manufacturing of consumer and commercial products, and as a sanction for failing to meet statutory requirements.
6. The proposed statute should earmark funds collected from fees and penalties to the Department of Environment rather than to the general treasury. The goal here is to create sufficient money to assure resource-intensive demands for environmental management.
7. The proposed statute should modify existing tax codes, zoning provisions, and land use planning to provide effective economic incentives. Possible modifications include accelerated depreciation of capital equipment used for pollution control, corporate income tax deductions or credits for pollution abatement costs, and property tax waivers based on decreasing pollution releases.
8. The proposed statute should include a provision requiring firms, or individuals, to be financial responsible for the clean-up of contaminated sites if the firm, or individual, is not in compliance with environmental regulations. This will encourage firms to comply with all regulations.

Without reviewing other Bangladesh laws and regulations, particularly those with municipalities, it might be advisable to amend other pieces of legislation to allow entrepreneurs and private firms to construct and operate solid waste collection and disposal systems and wastewater treatment facilities.

## VI. CASE STUDY - WASTEWATER TREATMENT IN HAZARIBAGH LEATHER TANNING DISTRICT

The purpose of this case study is illustrate generic issues that arise in designing and implementing an economic incentive program. The tannery district in Dhaka was chosen for study because the pollution created by the tanneries is the source of environmental degradation in the Hazaribagh area of Dhaka. Previous studies have shown that industrial discharges have decreased water quality for water impounded by the flood protection embankment. The industrial wastes are accumulating in the impoundment ditch and the water is not suitable for drinking water or bathing, and it emits odors. During the dry season the area submerged by tannery waste in the post embankment period is approximately 8-10 times larger than pre-embankment. The decreased water quality and the accumulation of tannery wastewaters threatens the groundwater supply, the main source of drinking water in the Hazaribagh.<sup>8</sup>

Below is a discussion indicating how an economic incentive program could function in the Hazaribagh area. This case study does not assess either the capacity, or the construction specifications, of a centralized wastewater treatment facility, nor does it discuss financing the construction activities. However, it presents an economic incentive program to fund the continued operation and maintenance of the wastewater treatment facility.

The tannery industry first started in Hazaribagh area of Dhaka in 1956. Currently there are approximately 160 tanneries and 1 chemical facility<sup>9</sup> concentrated into a very densely populated area. Wastewaters from the leather tanneries are untreated and discharged directly to open sewers.<sup>10</sup> Domestic sewage also combines with the industrial wastewaters. The combined wastewaters flow toward the river but are impounded by a flood protection embankment. The Hazaribagh area is densely populated and the leather tanning operations are too small and lack space to build individual wastewater treatment facilities.

Mr. Abdul Sobhan Deputy Minister Ministry of Environment, Dr. Karam Ali Ahmed distinguished professor at the Dhaka College of Leather Technology, and Mr.

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<sup>8</sup> Abdul Motaleb, May 1993. *Groundwater Contamination by Industrial Wastes: A Case Study In Dhaka City, Bangladesh*. Unpublished Masters Thesis, Delft.

<sup>9</sup> Abdul Motaleb, May 1993. *Groundwater Contamination by Industrial Wastes: A Case Study In Dhaka City, Bangladesh*. Unpublished Masters Thesis, Delft.

<sup>10</sup> Government of the People's Republic of Bangladesh, Ministry of Environment and Forestry. October 1991. *Bangladesh Country Report for United Nations Conference on Environment & Development (UNCED) Brazil, 1992*.

Lawrence K. Barber<sup>11</sup> have all suggested that the construction of a centralized treatment facility is the most appropriate technology for treating the discharge from the leather tanning district. Furthermore, both Mr. Sobhan and Dr. Ahmed recommend the construction of a community-wide treatment facility, instead of requiring individual leather tanning operations to control their effluent discharges. A community-wide wastewater treatment system would have the dual purpose of treating both industrial and domestic wastewaters.

Once constructed, the facility should be operated by entrepreneurs, or firms, experienced in operating wastewater treatment facilities. The phenomenon where the private sector operates services typically performed by the government is called public-private partnerships. There are two types of public-private partnerships. In the first, private developers contribute funds in exchange for contractually defined rights to use the public works, such as a wastewater treatment facility. The advantage of this system is the contribution of capital. In the second type of public-private partnerships, the investors would "own" the wastewater treatment facility through the purchase of certificates of participation or equipment certificates. The treatment facility is held by the government as collateral, and the facility operator makes lease payments, which, in turn, are used to pay the debt service. In both instances, the facility operator must have the legal ability to set and collect fees from the industries, and individuals, discharging to the treatment facility. It is these fees that attract entrepreneurs into public-private partnership arrangements. Fees enable the entrepreneur to pay the lease payments, maintain and operate the facility, and make a profit and for the government to retire the debt necessary to construct the facility.

The question that remains is how to determine the fee level that will cause operators of the industrial discharges to reduce the volume and toxicity of their effluent so that the combined effect is achievement of a desired ambient water quality goal. Determining the fee structure and level is important in creating economic incentive programs.

One way to set the charge would be through trial and error. It would be possible to set a charge, observe its effect, and then move it up or down as indicated until the desired financial returns are reached and held constant. Such an approach has the advantage of administrative simplicity. However, this method has many drawbacks that preclude its adoption. First, if the initial fee was well off the mark, the operator of the treatment facility may fall behind in lease payments and routine operation and maintenance expenditures. Second, if the initial fee is too high, leather tanning operators may not be able to pay and will be faced with either reducing production, or risking fines through illegal discharges of wastes. The trial-and-error method could also result in periods of financial instability for the operator of the treatment works

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<sup>11</sup> Personal communication with Mr. Sobhan and Dr. Ahmed. Mr. Barber's findings were reported in a second study which accompanies this study.

before stabilizing.

The method to set the fee should be from an analysis of the volume and toxicity of the wastewater discharge from each tannery and from the risk associated with the wastewater. This method would encourage the tannery operator to reduce both the volume of wastewater discharged and replace toxic materials with less toxic ones. Under this method the tannery operator has an economic incentive to take in-house measures to reduce pollution, because if either, or both, the volume of wastewater discharged and its toxicity is reduced, the fee assessed by the treatment facility will also be reduced.

Unfortunately at this time, this method is inappropriate for the Hazaribagh area. Tanneries may have more than one discharge point into an open sewer and the sewers are a combination of all industrial and domestic waste in the Hazaribagh. Continued monitoring and sampling of wastewater discharges would be cost prohibitive for the small to medium sized tanneries. Initially, the fee structure should be structured around levels of production for each facility. However, this system has drawbacks. First, not all tanneries finish the leather, therefore a graduated scheme would need to be devised to reflect wastewater discharges based on various stages of production. Second, a comprehensive survey of all leather tanning operators would be necessary to determine their daily and annual production levels.<sup>12</sup> This information would need to be periodically updated, by an independent contractor, to assure that the tanners do not underestimate their production, and that the operator of the treatment facility does not overestimate tannery production. Third, this system does not have economic incentives encouraging tanners to reduce the volume and toxicity of wastewater discharges because the fee is based on units of production.

Initially, the fee system should be based on units of production, but eventually the fee structure should be based on volume and toxicity of the discharges. Only with a fee system based on the volume and toxicity will the individual entrepreneurs have economic incentive to reduce their discharges. If the fee structure remains based on production, with no incentive to reduce wastewater flows, the treatment facility may eventually have insufficient capacity to treat the wastewater discharged in the Hazaribagh.

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<sup>12</sup> A starting point for a survey could be the recently completed industrial strategy study completed for The World Bank Resident Mission in Paribagh, Dhaka by Environmental Research & Development Agency Limited, November 30, 1993. *Export Prospects for Leather and Leather Products: Industrialization Strategy Study of Bangladesh Paper No. 12.* or BKH Consulting Engineers. September 1994 *Industrial Pollution Control Management, Bangladesh: Interim Report Phase I.* Report produced for the Government of the People's Republic of Bangladesh Department of Environment/Ministry of Industries and the Asian Development Bank.

## APPENDIX A

### Bill for Protection of the Environment, Development of Environmental Quality and Control and Neutralization of Environmental Pollution

Whereas it is expedient and essential to enact a law for environment protection, development of environmental quality and control and neutralization of environmental pollution:

Therefore, law is enacted as follows:

#### 1. Brief Title and Introduction:

- (1) This law will be known as Bangladesh Environment Protection Act, 1993.
- (2) This law will come into force from the date determined by the Government through gazette notification;

#### 2. Definition: If nothing exits contrary to the subject or context, through this law:

- (1) "Directorate" will mean the directorate of environment;
- (2) "Removal Process" means controlled removal of solid, liquid and aerial wastes including refining process, activities and equipment;
- (3) "Occupant" means, in the case of any factory of its premises, such a person who has control over its affairs, and in the case of any substance a person who has control or proprietorship over it;
- (4) "Pollution" means change in the temperature, taste, smell, density or other features of air, water or soil (pollution of air, water or soil), change in their physical, chemical or organic properties, or means damaging, harmful for destructive activities on air, water, soil or environment, livestock, wildlife, birds, fisheries, plants or including all kinds of life, public health, household activities, trade, industry, agriculture, recreation or any other activities by emission of liquid, gaseous, solid, radioactive or any other substance;
- (5) "Determined" means what is determined by provisions of this law;
- (6) "Specific area" means area indicated under this law by the government;
- (7) "Environment" will include water, air, soil and physical resources and their existing mutual relations, and the existing mutual relations of water, air and soil with man, other animals, plants, and parasites;

- (8) "Environment Pollutant" means such things likely to take damaging shape for the environment or such solid, liquid or aerial substance likely to be damaging including heat, noise and radiation;
- (9) "Environment Protection" means development of the qualitative and quantitative standard of the various elements of the environment and resistance to deterioration of them;
- (10) "Ecosystem" means mutual interdependence of all elements of the environment and a complex and balanced combination that influences and helps the protection and growth of plants and animals;
- (11) "Ecologically critical area" means an area declared by government notification to be the same;
- (12) "Impact on Environment" means favorable, adverse or neutral changes due to environmental reasons as a result of various activities;
- (13) "Environmental Impact Assessment" means scientific impact assessment of favorable, adverse or other impacts created on the environment due to existing, ongoing or proposed projects and activities;
- (14) "Waste" means anything so determined or any liquid, solid or aerial substance which changes the environment through emission of dumping of such quantity;
- (15) "Waste refinery" means those processes and equipment through which pollutant wastes are refined, stabilized or deactivated;
- (16) "Dangerous Substances" means any substance whose chemical or bio-chemical property is such that its uncontrolled transportation may be harmful to environment;
- (17) "Handling" means in case of a substance's production, processing, activation, packaging, storing in warehouses, transportation, collection, destruction, transformation, sale proposal, transfer or similar arrangement regarding that substance or similar arrangements will be included;
- (18) "Regulation" means rules formulated under this law;
- (19) "Person" means any person or persons directly or indirectly associated with any company, business organization, society, organization, non-government organization, sector corporation, autonomous or government organization;
- (20) "Director General" means Director General of the Directorate of the Environment;

- (21) "Government" means the Government of the People's Republic of Bangladesh;
3. Power of formulating laws for protection of the environment, development of environment and control of environmental pollution. The government shall have the power to enact laws on all matters described below through gazette notification:
- (1) Determine quality limits for air, water, soil and noise for many area including specific areas and for different purposes;  
But the condition is that the government will be able to postpone that quality limit considering each situation alone or collectively, in the case of existing industry or project;
  - (2) Development of safe methods for use, storage and transportation of dangerous substances, control, restrictions and ban;
  - (3) Establishment of industrial units in specific areas, including any area, in the interest of protecting the environment, production process of the factory, selection or substance for it and control and ban on other necessary activities;
  - (4) Preparation of security measures for resisting any environmental accident including accidents which may cause pollution of the environment, and remedial programs for such accidents and programs for environmentally acceptable disaster management;
  - (5) Determination of regulations for adoption and selection of various projects or their activities including projects for factories, urban lands, transports, projects for agriculture, sanitation and water management plants, mining projects, and projects for land use, etc.;
  - (6) Formulation of code of guideline for control and mitigation of environmental pollution, and preservation and development of the environment;
  - (7) Determination of degree of emission and discharge of waste from any source;
  - (8) Determination of degree of emission and discharge of waste from any source;
  - (9) Determination of the procedure and terms of reference for ascertaining, evaluating, and approving of environmental affect of various projects or their activities;
  - (10) Formulation of a process for preservation of environmental and ecological resources;
  - (11) Formulation of regulations for giving approval of outlets for urban drainage including all forms of emissions, ejections, or outflows; and

(12) Any other issue related to the environment.

4. Determination of critical areas from an ecological perspective

- (1) If the ecosystem of an area becomes critical or is feared to become critical due to erosion or the environment, the government can declare the areas as ecologically critical through gazette notification in order to mitigate such environmental erosion;
- (2) Any activity which creates or may create a negative impact on mitigating environmental erosion cannot be continued or initiated in the critical area as designated under subclause (1).

5. Determination of environmental impact and issuances of environmental permit

- (1) In accordance with subclause 3 (9), a permit must be taken after evaluation of environmental impact of the project or activities.
- (2) Permit may be given with or without conditions as and where applicable or may be rejected after consideration of the report for determination of environmental affects and its assessment report.

6. Authority and functions of the Director General

- (1) For preservation of environment, improvement of environmental levels, and control and mitigation of environmental pollution, the Director General, subject to the provisions of this law, may take all or any of the following programs:
  - (A) Coordination of day to day activities of any authority or organization related to the objectives of this law;
  - (B) Giving directives for preventing any possible accident, for taking safety measures and taking remedial measures in such accidents which may cause erosion and pollution of the environment;
  - (C) Determination of safety measures and giving suggestions and directives to the relevant persons and organizations in use, preservation, transport, import and export of dangerous material or its components;
  - (D) Carrying out investigations and research for information related to the environmental protection, development and pollution and giving similar cooperation to any other authority or organization;
  - (E) Publication and publicizing information related to environmental pollution;
  - (F) Giving suggestions to the government for avoiding those production processes,

goods and materials which may pollute the environment;

- (G) Operation of a program for monitoring standards of drinking water and ascertaining where the standard for drinking water is not being followed;
- (H) Any other issue which the government may think just and necessary for proper implementation of the provisions of this law.

#### 7. Authority for giving directives by the Director General

- (1) Whatever remains in any other existing laws, the Director General, subject to the provisions of this law, can give written orders to any organization or any person for performing his responsibilities under this law;
- (2) Directives given under subclause (1) may include stoppage, banning or control of any factory, initiative or production process.
- (3) Organizations, officials or persons who receive such directives under subclause (1) are obliged to follow those directives;
- (4) Before closing and activities or any factory or process or any development works, the Director General will give a reasonable time and opportunity to relevant organizations for making those activities acceptable to the environment;
- (5) But there is a provision for giving immediate order if there is a risk of disrupting life and environment.

#### 8. Control and prevention of pollution arising out of accidents.

- (1) If pollutants are emitted or likely to be emitted in excess of the determined quantity due to accident or any unexpected act or incident, persons responsible and persons occupying the place of emissions are liable for proper control or mitigation of environmental pollution.
- (2) Immediately after the occurrence of the activity or event mentioned in sub-section 1, or on the possibility of its occurrence the person or the occupant of the premise should notify the Director General with the relevant information;
- (3) The receipt of any information as per sub-section 2 or if it is otherwise apparent to the Director General, then he/she may adopt the necessary preventive measures to control and check environmental pollution, and the person concerned will be compelled to help and cooperated with the Director General according to his/her demands;
- (4) Any expenditure incurred for adopting preventive measures under this sub-

section in order to control or check environmental pollution will be due to the government from the person or persons mentioned in sub-section 1, and will be realized under public demand.

**9. Power of Access**

- (1) According to the rules of this sub-section, any official empowered or specially empowered for this purpose is entitled, at all reasonable times, with such cooperation as he/she deems necessary, to enter any building or premise for the following purposes:
  - (A) To perform the duties entrusted to him/her under this law or the rules under this law;
  - (B) To inspect said building or any activity on the premise as per this law; or notice, order or instruction formulated as per the rules of this law;
  - (C) To investigate/examine and test any equipment, industrial plant, record, register, documents or any other important thing of relevance;
  - (D) To conduct a search of the building or premises if the said official has any reason to believe that a crime has been committed in any building or premise violating this law or rule or any notice, order or instruction served under this law;
  - (E) To seize any equipment, industrial plant, record, register, document or anything else which may be used as evidence of a crime punishable under this law or rule;
- (2) Any person directing industrial activities or processes or using dangerous substances will be compelled to provide all assistance and cooperation to the official empowered by the Director General to perform the tasks entrusted by this law;
- (3) The Code of Criminal Procedure, 1898 (Act V of 1898) will be followed in relation to all searches and seizure.

**10. Power of Sample Collection, etc.**

- (1) Any official empowered by the Director General of this purpose may collect samples of air, water, soil and any other substance for the purpose of analysis from any factory, premise or place according to the process specified by the rules.
- (2) If the rules of sub-sections (3) and (4) are not observed then analysis results of samples collected under sub-section (1) will not be acceptable as evidence

in legal proceedings.

- (3) Subject to sub-section (4), the official collecting samples under sub-section (1)
  - (A) Will serve a notice as per the procedures of the rules to the occupant or agent of the place regarding his purpose for collecting such samples;
  - (B) Will collect samples in the presence of the occupant or agent;
  - (C) Will place the sample in a container and mark it with the said occupant's or agent's signature and seal it with wax;
  - (D) Will prepare a report of the sample collected and sign it and require the occupant or the agent to sign it;
  - (E) Will send the said container immediately to the specified laboratory.
- (4) Where samples are collected under sub-section (1), and the collecting official services notice as per sub-section (3)(A), and the occupant or agent deliberately remains absent during sample collection, or refuses to sign the sample and the report despite being present, the collector will mark it by signing it himself and will seal it with wax; and the official will cite the absence of the occupant or agent or their refusal to sign, and send it immediately to the laboratory for analysis;
- (5) The said sample will be analyzed in the laboratory of the Directorate of Environment or any laboratory specified by government notification.

#### 11. Prevention and Eradication of Pollution, etc.

- (1) The Director General or any empowered official of the Directorate, any, for the purpose of controlling pollution, order any person or commercial or industrial organization to build, change, expand or replace the wastage disposal system;
- (2) As per the order under sub-section (1), the said person or commercial or industrial organization will be compelled to provide all information relating to wastage, sewerage system or wastage refinery in any area under their control within the specified time.
- (3) As per the order under sub-section (1) any person or commercial or industrial organization will be compelled to allow the said official to enter, inspect and examine any area under his/her control or that of the organization and to provide all reasonable facilities in performing the duties required of him/her.
- (4) The Director General or any empowered official may, after examination as to whether a person is driving a vehicle injurious to health or harmful for the

environment, instruct the said person to rectify if within a specified time. Such a vehicle may not be used again with rectification.

12. Assessment and Mitigation of Loss to the Ecosystem. If any activity appears to the government to be directly or indirectly damaging to the ecosystem, the government may instruct the person or organization responsible to adopt rectifying measures after assessing the extent of such damage and the concerned person or organization will be bound to comply with the order.

13. Application to the Director General about Environmental Pollution or Degradation

(1) Any person or organization suffering a loss due to environmental pollution or degradation or apprehensive about the possibility of damage due to pollution or degradation then he/she may make an application to the Director General in the form specified, for taking preventive measures against such pollution or degradation. However, if such a specified organization was established under the permission of a proper government authority, or if the subject of the complaint is within the control of a similar government authority, then a direct application has to be made to the relevant authority for the settlement of such complaints, and the relevant authority may take advice from the appropriate Directorate if he/she deems it necessary.

(2) After considering the application received under sub-section (1) the Director General will resolve it and will apprise the applicant of the settlement.

(3) The Director General or any empowered official, not below the post of a director, may if necessary, arrange a mass-hearing to resolve the application received.

14. Appeals.

(1) Any person aggrieved by an notice, order or instruction as per this law or rule may appeal to the government against said notice, order or instruction within thirty days of its receipt.

(2) The government will create one or more appropriate Appeal Authorities consisting of one or more persons. The government may if necessary, including experts in the Appeal Authority. Such an Appeal Authority will be notified through government order.

(3) Sub-section (1) will specify, for each Appeal trial, the particular procedures to be followed for being present before an Appeal Authority and the principles to be followed by the Appeal Authority.

(4) After the acceptance of any appeal presented as per sub-section (1) the Appeal

Authority will allow the Appellant and the Directorate of the Environment to have their say and will settle the appeal within a period not exceeding three months.

15. Punishment, etc. under the rules of this Law.

- (1) If any person violates the provisions of this law or rule or fails to perform the tasks according to any notice served or fails to fulfill any order or instruction as per this law or rule then he/she will be liable under such violation and such a violation or failure will be held as a punishable offence. The following penalties will be imposed for such violations and failures:
  - (A) No more than five years imprisonment or a fine of any sum within take five lakh or both for offenses punishable under rules relating to the use, transport, control, restriction and prohibition of dangerous substances in the specified area;
  - (B) No more than five years imprisonment of a fine of any sum up to taka fifty thousand or both for offenses punishable under rules relating to the establishment of industrial plants, restriction and prohibition on production processes and activities related to the use of substances in a specified area;
  - (C) No more than five years imprisonment or a fine of any sum within taka one lakh or both for the offence of failing to comply with or violating orders as per sub-section (7).
  - (D) No more than five years imprisonment or a fine of any sum within taka one lakh or both for the offence of failing to comply with or violating orders as per sub-section (11).
  - (E) No more than one years imprisonment or a fine of any sum within taka fifty thousand or both for the offence of failing to perform the tasks according to the notice served or failure to fulfill the orders and instructions or violation of rules formulated under sub-sections (3) and (11);
  - (F) A fine of any sum with taka one lakh for offenses under sub-section (12);
  - (G) Six months imprisonment for every ten thousand taka fine or a part of it unrealized under sub-section (1)(A) to (1)(F);
  - (H) The penalty described in sub-section (1)(A) will be applicable for any offenses committed by violating the rules of this law and those of any sub-section not mentioned above.
- (i) A person committing the same offense or any other offenses under this rule, deliberately and repeatedly, will be penalized doubly or accordingly.

- (2) A case can be filed in a first class magistrate court or session court against the concerned person or organization, on the basis of a specific, written complaint based on an Appeal judgement after the Appeal hearing for matters relating to appeal as per sub-section (14). The Director General or any official empowered by him or her may file a case or suit on behalf of the government. However, the condition holds that if the aggrieved person or organization does not appeal to the government within the stipulated time, or if the matter is not within the jurisdiction of the Appeal Authority, a similar case may be filed against the said person or organization or in a case of similar matters.
- (3) The organization described in this sub-section will refer to a holding company established as per company law, statutory government or autonomous corporations, commercial or industrial organizations, societies or associations.

16. Relations of Fees, etc:

The Director General may collect fees at specified rates from the person or organization receiving special services such as clearance, sale of specified forms and sample test, etc.

17. Enlistment.

All development activities relating to pollution and degradation and industries notified by Gazette as likely to cause pollution should be enlisted in the Directorate after filling out a specified pro-forma.

18. Relating to Wastage Management.

- (1) No wastage may be imported into Bangladesh without prior permission from the government.
- (2) The government will determine the definition, type, use, transport, and disposal process of harmful wastage by formulating rules under this law, through Gazette notification.

19. Actions in good Faith

- (1) Any person suffering a loss or apprehensive about the possibility of a loss due to any action done in good faith as per this law or the rules formulated under this law may not file any cases in civil courts or criminal courts nor take any legal actions against the government, the Director General, any officials or employees of the Directorate.

20. Entrusting Power.

- (1) The government may hand over power from the Director General to any other

official of the Directorate through government Gazette notification as per this law or rules formulated under this law.

**21. Power of Formulating Rules.**

- (1) The Government may formulate rules to fulfill the objectives of this law through government Gazette notification.

**22. Repeal and Preservation.**

- (1) The Environment Pollution Control Ordinance, 1977 (Act XIII of 1977) is hereby repealed.
- (2) Despite such repeal, actions committed or measures adopted under the repealed ordinance will be regarded as being committed under this law, whatever it may contain.

## APPENDIX B

### BIBLIOGRAPHY

- 57 Federal Register 4413-48, February 5, 1992.
- 58 Federal Register 11110, February 23, 1993.
- Anderson, Frederick R., Allen V. Kneese, Phillip D. Reed, Serge Taylor, and Russel B. Stevenson. 1977. *Environmental Improvement Through Economic Incentives*. Baltimore, Maryland: The Johns Hopkins University Press.
- Atkinson, Scott, and Tom Tietenberg. 1991. "Market Failure in Incentive-Based Regulation: The Case of Emission Trading." *Journal of Environmental Economics and Management*. 21:17-32.
- Baldwin, Malcolm Forbes. October 1989. *An Assessment of Governmental Laws and Institutions Affecting Natural Resource Management in Bangladesh: Revised Draft*. An Annex of the Bangladesh Environment and Natural Resources Assessment.
- BKH Consulting Engineers. September 1994 *Industrial Pollution Control Management, Bangladesh: Interim Report Phase I*. Report produced for the Government of the People's Republic of Bangladesh Department of Environment/Ministry of Industries and the Asian Development Bank.
- Downing, Paul, and L. White. 1986. "Innovation in Pollution Control." *Journal of Environmental Economics and Management*. 13:18-27.
- Dudek, Daniel and John Palmisano. 1988. "Emissions Trading: Why is This Thoroughbred Hobbled?" *Columbia Journal of Environmental Law*. 13:18-27.
- Environmental Research & Development Agency Limited, November 30, 1993. *Export Prospects for Leather and Leather Products: Industrialization Strategy Study of Bangladesh Paper No. 12*. Study completed for The World Bank Resident Mission in Paribagh, Dhaka.
- Gibboris, Diana C. *The Economic Value of Water*. 1987. Baltimore, Maryland: The Johns Hopkins University Press.
- Government of the People's Republic of Bangladesh. July 1991. Environmental Quality Standards for Bangladesh.
- Government of the People's Republic of Bangladesh, Ministry of Environment and Forestry. October 1991. *Bangladesh Country Report for United Nations Conference on Environment & Development (UNCED) Brazil, 1992*.

- Government of the People's Republic of Bangladesh. 1993. Bill for Protection of the Environment, Development of Environmental Quality and Control and Neutralization of Environmental Pollution.
- Hahn, Robert and Robert Stavens. 1991. "Incentive-based Environmental Regulation: A New Era from an Old Idea?" *Ecology Law Quarterly*, Vol. 18, No. 1, pp 1-42.
- Kohli, Kedar N. 1993. *Economic Analysis of Investment Projects: A Practical Approach*. Hong Kong: Oxford University Press.
- Milliman, S., and R. Prince. 1989. "Firm Incentives to Promote Technological Change in Pollution Control." *Journal of Environmental Economics and Management*. 17:247-65
- Motaleb, Abdul. May 1993. *Groundwater Contamination by Industrial Wastes: A Case Study In Dhaka City, Bangladesh*. Unpublished Masters Thesis, Delft.
- Oates, Wallace E., Paul R. Portney, and Albert M. McGartland. 1989. "The Net Benefits of Incentive-Based Regulation: A Case Study of Environmental Standard Setting." *American Economic Review*, 75:1223-1242.
- Pearce, David W., and R. Kerry Turner. 1990. *Economics of Natural Resources and the Environment*. Baltimore, Maryland: The Johns Hopkins University Press.
- Shapiro, Michael, and Ellen Warhit. 1983. "Marketable Permits: The Case of Chlorofluorocarbons." *Natural Resources Journal*. 23:577-591.
- U.S. Environmental Protection Agency. July 1992. *The United States Experience with Economic Incentives To Control Environmental Pollution*. EPA-230-R-92-001. Page 3-3.
- U.S. General Accounting Office. February 1993. *Implications of Using Pollution Taxes to Supplement Regulation*. GAO/RCED-93-13.
- Winpenny, James. 1994. *Managing Water as an Economic Resource*. New York: Routledge.

## APPENDIX C

### ITINERARY

September 21	Depart for London, England
September 22	Arrive London, England Depart for Dhaka, Bangladesh
September 23	Arrive Dhaka, Bangladesh
September 24	Meet with Craig Anderson (U.S. AID) at Sheraton Hotel Meet with officials from the Dhaka Business Advisory Center and Leather Tanning-Entrepreneurs. Visit the Sarwar Leather Tanning Company.
September 25	Travel to U.S. Aid to meet with Craig Anderson. Visit to Reliance Tannery Ltd. Visit to Pragati Leather Complex
September 26	Visit Mr. Adbus Sobhan, Deputy Director, Bangladesh Department of Environmental.
September 27	Work in hotel.
September 28	Hartel, unable to leave hotel, cancelled all appointments.
September 29	Revisit Sarwar Leather Tanning Company Revisit Pragati Leather Complex Tour Hazaribagh area, embankment, and potential location for centralized treatment facility with Mr. Sobhan
September 30	Off
October 1	Work in Hotel.
October 2	Work in Hotel.
October 3	Visit Dhaka City Hide and Skins Ltd. Visit Bay Leather Company.
October 4	Visit Apex Tanning Ltd.
October 5	Debriefing at U.S. AID with Craig Anderson.

October 6 Meet with Mr. Audus Sobhan, Deputy Director, Bangladesh  
Department of Environment.  
Debriefing at Dhaka Business Advisory Center.

October 7 Off

October 8 Travel to Hong Kong

October 9 Hong Kong

October 10 Hong Kong

October 11 Depart for Washington, D.C.

## APPENDIX D

### PERSONS AND ORGANIZATIONS VISITED

Dr. Craig Anderson  
Mission Environmental Officer  
U.S. AID Mission to Bangladesh  
American Embassy  
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Dr. P.K. Barua  
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Business Advisory Services Center  
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Project Director  
Business Advisory Services Center  
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Managing Director  
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Mr. Md. Shaheen  
Leather Technician  
Reliance Tannery Ltd.  
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Mr. A.M. Khorshed Alam  
Leather Technologist  
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Mr. Abdul Sobhan  
Deputy Director  
Bangladesh Department of Environment  
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Dhanmondi, Dhaka, Bangladesh

Mr. M.A. Majed  
Executive Director (Works)  
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127 Hazaribagh Tannery Area  
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**APPENDIX E**  
**BUSINESS CARDS OF PERSONS CONTACTED**



Md. Shaheen.

~~XXXXXXXXXXXXXXXXXXXX~~  
Leather Tech.

**Karam Ali Ahmed Ph.D**  
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## APPENDIX F

### LIST OF DOCUMENTS RECEIVED

Baldwin, Malcolm Forbes. October 1989. *An Assessment of Governmental Laws and Institutions Affecting Natural Resource Management in Bangladesh: Revised Draft*. An Annex of the Bangladesh Environment and Natural Resources Assessment.

BKH Consulting Engineers. September 1994 *Industrial Pollution Control Management, Bangladesh: Interim Report Phase I*. Report produced for the Government of the People's Republic of Bangladesh Department of Environment/Ministry of Industries and the Asian Development Bank.

Environmental Research & Development Agency Limited, November 30, 1993. *Export Prospects for Leather and Leather Products: Industrialization Strategy Study of Bangladesh Paper No. 12*. Study completed for The World Bank Resident Mission in Paribagh, Dhaka.

Fallon, Louise. 1989. *A Conceptual Framework for Sustainable Development: An Analysis of Economic and Policy Factors Affecting Natural Resources Management in Bangladesh: Revised Draft*. An Annex of the Bangladesh Environment and Natural Resources Assessment.

Government of the People's Republic of Bangladesh. 1993. Bill for Protection of the Environment, Development of Environmental Quality and Control and Neutralization of Environmental Pollution.

Motaleb, Abdul. May 1993. *Groundwater Contamination by Industrial Wastes: A Case Study In Dhaka City, Bangladesh*. Unpublished Masters Thesis, Delft.

## APPENDIX G

### CURRICULUM VITAE

MARK C. PFEFFERLE

#### EDUCATION

Duke University: M.E.M., Economics and Policy, Duke University, 1988.

Simon Fraser University: B.A., Political Science, 1984.

Yale University: Course work in: Political Science, Economics, Environmental Science, and Chemical Engineering, 1985.

#### SUMMARY OF EXPERIENCE

Mr. Pfefferle is an economist and policy analyst, with eight years of experience, specializing in environmental finance and cost-benefit and cost-effectiveness analyses.

#### EMPLOYMENT HISTORY

July 1990 to present: Science Applications International Corporation (SAIC)

- Completed an assessment of the economic and financial opportunities for American firms to export clean technologies (pollution prevention technologies) to Egypt, Jordan, Morocco, and Tunisia for the U.S. Agency for International Development's (AID) Near East Bureau. The study focused on the pulp and paper industry, electroplaters, plastic manufacturers, and leather manufacturers. This study was done to assist the Near East Bureau in preparing a Clean Technology Project Paper.
- Projected water quality and quantity and solid waste management "needs" within the State of Washington. This included analyzing survey results, verification of data, extrapolating "needs" on a per county and per capita basis, and writing the final report. The report *Washington Department of Ecology Needs Assessment Study: Report on Needs Assessment Survey Data Analysis* was presented to the State legislative assembly in February 1993.
- Developed financing schemes and scenarios to maximize the limited funds available for environmental programs within Washington State. The financing schemes compared the present value of funds available under a bond issue, a pay-as-you-go program, and a State-Revolving Fund (SRF). Each scheme was assessed with various interest rates and repayment schedules. The results were submitted to the State legislative assembly in February 1993.
- In cooperation of U.S. Environmental Protection Agency's Chesapeake Bay Program Office and the Pennsylvania Department of Environmental Resources

(PADER), Mr. Pfefferle is currently assessing PADER's agricultural cost-sharing program from a total quality management (TQM) perspective. Problems have arisen in that the disbursement of funds to farmers and contractors has not been timely. Mr. Pfefferle identified the location and cause of the delays and provided recommendations on how to expedite the processing of funding requests.

- Conducted an analysis of the economic incentives and disincentives for farmers to voluntarily adopt best management practices (BMPs) for nonpoint source pollution control in the Chesapeake Bay Basin. The study analyzed current cost-sharing programs, the cost of implementing BMPs, and economic restrictions that impede farmer adoption of nutrient management systems. This work was completed for the Nonpoint Source Pollution Panel of the Chesapeake Bay Committee.
- Reviewing, assessing, and responding to public comments on the economic costs and environmental benefits, submitted in response to EPA's publication of the Great Lakes Water Quality Initiative in the *Federal Register*. Mr. Pfefferle is augmenting the economic cost analysis, that was completed prior to publication in the *Federal Register*. The changes to the cost analysis are being made in response to additional cost information and in changes to the proposed regulatory options.
- Completed the *Economic Impact Analysis of the Codification of the OECD Decision Covering Transfrontier Shipments of Hazardous Waste Destined for Recovery*. The purpose of the economic impact analysis (EIA) was to estimate the economic costs and benefits that would result from the codification of the OECD Decision on the transfrontier shipment of hazardous wastes.
- Completed a study of natural resource valuation methods used by twenty-one western States to determine the methodologies used for water resource damage assessment. The methods assessed damages from reduced recreational opportunities, fish kills, reductions in recreational fishing trips and commercial fish catches, and aesthetics.
- Performed an economic achievability (EA) analysis of the U.S. Vanadium Corporation in Hot Springs, Arkansas. In conducting an EA, a firm-level test is performed using publicly available data to test the economic feasibility and achievability of proposed pollution control technologies. The test results indicate the financial impact of compliance costs on the firm. The next step is to conduct financial tests using confidential and plant specific financial statements. The two-step analysis indicates the level of compliance that is economically achievable by both the firm and the plant. The proposed control technologies are considered economically feasible if the firm remains financial viable after complying with the pollution control requirements. The results of the EA analysis were presented at a public forum in Little Rock, Arkansas.

- Assessed the potential cost savings to the carbamate industry if the industry were to increase pollution prevention activities. The main source of information for this study was RCRA §3007 survey reports which provided EPA with confidential business information, from the carbamate industry, for unit production costs, disposal costs, and sales prices. From this source of information, as well as others, a lost opportunity cost to the carbamate industry was calculated.
- Assisted in estimating the costs of alternative management practices and regulatory scenarios for large volume coal combustion wastes. The work was completed for EPA's Office of Solid Waste. The cost estimates developed in this task provided technical background to support EPA's regulatory determination as to whether or not the large volume coal

#### **August 1988 to May 1990: Apogee Research**

- Performed a cost-benefit analysis on the viability of child safety seats on all airplanes. The Federal Aviation Administration has proposed the mandatory use of child safety seats for all children 3 years and younger on all general aviation, commuter and domestic flights. The analysis included a detailed review of infant fatalities on all airline flights since 1978; an estimation on the number of families diverting vacation plans from airline to automobile travel and the economic effect of this diversion; and the effect on the airline industry and supporting businesses. A total societal cost was determined from implementing the proposed rule.
- Conducted a preliminary cost-benefit analysis on the creation of a limited access toll road from Niagara Falls, New York to West Virginia. The new toll road would run in the approximately the same location as the current U.S. Route 214. Some of the factors taken into consideration include increased commercial truck traffic from better transportation routes, increased trade between Canada and the United States resulting from the Free Trade Agreement, and the benefit of greater access to Central Pennsylvania for manufacturing and recreational opportunities.
- Assisted in three financing studies for the Narragansett Bay Project. The first was an examination of the financial alternatives available to fund the upgrading of wastewater treatment facilities in Cranston, Warwick, and West Warwick, Rhode Island. In a second study, Mr. Pfefferle assisted in developing a guide for a storm water management utility in the Narrow River Watershed. The third study was a beneficiary-based financing study for soil erosion and storm water management regulations.
- For the Buzzards Bay Project, Mr. Pfefferle prepared cost estimates for a number of storm water pollution control measures. Included were estimates of capital and maintenance costs for dry detention ponds, wet ponds, infiltration trenches, infiltration basins, porous pavement, and grassy swales. The

estimates were developed to assist the Buzzards Bay Project in developing cost-effective means for controlling and preventing further degradation of Buzzards Bay, Massachusetts.

- Assisted in developing a storm water management financial guidebook for the Puget Sound Water Quality Authority. In this project, Mr. Pfefferle collected background information on storm water utilities in Snohomish County, Washington and Everett, Washington.

**May 1987 to May 1988: North Carolina Department of Natural Resources and Community Development**

- Developed a model to determine the economically efficient level of loss-prevention for structures along the North Carolina ocean front. The model determines the socially optimal expenditure level for protecting ocean front structures from coastal erosion and storms. The model considers only structural relocation and beach nourishment. In creating the model, Mr. Pfefferle followed the regulations which govern all coastal developments in North Carolina. The paper, "An Economic Analysis of Loss-Prevention on the North Carolina Ocean Front High Hazard Zone" was presented as his Masters thesis at Duke University.