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EVALUATION OF WASTE MINIMIZATION OPPORTUNITIES AT FIVE INDUSTRIAL FACILITIES IN THE MORATUWA-RATMALANA REGION OF SRI LANKA

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WEC

WORLD ENVIRONMENT CENTER

DISCLAIMER

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I. EXECUTIVE SUMMARY

On February 18 - March 4, 1995, Mr. Donald L. Brosky, of the 3M Company (hereafter referred to as the WEC Industrial Expert) traveled to Colombo, Sri Lanka to evaluate waste minimization opportunities in the Moratuwa-Ratmalana region. The purpose of the visit was to recommend candidate industrial facilities for waste minimization projects. Funding for waste minimization projects at the recommended candidate facilities may be available through a donor loan program. While in Sri Lanka, the WEC Industrial Expert evaluated manufacturing facilities in five industrial sectors. candy, batteries, electric cable, plastics, and paint.

Only two of the facilities visited were found to have significant waste minimization opportunities. These are the candy factory and the battery factory. For the candy factory, three waste minimization opportunities were identified: 1) minimizing waste from defective batches; 2) segregating washwater rinses for reuse; and 3) optimizing cooling water reuse. The following three waste minimization opportunities were identified for the battery factory: 1) eliminating use of Teepol foam as a vapor suppressant; 2) recycling scrap battery casings; and 3) recycling furnace slag. One recommendation identified for each facility was found to have a quality benefit in addition to an environmental benefit.

In addition to these specific waste minimization opportunities, the WEC Industrial Expert identified four generally applicable concepts for minimizing industrial wastes in the Moratuwa-Ratmalana region. These are: 1) establishing a system using septic tanks and low pressure force mains to convey wastewater to a future treatment plant; 2) establishing mini-treatment cooperatives to encourage adjacent industries to enact multimedia pollution prevention solutions; 3) utilization of membrane processes to separate wastes from water and allow their reuse; and 4) developing composting systems to perform natural breakdown of wastes to useful products.

Funding for this project was provided through a Cooperative Agreement between the World Environment Center and the United States - Asia Environmental Partnership (US-AEP), United States Agency for International Development (USAID). While in Sri Lanka, support was provided by M. Thiruchelvam, USAID/Sri Lanka, and others. During the second week of the visit, Mr. Burton Hamner, Pollution Prevention Manager, Shapiro & Associates, joined Mr. Brosky on several plant visits. Mr. Hamner served as the WEC Institutional Expert on the project.

II. INTRODUCTION

On February 18 - March 4, 1995, Mr. Donald L. Brosky, of the 3M Company (hereafter referred to as the WEC Industrial Expert) traveled to Colombo, Sri Lanka to evaluate waste minimization opportunities in the Moratuwa-Ratmalana region. The purpose of the visit was to recommend candidate industrial facilities for waste minimization projects. Funding for waste minimization projects at the recommended candidate facilities may be available through a donor loan program. Originally, the project was to include an evaluation of 20 industrial facilities covering the following categories: paints, adhesives, rubber processing, detergents, and fertilizer formulation plants. Upon arrival in Sri Lanka, however, the WEC Industrial Expert learned that the scope of the project had been narrowed to include only five facilities from the following manufacturing industries: candy, batteries, electric cable, plastics, and paint.

The process of identifying waste minimization opportunities at a facility usually took two days. During the first day, the facility was visited to gain familiarity with the wastes and the processes producing the waste. During the second day, options for integrating the wastes into a waste minimization/pollution prevention program were considered. Although there may be reasons why some of the alternatives considered were impractical, it was the approach of the WEC Industrial Expert to consider approaches from the broadest perspective possible, and then to eliminate those that had little chance of success. The remaining viable options worthy of additional consideration are presented in this report. The WEC Industrial Expert also focused on quality problems at the facilities which involve environmental wastes. Whenever a solution was found that could eliminate a quality defect and reduce or eliminate an environmental discharge, it was deemed preferable. Therefore, recommendations presented in this report that have both a quality benefit and an environmental benefit should be considered first.

This report includes recommended waste minimization alternatives for the facilities visited. It should be noted, however, that only two of the facilities visited were found to have significant waste minimization opportunities. These were the candy factory and the battery factory. In the opinion of the WEC Industrial Expert, all of the recommended waste minimization alternatives are viable, and their consideration might lead to additional alternatives. In particular, recommendations associated with water conservation and reuse will lead to less sewage flow and less total pollution to the environment. The report also presents recommendations for universally applicable waste minimization concepts.

III. DISCUSSION AND FINDINGS

This section presents detailed information on each facility visited, including a summary of discussions held and significant findings.

A. Uswatta Confectionery Plant - February 22, 1995

The Uswatta Confectionery Plant (Uswatta), located at 437 Galle Road in Kandawalla, is an industrial factory that makes candy products. The WEC Industrial Expert and the local USAID representative met with Mr. A.E. Clian Fernando, Production Manager of Uswatta.
Following an initial briefing by the WEC Industrial Expert on the 3M Pollution Prevention Program in the U.S., Mr. Fernando led the WEC Industrial Expert on a tour of the facility.

1. Process Description/Update to CIDA Consultants Audit Report

The following process information was obtained by the WEC Industrial Expert for the purpose of updating the previously published CIDA Consultants audit report on the Uswatta facility. The information presented below is organized according to sections found in the CIDA Consultants report :

Background Information

- The CIDA Consultants audit report stated that there are no tube wells at the site. In fact, a tube well was observed on the north side of the boiler house. This well consisted of two pumps on a shelf with approximately 3 meters of suction head pipe. The suction lines were about 3 centimeters in diameter.

- Approximately 25 percent of the total of well water usage (20,000 cubic meters per day) is heated to 80 to 90 °C. A fraction of the drinking water at the site is also heated.

- The dug well is located behind a locked door on the east side of the boiler. (The WEC Industrial Expert did not actually see this well.)

- Uswatta has renewed their sewer license.

- The facility sketch in the CIDA Consultants audit report contains some errors, particularly with respect to the facility's location in relationship to Galle Road.

Raw Materials Stored On Site

- In contrast to information presented in the CIDA Consultants report, plant representatives reported that about 20,000 Rupees per year are spent on chemicals to soften the well water.

Process Description

- The WEC Industrial Expert requested an opportunity to observe one of the washwater sequences. However, because this operation occurs later in the day at about 6:30 p.m., it was not possible for him to observe it.

- The WEC Industrial Expert inquired about whether any process equipment existed that was either underutilized or not utilized at all. Examples of such equipment might be old tanks or piping that have been taken out of service. It may be possible to use such existing and available equipment which is already paid for as part of a permanent waste minimization solution at reduced cost. Plant representatives indicated that the "Old Ice Cream Plant" equipment was being put out for bid and was not available. However, they also reported that one of the candy making lines used for candy and toffee is currently used only two days a week because of a drop in product demand.

- The location of the three surface trench drains was observed by the WEC Industrial Expert. The southernmost trench drain has a building over it that is not shown in the CIDA Consultants audit report sketch. Periodic cleaning is necessary to keep this trench open. A second trench located along the property line on the east side of Galle Road was observed to be blocked by debris. The WEC Industrial Expert noted that blockage of the trench drains would hinder stormwater drainage during rainfall events and result in back-up of the drainage system. Plant representatives reported that rain causes flooding of the factory building to a level of approximately 15 centimeters about once every year.

- Vehicle washing accounts for a minuscule amount of water use at the facility.

- Floor sweepings/washings that could contain sugar and flour enter the open trench drains.

- The use of piping for conveying product is limited to two operations involving a dough line and a candy center application. In these instances, raw materials are mixed in kettles and transferred to a second step where

the material is dispensed through a 2 meter piece of piping. The piping is removed at the end of the shift and cleaned by hand.

Current Waste Management Practices

- Rejects, including spoiled raw materials and defective product batches, are disposed of as trash. In particular, approximately once per month, the facility experiences a problem where a sugar solution which has been heated to drive off the water gets too hot. The sugar then crystallizes and forms a "rock like" waste which is disposed of with the trash. All trash from the facility is hauled to a site approximately 10 kilometers south of the facility where it is either landfilled or spread.

Waste Minimization Opportunities

- There are five cooling water systems at the site. This water is reused approximately twice before it is discharged to the sewer.

- Washwater use occurs during a 30-minute period at the end of the shift. "Rinsing" is performed with the same softened water that is used to initiate the cleanup.

- The boiler burns No. 2 fuel oil and produces steam and hot water for use primarily as washwater. The boiler generates steam at 140 pounds per square inch (psi) which is used for steam jacket process heating. The cost of the fuel oil is 6.85 Rupees per liter.

- There is a Singer Plant immediately to the north of the facility.

2. Discussion of Waste Minimization Opportunities

The WEC Industrial Expert held the following discussions with plant representatives about waste minimization opportunities at the facility.

Recycle of Cooling Water

A discussion was held regarding the possibility of increasing the recycling of cooling water over current levels. Plant representatives requested advice in this area and provided the WEC Industrial Expert with reports on the cooling water analysis and the softened water analysis.

The WEC Industrial Expert described a process where an experiment is performed to determine the "natural" scale formation point of the cooling water. The concept

involves reducing the makeup until scale formation was evident on one of the units. This would provide an indication of the maximum reuse that the water supply can tolerate before scaling. The WEC Industrial Expert suggested that assistance for this experiment could likely be obtained from a university or consultant.

In addition, the WEC Industrial Expert and plant representatives discussed: 1) the addition of circulating cooling water chemicals that inhibit scale formation, and 2) the possibility of letting the scale form to a point where it is beginning to reduce the heat exchanging capacity of the cooling system and then using the aggressive scale removal chemicals to eliminate the scale. Both of these methods would allow even further recycling of the cooling water beyond the "natural" limits mentioned previously. It was pointed out by the WEC Industrial Expert that these aggressive chemicals are usually hazardous and some of the scale inhibitors can cause harm to the environment.

Disposal of Defective and Non-Saleable Materials

Another item of discussion was options for minimizing wastes from defective and non-saleable items (i.e., QC samples). The WEC Industrial Expert suggested that plant representatives consider composting of the solid waste that has a natural origin. The resulting residue would be reduced by a factor of 10 and would make an excellent soil or planting conditioner.

3. Additional Waste Minimization Recommendations

Following the facility visit, the WEC Industrial Expert provided the following additional waste minimization recommendations.

Recycle of Washwater

Process washwater used for the final rinse step has a hardness of 5 and a temperature of 80 °C. Instead of discharging this rinse water to the sewer, the facility should consider ways to reuse this clean washwater with a high energy content. For example, this washwater could be pumped to the cooling water sump at the end of the shift, where it would replace cooing water with a hardness of 78. Some of the benefits of this approach would be:

- Reusing washwater would reduce the amount of wastewater generated.
- Circulating the 80 °C washwater in the cooling water piping/heat exchanger would aid in disinfection prior to cooldown, cleaning and suppressing biological growth and likely improving the heat transfer.
- The recyclability of the washwater portion of the cooling water would be increased by approximately the ratio of 78 to 5.

- Cooldown of the washwater would be accomplished prior to the start of the next shift.

If Uswatta has no use for the washwater after the final rinse, it should inquire whether the nearby Singer facility has a use for it. Diverting this washwater to another facility would require installation of a diversion system including piping, pumps, and controls. A sketch of a possible diversion system is presented in Figure 1.

Alternatively, Uswatta could pump this washwater to an insulated tank on a truck where it could be transported for sale to other industries in the area. These industries may have a use for 80 °C water to flush out piping systems, wash down spills, clean surfaces prior to painting, or sanitize washrooms. This could provide an additional source of revenue to Uswatta.

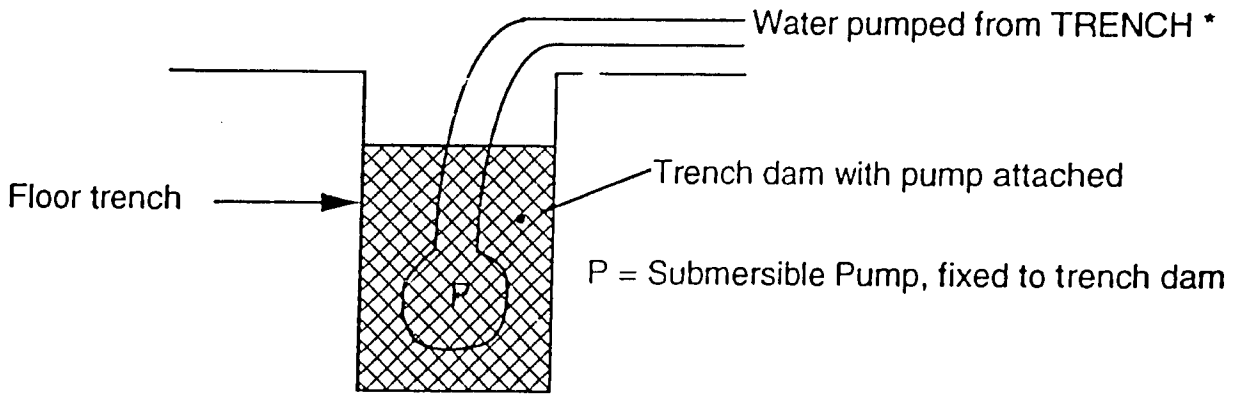
In general, the WEC Industrial Expert believes that all the washwater (after the first flush) would probably be reusable as cooling water. It might even be feasible to reuse this washwater for the initial cleaning step in the next process washing. If it could be diverted to an insulated tank, it would require less energy to reheat this recycled washwater for reuse than to heat fresh well water.

Minimizing Wastes from Defective Batches

As described previously, the facility experiences a problem periodically where the sugar in a candy batch crystallizes forming a "rock like" waste. This waste is disposed of as trash. If the process that causes the crystallization of the defective batches does not destroy the palatability of the crystallized material, then it may be possible to sell it, or donate it to a children's charity. It would probably be necessary to crush it and package it into smaller portions, but the value derived might be worth the expense of these operations.

Based on experience in observing candy making at home, the WEC Industrial Expert also noted that care is taken to ensure that sugar crystals are not allowed to remain on the side of the pot above the evaporating sugar solution. Candy recipes call for the sugar solution to be boiled down to the point of supersaturation. This means that the remaining liquid is very easily turned into a solid. One tiny speck of sugar crystal that falls into the supersaturated liquid will initiate the crystallization and solidify the whole batch. This initiating crystal could fall into the batch from the air as well. The WEC Industrial Expert suggests that the number of defect crystallizations possibly could be reduced by making certain that sugar specks do not fall into the supersaturated solution from the sides of the evaporating kettle, or the air above it.

CANDY FACTORY TRENCH



TRENCH SECTION

Trench Dam & Pump assembly are portable and can be placed and removed quickly by hand.

* Water may be hot or cold, destination can vary according to need (flexible discharge).

Figure 1

There is also a problem with crystallization when the temperature of the evaporating solution gets too high. If the temperature controller is not precise, this may be the cause of the defective batches.

B. Associated Battery Manufacturers (Ceylon) Ltd. - February 23 and February 27, 1995

The Associated Battery Manufacturers (Ceylon) Ltd. is located at 31 Katukarunduwatte Road. The WEC Industrial Expert and a local USAID representative met with Mr. R.M.D. Bandara, Production Manager. On February 23, the WEC Industrial Expert gave an introductory briefing on the 3M Pollution Prevention Program and held initial discussions about waste minimization opportunities. On February 27, the WEC Industrial Expert returned to the facility for a tour and additional discussions.

1. Process Description

Below is a description of the process operations observed by the WEC Industrial Expert during his visit to the facility.

Battery Plate Casting and Preparation

In this operation, lead grid batter plates are cast into various sizes for use in batteries. Fuel for the casting operation is butane gas. Wastes include air emissions, which are ducted through the roof, and the dross produced as a residue. The dross is recycled to a "furnace" (i.e., smelter). The plates are cast from lead recycled from this furnace.

The plates are next sent to a station where a paste of lead oxide powder, water, and sulfuric acid is pressed into the openings (about 1 x 2 centimeters) in the grid plate. The grid plates are passed through an oven which dries the paste mixture to a solid. The waste generated in this step is a solid residue of paste that settles in tubs of water. This waste is also recycled to the furnace. The lead powder used in this step is ground from ingots imported from Australia.

Electrolytic Charging

The plates next undergo charging in electrolytic cells. In this operation, sulfuric acid solution and the plates are arranged in a metal framework which imparts either a positive charge or a negative charge to the plate when the appropriate direct current is applied. The present operation includes a layer of foam on the surface of each cell generated from Teepol Detergent. It appeared to be about 3 centimeters thick. The foam suppresses vapors coming off the cells out of the solution. When the specific

gravity of the cell liquid exceeds 1.01, liquid is removed and replaced with fresh water. (About 10 percent of the cell liquid is replaced daily.) The removed "acid liquid," containing dissolved lead, is sent to the neutralization step.

At present, there are 240 cells and the facility has plans to add 40 additional cells. Each cell appeared to be made of fiberglass and contains about 60 liters of solution. The plates remain in the cells for about 24 hours. Most of the fumes are generated at night. The facility is considering building a hood, ductwork and vent fan to collect vapors to reduce operator exposure.

The quality of the plates is improved if the temperature of the electrolytic bath is maintained below 55 °C. Presently, the Teepol foam does not allow heat to escape from the bath during electrolytic conversion and the temperature rises above 60 °C. Replacing the Teepol foam with another material that allows heat transfer may improve the quality of the plates. In addition, eliminating of the Teepol foam might allow the waste acid liquid to be recycled thereby avoiding the need for neutralization.

After the plates are removed from the electrolytic bath they are placed in a rack and taken to a drying oven. This operation prepares the plates for insertion into the battery case.

Battery Case Manufacturing

Battery cases are made on-site by mixing rubber, sulfur and coal dust in a heated "Banbury-type" mixer. The mixture comes out in a sheet which is cut into strips for use in the case molding operation. The hot molded cases are trimmed and checked against a standard. The trimmings are not recyclable and are disposed of as waste. Terminal post pieces, top pieces with holes to reconstitute the liquid, and the battery posts are also cast and/or molded. These are all brought together, assembled, and soldered to connect the internal cell plates. The top is installed and sealed with a torch. Different color caps are placed on the holes of different batteries to identify them.

Storage

Used batteries are stored in an outside area measuring approximately 20 meters by 30 meters. The used battery piles were as high as 2 meters. The WEC Industrial Expert estimated about 6,000 used batteries were stored in this area. Both rubber based and high density polypropylene battery cases (or tops) were observed. The plant accepts these batteries, breaks them up and recycles the lead plates through the furnace. The rubber cases are composed of about 16 percent rubber, 60 percent coal dust and an unknown amount of sulfur.

The facility also has storage tanks for fuel oil, two roof mounted well water storage tanks, and a number of ground-based well water storage tanks.

Lead Ingot Grinding

Lead ingots are ground by machine into powder for the grid plate paste. About 50 percent of the lead used is imported. The grinding machine puts the dust into a baghouse or cyclone. The dust is then collected in 50-liter drums for transport to the paste making operation. The Plant Manager indicated that the facility plans to install a new lead grinder and possibly a new baghouse next year at a cost of 20 million Rupees. The existing system produces a lot of nuisance dust.

Used Battery Breaking

The battery breaking area was observed to be relatively free of acid, suggesting that the acid is removed from the used batteries before they are stored. The polypropylene cases and tops are separated and placed into the back of a truck. The Plant Manager reported that they are transported to a manufacturer who uses them to make clothes hangers and other non-food products. Plates are removed from the used batteries and placed in the adjacent furnace. The furnace is charged with battery scrap, sodium carbonate, sodium chloride, iron fillings, and coconut shell charcoal. It may also have a fuel oil burner. The furnace was not in operation on the day of the WEC Industrial Expert's visit. It was shutdown for cleaning.

Air emissions from the furnace are discharged into a series of "W" shaped ducts which drop solids out in at least six low points before going to a baghouse. The baghouse has four sections, and uses synthetic bags of about 25 centimeter diameter. The temperature tolerance of the bags is 60 °C. The facility has experienced two consecutive circumstances when the bags caught fire. Solids from the low points in the "W" ducting and the baghouse dust are returned to the furnace for lead recovery. The furnace produces lead ingots about 1 meter in length, 30 centimeters thick, and 60 centimeters wide. Similarly sized slag ingots are produced and must be disposed of. About 10 slag ingots, weighing approximately 200 kilograms each, are produced daily.

2. Discussion of Waste Minimization Opportunities

The WEC Industrial Expert and the Plant Manager discussed the following waste minimization opportunities:

- Substituting Teepol foam with another material in the electrolytic cells to allow the waste acid/dissolved lead to be recycled;

- Finding a productive use for the scrap battery casings such as for road construction, as a fuel in cement kilns and other uses;

- Finding a productive use for the slag ingots such as for ceramic pieces, road construction, or cement;

- Identifying a baghouse fabric material with a higher temperature tolerance; and

- Recycling the water from the paste sediment.

In addition, it was discussed that membrane processes like reverse osmosis and ultrafiltration may be useful to separate lead ions/particulate material from recycled water (or acid water). This may be feasible in place of neutralization of certain wastewaters that results in production of waste sludges. Finally, the WEC Industrial Expert mentioned that Hach Chemical produces a small pH monitoring unit for use in determining when neutralization is complete. This was suggested as a better alternative to using "effervescence" as a measure.

3. Additional Waste Minimization Recommendations

The following additional waste minimization recommendations were provided by the WEC Industrial Expert.

Substitute for Teepol Foam

Three alternatives to the use of Teepol Foam to suppress fumes from electrolytic cells were identified.

The first alternative is for the facility to Install a fume hood, ducting, and fan to collect and exhaust fumes generated from the electrolytic cells. This approach may also require a scrubber to capture the fumes into a liquid followed by treatment of the scrubber effluent. Elimination of Teepol foam may allow the recycling of the acid/dissolved lead liquid that results when the specific gravity is lowered to 1.01. This recycling and the Teepol elimination might provide a payback for the total project. An added benefit would be that Teepol Foam removal would allow the electrolytic bath temperature to operate below
55 °C and improve the plate quality. This alternative is considered "foolproof" and will most likely accomplish the environmental objectives and may accomplish the quality objectives as well. It is likely to be costly, however. Therefore, if it is feasible to accomplish the objectives in other less expensive ways, these should be considered.

The second alternative is to install a floating barrier of hollow spheres which will allow access to the plates below but reduce the fume emissions. This approach may provide a direct substitute for the Teepol foam and allow the removed liquid to be recycled. An additional benefit might accrue if the spheres can conduct heat to the surface and reduce the bath temperature to 55 °C or below. This will improve the plate quality. Perhaps small glass, PVC, or polypropylene spheres could be used for this purpose. If the spheres can't reduce the bath temperature sufficiently, perhaps some cooling water sprays directed from a pipe between two of the fiberglass containers could be turned on when the temperature exceeded 55 °C. Figure 2 presents the recommended configuration for the cooling water sprays. There is the additional possibility that keeping the temperature below 55 °C will also result in less fume generation. To implement this alternative it would be necessary to: (a) evaluate spheres or other floating objects for their fume suppression and ability to conduct heat from the electrolytic bath; (b) add cooling water sprays between fiber glass cells to function when the bath temperature exceeded 55 °C; and (c) determine whether 55 °C maximum bath temperatures reduce the potential to generate fumes. This alternative is likely to cost significantly less than the fume hood alternative.

The third alternative is to install a tap below the liquid surface of the electrolytic cell to allow drawoff below the foam (unless the Teepol is truly dissolved in the liquid). Figure 3 presents the recommended configuration for the tap installation. This approach could be combined with the cooling spray technique described above. This alternative is based on the assumption that Teepol may be much more concentrated in the foam layer than in the liquid layer.

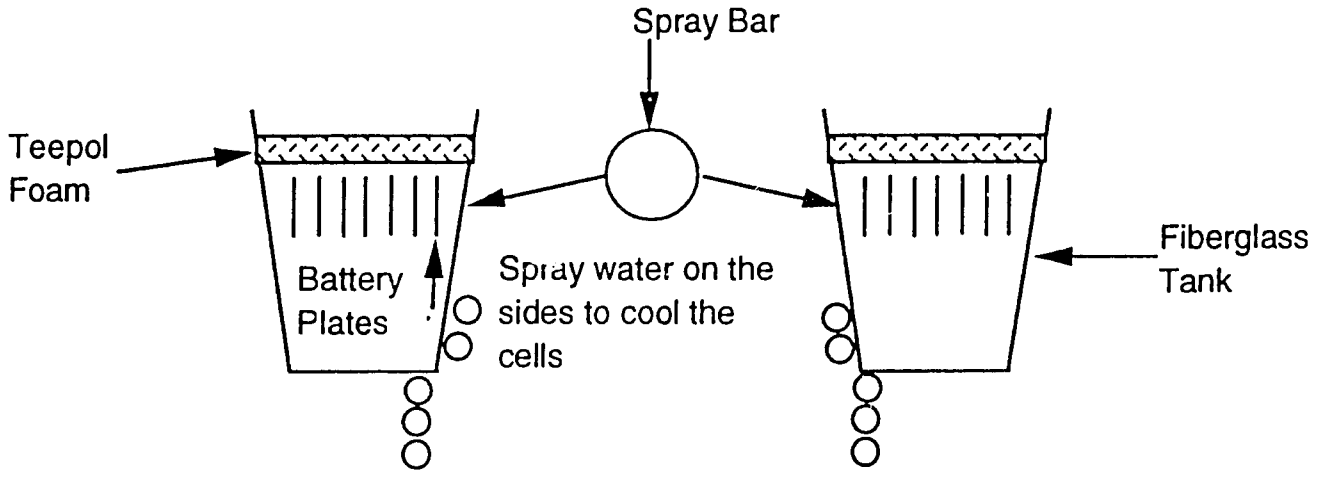
Recycle of Scrap Battery Casings

The WEC Industrial Expert recommended that a study be conducted with appropriate institutions including the Ceylon Institute for Scientific and Industrial Research (CISIR), the Rubber Institute, the Transportation Ministry, and the Environment Ministry to find a satisfactory reuse for the scrap battery casing. Such reuse options may include utilizing the material for roads, footpaths or other paving substitutes. In this case the scrap may have to be washed of any acid/lead residue. An additional alternative is using the material for its heat content as cement kiln material or a substitute fuel (blended with fuel oil or mixed with coal) for possible on-site use. In this case it may be necessary to break the pieces up rather small. Potentially, this could be accomplished using the present lead ingot grinder after it has been replaced. A final possible use of the scrap casing material is as a "filler' or "extender" for asphalt or tar in roofing, paving, or shingle applications.

Recycle of Furnace Slag

A consortium of Sri Lankan experts, including CISIR, the cement industry, the ceramic roof tile and brick industries, and possibly the glass industry, should

BATTERY FACTORY ELECTROLYTIC CELLS



End View

Figure 2

BATTERY FACTORY ELECTROLYTIC CELL

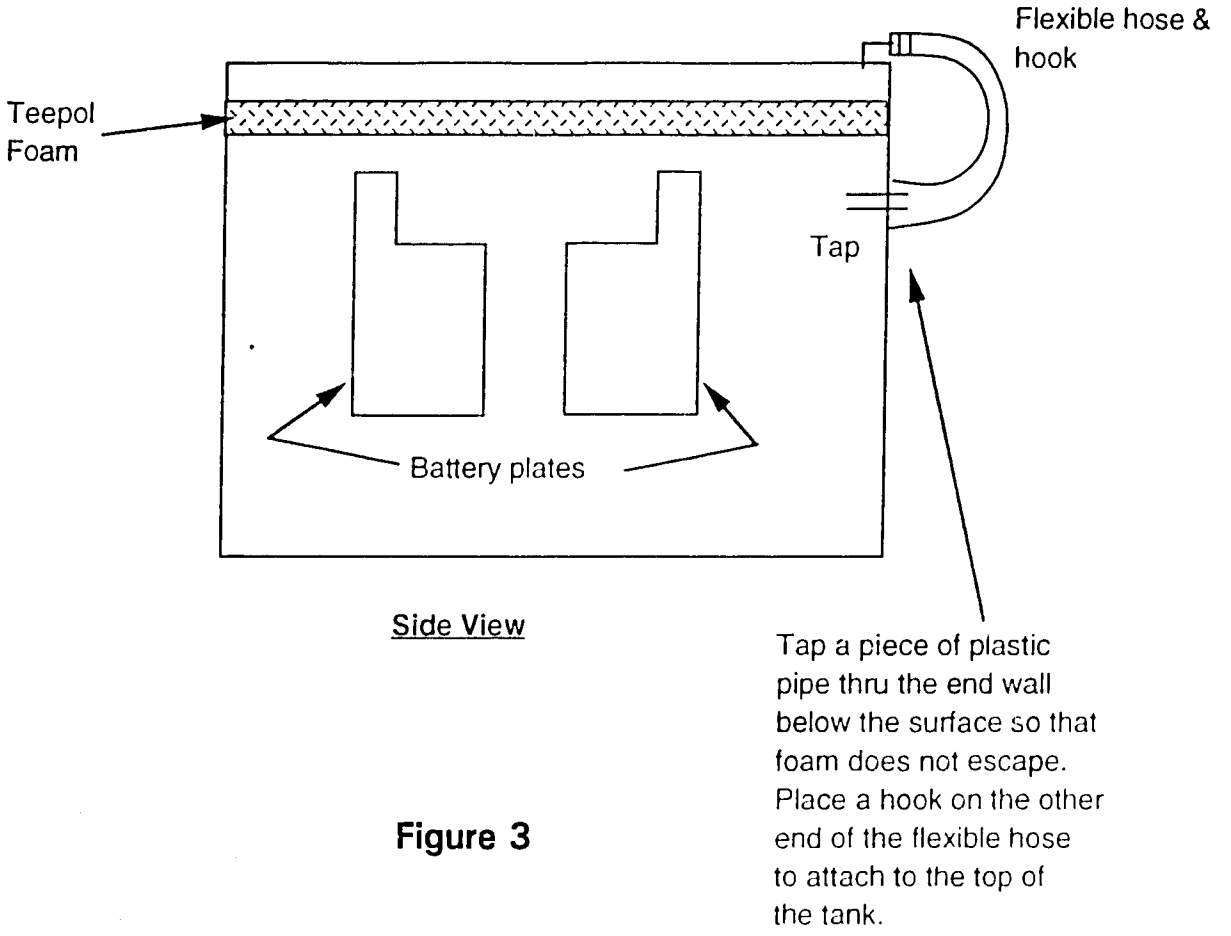


Figure 3

investigate alternative uses of this slag material. Possibilities include use as a low percentage filler in electrical insulators, roof tile, bricks and cement. The U.S. experience is that cement manufacturers use as a raw material fly-ash and bottom ash from hazardous waste incinerators such as 3M operates at Cottage Grove Minnesota. This in no way reduces the quality of the manufactured cement which has to provide these chemicals as a raw material in any case. It will probably be necessary to have a very complete analysis of the slag and determine its range of variability.

Replacement of Filter Bag Material

The WEC Industrial expert is aware of baghouse filter bags sold in the U.S. with temperature ratings of greater than 100 °C. A U.S. manufacturer of baghouse bags, Baghouse Associates Group International, has a representative in Bombay (Contact: Pradeep Bawaskar, 609/610 Keshava Bldg, Bandra East, Bombay, India 400051; phone 91-22-645-4703 or 4704; fax 91-22-645-4705). The U.S. manufacturers may not produce filter bags in metric sizes. If this is the case, it may be possible for fabric to be imported by the Sri Lanka textile industry to make bags according to metric measurements.

Recycle of Paste Sediment Overflow Water

Overflow water containing paste sediment is a small stream for potential recycle. A state-of-the-art membrane process could provide the simplest, most efficient separation process for this type of wastewater stream. Ultrafiltration (UF) membranes are very cost-effective methods for separating small solid particles (down to the latex paint dispersion sizes) from liquids. This process has enabled a wastewater composed of water and a colored dispersion to be recycled back as the concentrated dispersion and water separately. These membranes remove particulate material from water and pass the dissolved constituents.

Reverse osmosis (RO) membranes, on the other hand, separate water from dissolved constituents. Ionic lead should be able to be concentrated by an RO membrane and removed from the solution at low concentrations. Typically, it is possible to recycle the material that is retained by the membrane along with the liquid passing through the membrane. Such a process might provide a precursor for lead (or other valuable/objectionable dissolved chemical constituent) to be recovered by ion exchange, followed by precipitation as a solid or other effective method when the liquid volume is minimized. The other benefit of this approach is that the water passing the RO membrane is lead free and probably recyclable.

CISIR should investigate whether any industry in Sri Lanka such as the textile industry has experimented with these techniques and seek equipment manufacturers

who would be willing to work with major wastewater producers in Sri Lanka. Other industries in Sri Lanka besides the battery manufacturing industry including paint, textiles, dairy, and food industries are candidates for these membrane technologies as well. A U.S. manufacturer of membrane technology, Koch Membranes, has a representative in Bombay (Contact: Deepak Rao, Ion Exchange India, Tiecicon House, Dr E Moses Road, Bombay, India 400011; phone 91-22-493-9520; fax 91-22-493-8737).

Other Waste Minimization Opportunities

There may be other waste minimization alternatives to pursue at the facility. Perhaps the neutralization wastewater can be recycled or the acid in the wastewater can be used to neutralize the caustic in the nearby Asbestos Cement factory effluent. In addition, some of the heat produced by the furnace may be able to be recycled/reused or the neutralization plant sludge could be recycled. Another possibility would be to dispose of the "lead contaminated polypropylene gunny sacks" mentioned in the CIDA Consultants Audit Report by burning them in the furnace. In this regard, it may be possible to put dust from some of the recovered lead streams into these polypropylene gunny sacks to charge them into the furnace and minimize dusting. The polypropylene could substitute for some of the coconut shell charcoal.

C. ALUCOP Cables Ltd. - March 2, 1995

ALUCOP Cables Ltd., located at 138 Maligawa Road in Ratmalana, is a wire drawing facility. A team consisting of the WEC Industrial Expert, the WEC Institutional Expert, and a USAID representative met with Mr. J.S. Gunasekara, Director, Mr. T. Satyamurthy, Director/General Manager, and Mr. D.K. Desilva, Production Superintendent. The WEC Industrial Expert gave an introductory briefing on the 3M Pollution Prevention Program. Afterwards, Mr. DeSilva led the team on a tour of the facility.

1. Process Description

The ALUCOP Cables Ltd. facility is primarily a wire drawing facility which pulls copper or aluminum wire through dies. Wire is then either spun into cables or insulated or covered with polyvinyl chloride (PVC) insulation for electrical insulation. The larger sized copper wire is spun and coated while the aluminum wire is spun, but not coated in the larger sizes. Some of the smaller aluminum wire is coated. The majority of the coatings are applied in a single pass, but some products receive two coatings The PVC is of very high quality allowing the scrap to be recycled back into the product in the amount of up to 5 to 6 percent. Cost per month for PVC is 250,000 Rupees, while the value of scrap PVC is estimated at 75,000 Rupees per

month. The facility apparently purchases power costing 300,000 - 400,000 Rupees per month.

Waste from the facility is primarily scrap PVC, aluminum metal and copper metal, all of which are recycled. There is a small amount of cutting oil, which may contain fines of aluminum or copper, that is recycled for use as fuel oil. Three 204-liter drums of cutting oil were observed. Water discharges are minimal, although the hot coated wire from the extruder is cooled in a water bath. One of the machines sits near the sump for cooling water. There is one production line which has an "on-line" device for detecting coating defects.

An adjacent operation accepts plastic which is then extruded into a bath and broken up into pellets for recycle. The recycled material is used to manufacture yogurt cuphandles and clothes hangers. About a month's supply of plastic scrap was observed to be stored in piles below the shed roof. Price for this recycled material is as much as 15 Rupees per kilogram for the best white plastic.

2. Discussion of Waste Minimization Opportunities

Plant representatives were interested in waste minimization opportunities for the cutting oil that is used in the aluminum drawing system. The oil is held in a sump below the operation and is potentially exposed to extremely high temperatures. Water-based fluids can not be used in place of the cutting oil because water reacts with the aluminum.

D. MOLDEX/Ceylon Metal/Mona Plastics - March 3, 1995

The MOLDEX/Ceylon Metal/Mona Plastics facility, located at 70 Attidiya Road in Ratmalana, performs plastics and aluminum molding and finishing operations. A team consisting of the WEC Industrial Expert, the WEC Institutional Expert, and a USAID representative met with Mr. R. Rohan Karunaratne, Factory Manager.

1. Process Description

The facility performs plastics and aluminum molding and finishing. Products include novelties and figurines. The majority of the facility products are for Hallmark Company in the United States. Products are generally extruded or blow molded from high impact polystyrene and low density polyethylene.

2. Discussion of Waste Minimization Opportunities

The painting operation is the primary opportunity for waste minimization observed during the visit. The facility uses solvent to clean the "paint masks" and other painting equipment. The solvent is recycled. An opportunity exists to minimize the

paint usage through employee training and by identifying operators who use the paint most efficiently. Electrostatic spray equipment may also be used here to help pull the spray to the spots on the mask where the paint is desired.

There is a scrubber on the air exhaust which pulls paint fumes from the employees working area. This must be cleaned periodically to remove accumulated sludge.

Plant representatives reported that they have been working with an electrical consultant to improve the power factor of their electrical consumption. Payback for this project is 1.5 years. The facility has also installed more efficient equipment to improve their electrical efficiency. As a result, their energy efficiency has improved from 100 pieces per 8 kilowatts to 200 pieces per 5 kilowatts.

E. Chemitrade - March 2, 1995

Two Chemitrade paint manufacturing facilities were visited. The first facility is located at 7 Sangabo Mawatha in Ratmalana. The second plant, a newer facility, is located at Tembagangoda, Welmilla, Polgasovita. At the first facility, the WEC Industrial Expert and two USAID representatives met with Mr. Priya Wickremasinghe, and Mahendra Gooneratne, Joint Managing Directors. At the second facility, Mr. Nimal Gunaratne, Chemist, hosted the WEC Industrial Expert and a USAID representative.

1. Process Description

A description of the process at the Ratmalana facility and the Polgasovita facility is given below.

Ratmalana Facility

This facility makes paints and solvents to specific orders. The intermediate paint clean-ups are made with the same solvents in the recipe and are put into the final batch where possible. There remains in the final batch tank a layer of paint that builds up everytime a batch is made. However, it appears that this tank is used only for one product, so it can't contaminate another one.

Solvent blending is performed starting with a 204-liter drum to which successive quantities of the blend are added. Two solvents are delivered in bulk to one or more underground tanks. Solvents are pumped from the tank using a rotary hand pump. The drums were observed to be bulging, indicating that the solvent vapor pressure exerts enough force to distort the drumheads. Plant representatives pointed out face mask protection for the employees use. However, the WEC Industrial Expert noted that the face masks may not have been sufficient to absorb the vapors present at the

employee's breathing level. Stacks of product cans and bottles filled every available space in this area.

Polgasovita Facility

The Polgasovita facility has similar operations as the Ratmalana facility. However, because it is newer, the facility has a number of improvements. For example, the facility operates a ball mill which utilizes a simple, but effective cooling water loop. The facility also operates a power mixer to mix materials from 204-liter drums to 15-liter pails. The rag waste and container clean-up are accomplished outside. Both residues are buried after the solvents evaporate.

2. Waste Minimization Opportunities

Waste minimization opportunties at the Ratmalana facility and the Polgasovita facility are described below.

Ratmalana Facility

Plant representatives report that little or no waste is generated at the facility. Therefore there is little potential for waste minimization. The WEC Industrial Expert noted that it may be worthwhile to verify the amount of solvent evaporated during the solvent blending operation. In addition, the WEC Industrial Expert expressed concern about the integrity of the underground tank used to store solvents. This tank is buried in clay soil which generally is aggressive to corroding steel in a high water table circumstance. The solvent would then leak into the groundwater.

Polgasovita Facility

Similar to Ratmalana facility, this facility also minimizes the amount of solvent waste generated. The WEC Industrial Expert's primary concern was for the worker who dips solvent from one large open-top drum to another, using a 3-liter plastic scoop. This operation involved the worker leaning into the first drum where he was exposed to solvent vapors. As the scoop was emptied into the second container, vapors were displaced over the top of the drum and onto the floor. The worker also was observed not to be wearing gloves or breathing protection. The WEC Industrial Expert recommended that this manual operation be replaced with a rotary hand pump which is metered (i.e., each crank turn is equal to 0.25 liter or similar). The solvent drums could be emptied and filled through the small bung, thereby minimizing losses. This alternative would also minimize the amount of solvent vapors that workers are exposed to.

IV. RECOMMENDATIONS AND CONCLUSIONS

Of the five industries visited, only two were observed to have specific waste minimization opportunities. These were the Uswatta Confectionery Plant and the Associated Battery Manufacturers Plant. There did not appear to be many specific waste minimization opportunities in the paint, plastics, or electric cable facilities visited, with the exception of a possible paint reduction program at the plastics factory. In addition to the specific waste minimization opportunities identified for the candy and battery facilities, several universally applicable waste minimization opportunities were identified. These were derived from the WEC Industrial Expert's overall experience and observations while in Sri Lanka and are intended to be generally applicable rather than be specific to one factory.

It was not possible to develop a "ranking" of these waste minimization opportunities for the purpose of developing a priority list for available funding.

The waste minimization opportunities are presented in Table 1 and summarized below.

A. Specific Waste Minimization Opportunities at Uswatta Confectionery Plant

The following specific waste minimization opportunities were identified for this facility:

1. Minimize Waste from Defective Batches

This is an example of a quality problem which also involves environmental wastes. The focus was on solutions that could eliminate the quality and reduce or eliminate the environmental discharge. Suggestions for reducing or eliminating waste generated from crystallized candy batches include installing a temperature controller to prevent overheating, by taking steps to avoid sugar crystals entering the batch, or by selling the crystallized product as "rock candy". This is essentially a quality problem which, if solved, will result in an environmental improvement. These steps would eliminate the solid waste associated with approximately one defective batch per month. While these options have an associated cost, they will result in increased sales and reduced disposal costs.

2. Segregate Washwater Rinses for Reuse

Several opportunities exist for reuse of process washwater after the final rinse. These include on-site uses such as cooling water make-up and reuse as first flush in next cleaning. In addition, off-site uses for this water could include use for general cleaning purposes or other specific uses at the nearby Singer plant. By reusing this

TABLE 1

SUMMARY OF RECOMMENDED WASTE MINIMIZATION ALTERNATIVES

APPLICABLE FACILITY	ALTERNATIVE	DESCRIPTION	POLLUTION PREVENTED	COSTS/BENEFITS
Uswatta Confectionary Plant	Minimize waste from defective batches	Prevent waste from crystallization of batches Options: • Install temperature controller • Prevent sugar crystals falling in batch • Sell product as "rock candy"	Eliminates solid waste from one defective batch per month Results: • Eliminates defective product • Eliminates defective product • Recovers product for sale	Cost: • Equipment and materials Benefit: • Increased sales • Reduced disposal costs
	Segregate washwater rinses for reuse	Recycle for on-site or off-site reuse Options: • Reuse as cooling water on-site • Reuse final rinse as first flush rinse next cleaning cycle on-site	Eliminates disposal of 3 to 4 m^3/day of 80 °C softenened water Results: • Reduces well water consumption • Reduces well water and energy consumption	Cost: • Equipment, materials and labor Benefit: • Reduced water softening costs and energy costs • Possible source of revenue from off-site sales

TABLE 1

SUMMARY OF RECOMMENDED WASTE MINIMIZATION ALTERNATIVES

APPLICABLE FACILITY	ALTERNATIVE	DESCRIPTION	POLLUTION PREVENTED	COSTS/BENEFITS
Uswatta Confectionary Plant (Cont'd)	Segregate washwater rinses for reuse (cont'd)	• Reuse off-site for cleaning • Reuse by nearby Singer Plant	• Reuses water and energy • Reuses water and/or energy	
	Optimize cooling water reuse	Determine ultimate cooling water reusability • Experiment to find "natural scaling limit"	Unknown quantity • Reduces well water consumption	Cost: • Study cost (can be shared with other industries) Benefit: • Not available
Associated Battery Manufacturers	Eliminate Teepol foam	Reduce electrolytic bath temperature and vapors Options: • Install hood, ducting, and fan • Use hollow spheres and install cooling water spray • Install tap and cooling water spray	Eliminates 240 liters/day of lead/acid wastewater requiring neutralization Results: • Improves product and reduces wastewater generation • Improves product and reduces wastewater generation • Improves product and reduces wastewater generation	Cost: • Equipment and materials Benefit: • Lead/acid water from electrolytic baths can be recycled • Improved plate quality

TABLE 1

SUMMARY OF RECOMMENDED WASTE MINIMIZATION ALTERNATIVES

APPLICABLE FACILITY	ALTERNATIVE	DESCRIPTION	POLLUTION PREVENTED	COSTS/BENEFITS
Associated Battery Manufacturers (Cont'd)	Recycle scrap battery casings	Find suitable reuse for scrap materials Options: • Transportation/paving material • Cement kiln raw material • Substitute fuel • Filler/Extender	Eliminates waste from approx. 500 battery casings per day Results: • Recycles waste to productive use	Cost: • Study cost (can be shared with other industries) Benefit: • Reduced disposal costs • Revenue from recyled materials
	Recycle furnace slag	Find suitable reuse for furnace slag materials Options: • Electric insulators • Ceramic roof tile • Bricks • Cement	Eliminates waste from approx. 2,000 kg/day of slag ingots Results: • Recycles waste to productive use	Cost: • Study cost (can be shared with other industries) Benefit: • Reduced disposal costs • Revenue from recycled materials

TABLE 1 (CONTINUED)

SUMMARY OF RECOMMENDED WASTE MINIMIZATION ALTERNATIVES

APPLICABLE FACILITY	ALTERNATIVE	DESCRIPTION	POLLUTION PREVENTED	COSTS/BENEFITS
Universal	Septic tanks and low pressure force mains	Require users to process wastewater solids in septic tanks and pump the effluent	Eliminates problems from infiltration and need for construction of deep gravity sewers and fututre treatment plant components	Cost: • Capital and operating costs Benefit: • Utilizes existing septic tanks
	Mini-treatment cooperatives	Encourage adjacent industries to enact multimedia pollution prevention solutions	Maximizes the source reduction opportunties by enlarging the scope of available options	Cost: • Not available Benefit: • Reduced disposal costs • Reduced raw material costs • Reduced wastewater flow
	Membrane processes	Develop reverse osmosis and ultrafiltration recovery systems	Utilizes separation techniques which allow reuse of both sub-streams	Cost: • Not available Benefit: • Reduced production costs • Reduced disposal costs • Quality improvment

TABLE 1 (CONTINUED)

SUMMARY OF RECOMMENDED WASTE MINIMIZATION ALTERNATIVES

APPLICABLE FACILITY	ALTERNATIVE	DESCRIPTION	POLLUTION PREVENTED	COSTS/BENEFITS
Universal (Cont'd)	Composting Systems	Form "ceramic-plate ball" composters from waste material	Encourages rodent resistant natural breakdown of wastes to useful product	Cost: • Not available Benefit: • Reduced trash disposal • Generates beneficial mulch for landscaping

washwater, the facility will eliminate disposal of 3 to 4 cubic meters per day of softened 80 °C water. Savings in the form of reduced water and energy consumption will result. Moreover, if an off-site use for this washwater is found, it may provide a source of revenue to the facility.

3. Optimize Cooling Water Reuse

The facility may wish to undertake a study to determine the ultimate cooling water reusability. One option is to perform an experiment to determine the natural scale formation point of the cooling water. This approach should lead to reduction in water consumption, although the quantity of this reduction is unknown. The results of this study would be applicable to other industrial facilities in Sri Lanka.

B. Specific Waste Minimization Opportunities at Associated Battery Manufacturers Plant

1. Eliminate Teepol Foam

Another example of a quality problem which also involves environmental wastes is the use of Teepol foam to suppress vapors from electrolytic cells. Use of Teepol foam prevents optimum temperature operation resulting in lower quality plates. It also results in the generation of a dissolved lead/acid wastewater that requires neutralization and cannot be recycled. Elimination of the use of Teepol foam to suppress vapors from electrolytic cells would have two beneficial effects. First, it would allow the waste acid liquid from this process to be recycled. Second, it would allow the electrolytic bath to be operated at optimum temperature, thereby improving the quality of the produced plates. To accomplish this, the facility can either install a hood, ducting and fan to capture the fumes. Less expensive options would be to use either a combination of hollow spheres in place of the Teefol foam to suppress the vapors and a water spray to cool the fiberglass cells or to install a water tap below the foam surface along with a water spray. If successful, these techniques would prevent generation of 240 liters per day of acid wastewater that requires neutralization.

2. Recycle Scrap Battery Casings

A study should be conducted to determine if scrap battery casings can be reused in any of the following ways: 1) transportation/paving material, 2) cement kiln raw material, 3) substitute fuel, or 4) filler or extender for asphalt or tar in roofing, paving or shingle applications. Reuse of these scrap materials would eliminate approximately 500 battery casings per day that are generated as waste. Waste disposal costs would be reduced and revenue may be generated from sale of scrap for recycled products.

3. Recycle Furnace Slag

A related study should be conducted to determine if furnace slag material can be reused as a low percentage filler in electrical insulators, ceramic roof tile, bricks, or cement. Finding an acceptable use for this slag material would eliminate approximately 2,000 kilograms per day in slag ingots that are currently produced and disposed of as waste.

C. Universal Waste Minimization Opportunities

1. Septic Tanks and Low Pressure Force Mains

The existing septic tanks utilized by most of the industry in the Moratuwa-Ratmalana region are probably in need of pump-out and cleaning. Because the area is so low and prone to flooding, a good system would involve having everyone connecting to the ultimate sewerage system install a septic tank and then connect to a low pressure force main to convey their final effluent to a future treatment plant. This system would have several advantages including:

- Gravity sewers are notoriously expensive to install, especially in areas of high ground water and flooding. It is necessary to oversize the pipe diameter installed, even though the flow capacity is not utilized until much later in the life of the sewer (i.e., it is paid for initially but the benefits are not realized until later). Solids must be conveyed by a loss of gravity head and the sewers correspondingly get deeper as they go, in areas like Moratuwa - Ratmalana where the topography does not slope in the direction of sewer flow.

- With the solids removed by septic tanks, the remaining flow can be pumped through a shallow force main that can follow the topography. The force main can be trenched or plowed in, making the installation inexpensive. (Seamless plastic pipe would appear to be the best choice for the force main.) The flow would have to be pumped, and the cost of pumping would be borne by the user. This should be some incentive to minimize wastewater flow. The septic tanks will accomplish biological treatment while the waste solids are present, which will happen at no operating cost to the sewer authority. These also need to be pumped out periodically, but if this is done by the sewer authority it would be possible to analyze the stirred contents to identify what the user is actually discharging in their wastewater and to regulate it accordingly.

- Manholes, sewer pipe buoyancy and infiltration are all eliminated, the route of the force main can follow the road right-or-way, new connections are

simplified and inexpensive, and supplemental future capacity increases (e.g., an unforeseen bottleneck in the Force Main) will be much less costly because they don't have to follow the hydraulic grade line. If necessary, "pigs" can be sent through the Force Main to clean it out periodically. It also builds upon something that already exists, since most of the industries have septic tanks installed already. These would not have to be abandoned.

- When a municipal wastewater treatment plant is built, it will not need grit chambers, bar screens, and primary clarifiers. It will be necessary to provide a sludge handling facility for the septic tank contents that are hauled to the site, but this should be much smaller than if the primary clarifier was processing all the solids.

This system should be much less expensive, both for capital spending and operational cost, than a conventional sewer and conventional primary/secondary sewage treatment plant. All sewer users including municipal and domestic sewer connections should be included in this system. At a convenient location, several neighbors could install a septic tank that could be entered by gravity. The effluent would then be pumped to the low pressure force main. Perhaps the pumping can be accomplished with power from solar cells.

2. Mini-Treatment Cooperatives

This idea is based on a suggestion by Mr. Bandera, Production Manager, at Associated Battery Manufacturers. The Associated Battery facility has an acid wastewater while a neighboring asbestos cement factory has a caustic wastewater. It is recommended that a coordinating resource be provided to look for opportunities within neighborhoods to:

- combine wastewaters that have complementing constituents,
- treat, reuse and perhaps share cooling water streams, or
- reuse hot water wastes (like those generated by the candy factory).

The focus of the investigation should be on minimizing wastewater and maximizing reuse of any "pollutants" in the wastewater.

A program like this would encourage waste minimization at the source for more than water wastes. It is likely that as wastes from one media are identified to neighboring manufacturers, they may become raw material for someone else. For example, it might be possible for the Associated Battery plant furnace exhaust heat to be used as input for the asbestos cement factory kiln, if one is operated there.

Wastewater that can be used over and over will reduce the flow to the ultimate future treatment plant and also eliminate demand for water supplied to these factories (piped or well water). This concept is only viable at or near the source of the potentially recyclable component. It may be possible for some of these mini-cooperatives to supply services to their domestic neighbors as well. They could charge for this service and derive some income from it.

3. Consortiums

Sri Lanka appears to be a natural place to put groups together that have complementing skills or assets which could provide environmentally sound solutions to common problems. Specific topics that might be suitable for such an approach include the following.

Ultrafiltration and Reverse Osmosis Systems

Membrane systems should be considered for separating water from waste constituents in the wastewater. There are also manufacturing processes that could utilize ultrafiltration and reverse osmosis systems to make goods with higher quality and less waste, since today's membranes can tolerate solvents and high concentrations of acid or caustic.

Composting Systems

Composting systems should be considered for treating the biodegradable fraction of the trash that is widely generated. For example, a group could be formed that would make ceramic hexagonal or octagonal plates out of existing waste products that could be wired together to form a ball with a volume of approximately 1 cubic meter. A household, business or restaurant could place their food and yard scraps into this and mix it by rolling it about. The Sri Lankan climate would make the composting process go very quickly and might minimize the need for trash pick-up. The food scraps would be inaccessible to rodents and the final compost would be a landscape benefit.

Recycling Scrap Battery Casings

Alternatives for recycling scrap battery casings from the battery factory should be considered. One approach would be to conduct a study with the appropriate institutions including CISIR, the Rubber Institute, the Transportation Ministry and the Environmental Ministry to find a satisfactory reuse for the scrap battery casings. Other wastes may also be found that can be reused in similar ways.

Recycling Furnace Slag

Alternatives for recycling furnace slag from the battery factory should also be considered. A study involving CISIR, the cement industry, the ceramic roof tile and brick industries, and perhaps the glass industry could evaluate alternative uses for this material. Again, other wastes may be found that can be reused in similar ways.

D. Industry Role in Implementing Waste Minimization

The WEC Industrial Expert offered the following recommendations regarding the role of industry in implementing waste minimization opportunities in Sri Lanka. Industry has resources, the need to improve profitability, and the ability to shortcut the normal time required to accomplish waste minimization concepts compared to government, the domestic sector and other bureaucracies. The WEC Industrial Expert urged steps to facilitate the availability of seed money for industry to accomplish environmentally sound programs such as those recommended in this report. Waste minimization efforts by industry will spill over into the government and domestic sectors quickly.

In addition, the WEC Industrial Expert believes that as industry realization grows that environmental problems do not go away, and as concern increases by the regulatory agencies that certain discharges have to be eliminated or heavily taxed, prevention and recycling will become the preferred alternative and the instinctive solution. Sri Lanka has the opportunity to avoid the expensive and painful "command and control" mentality that has been the U.S. experience.

APPENDIX A

PHOTOGRAPHS

Colombo Drainage Canal

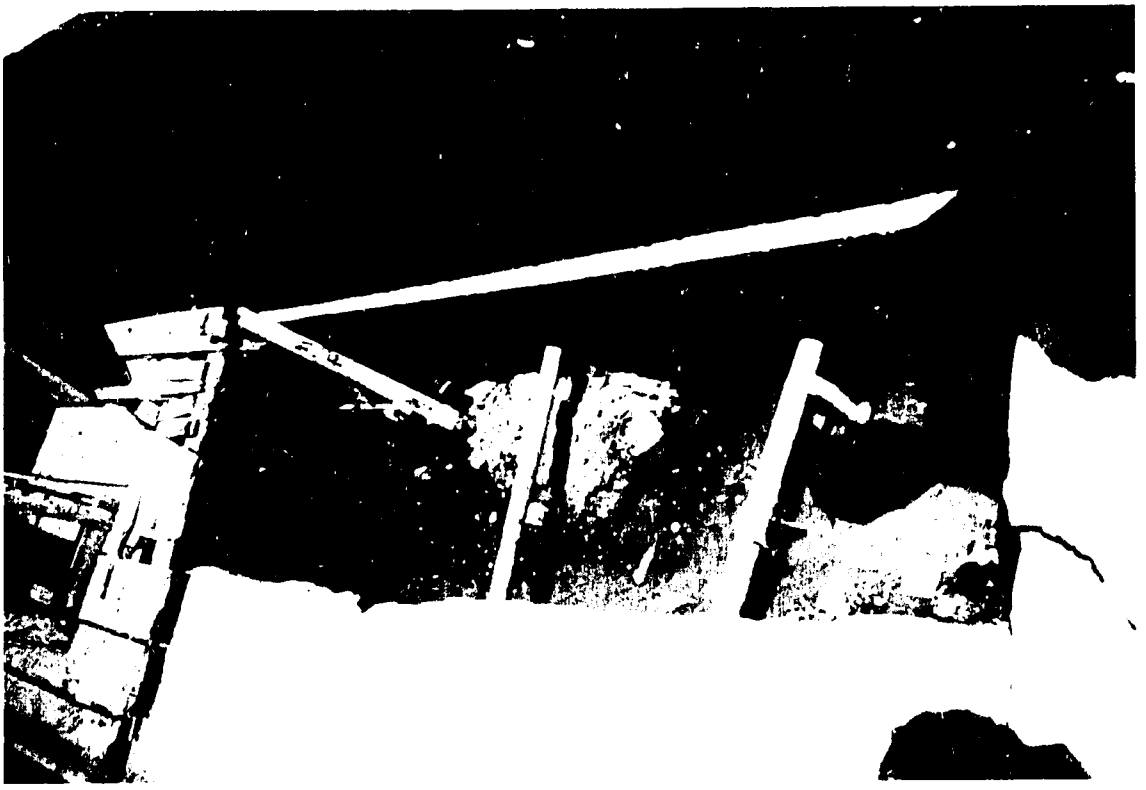
Ratmalana Residence and Debris

Wastewater Drainage Ditch Outside Textile Factory

Candy Factory: Street Sewer Trench Outside Factory

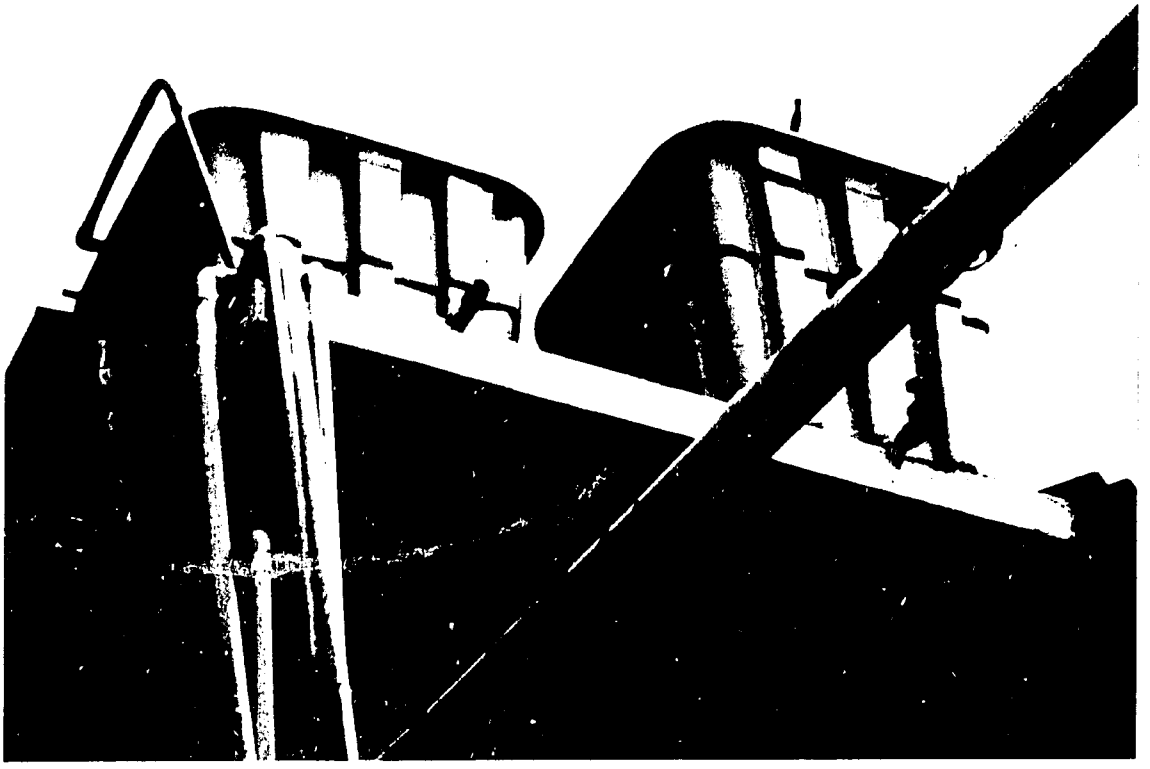
Candy Factory: Tube Well

Candy Factory: Boiler House



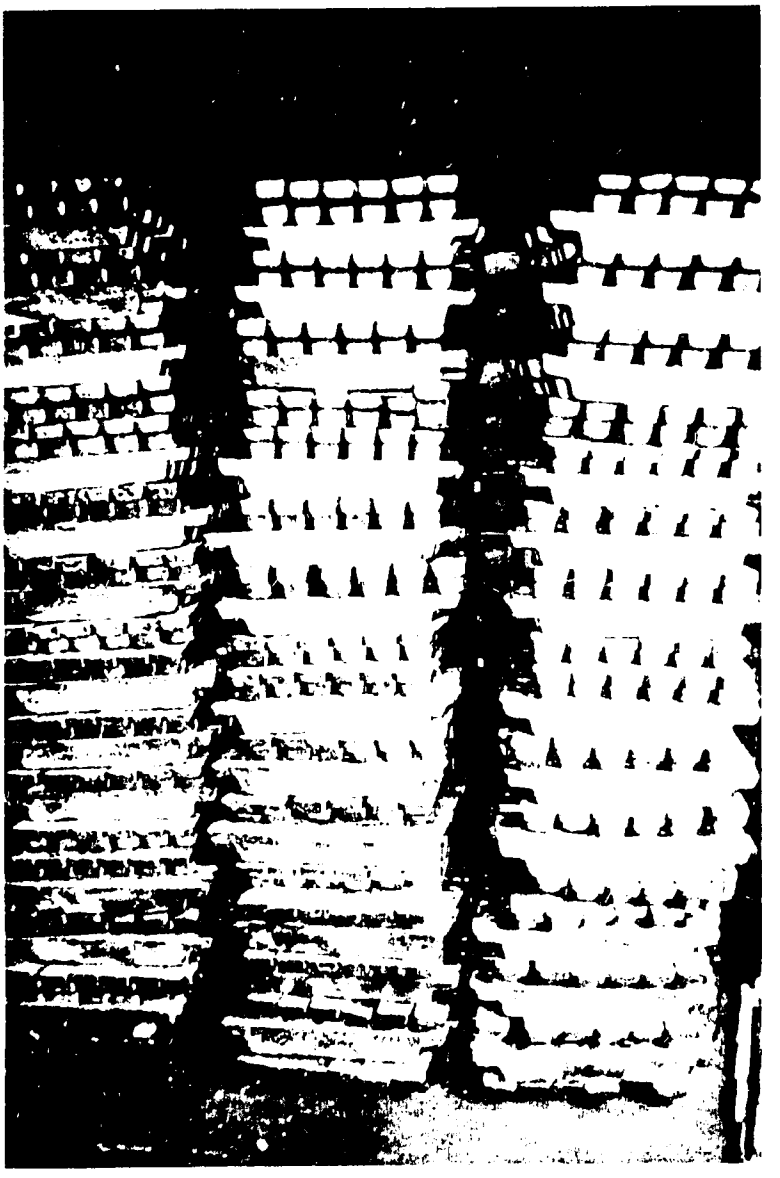
Candy Factory: Sewer Trench Inside Factory

Candy Factory: Trash



Battery Factory: Elevated Water Storage Tanks

Battery Factory: Recycled Polypropylene Cases and Tops

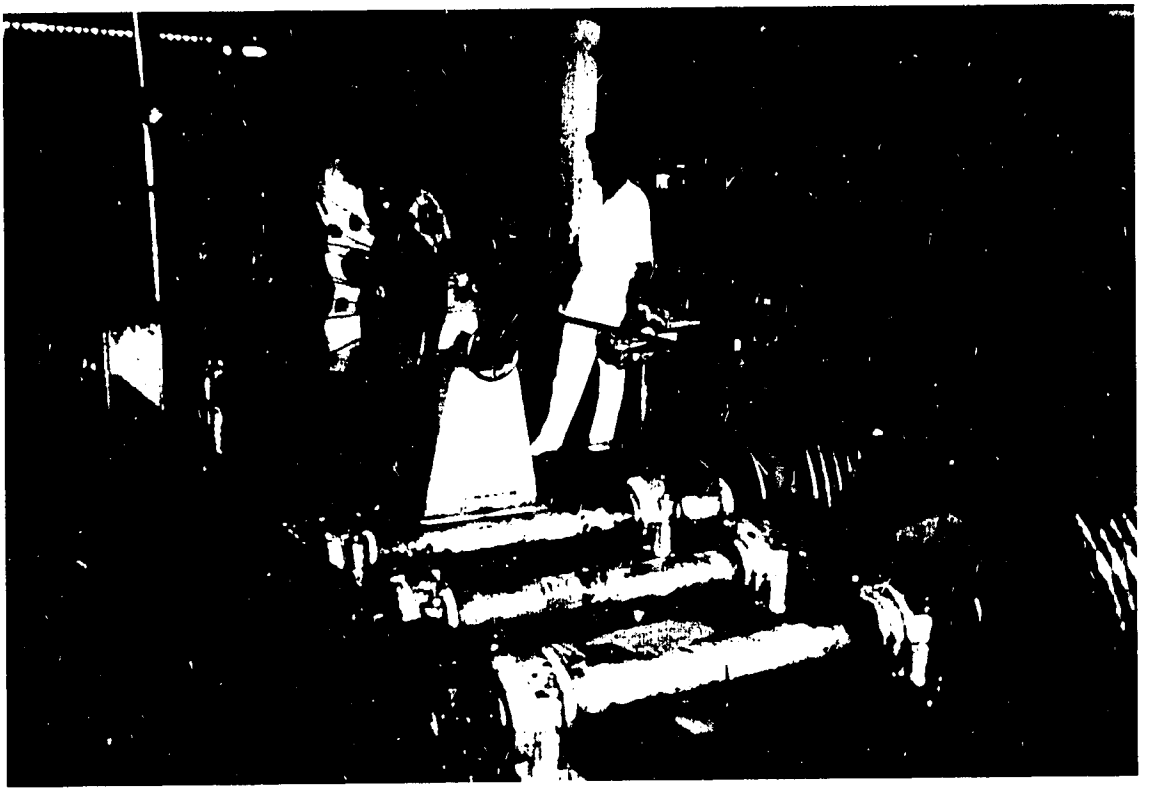


Battery Factory: Lead Ingot Storage

Battery Factory: Smelter Baghouse Bags

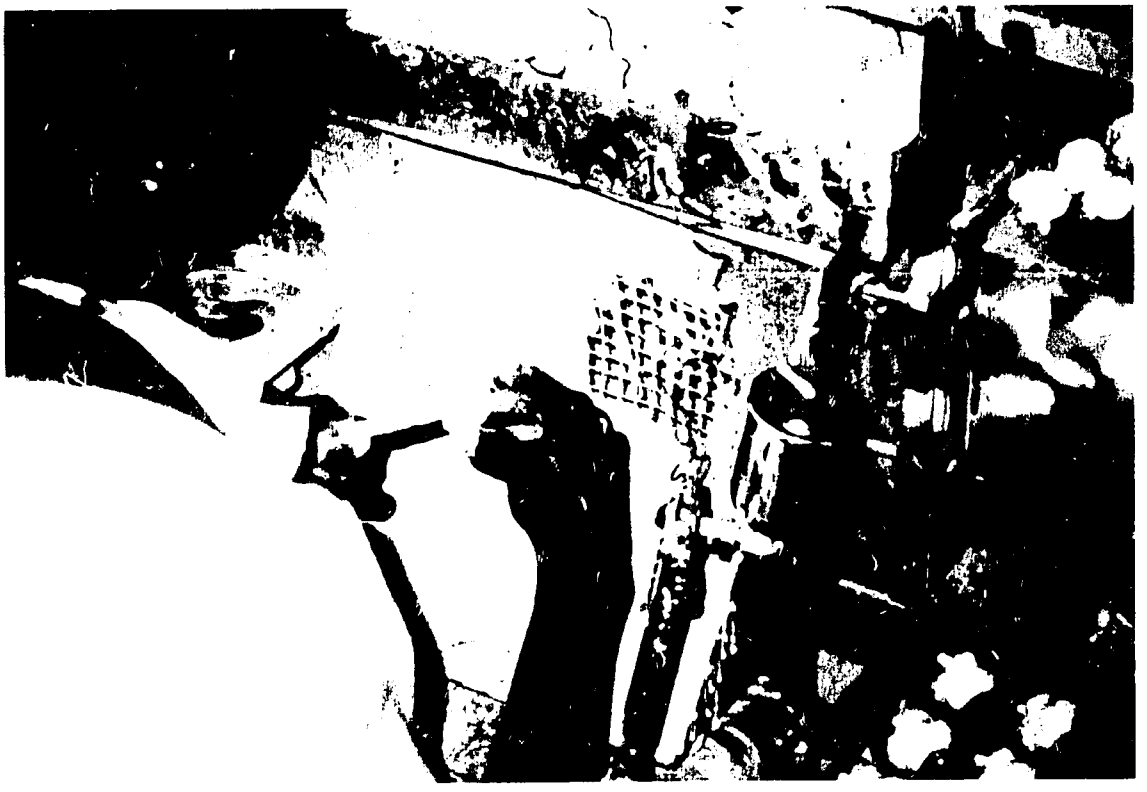
Battery Factory: Burned-Up Smelter Baghouse Bags

Cable Factory: Entrance

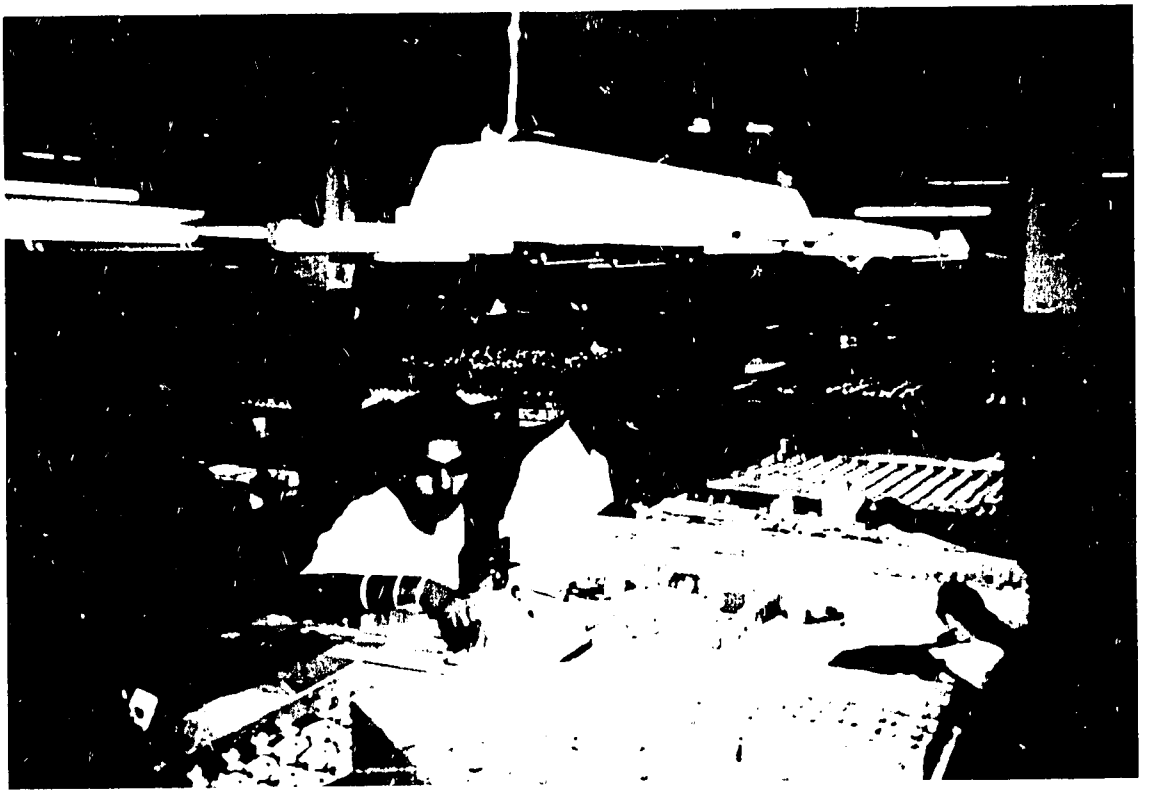


Cable Factory: Copper Wire Drawing Operation

Battery Factory: Copper Cable Spools



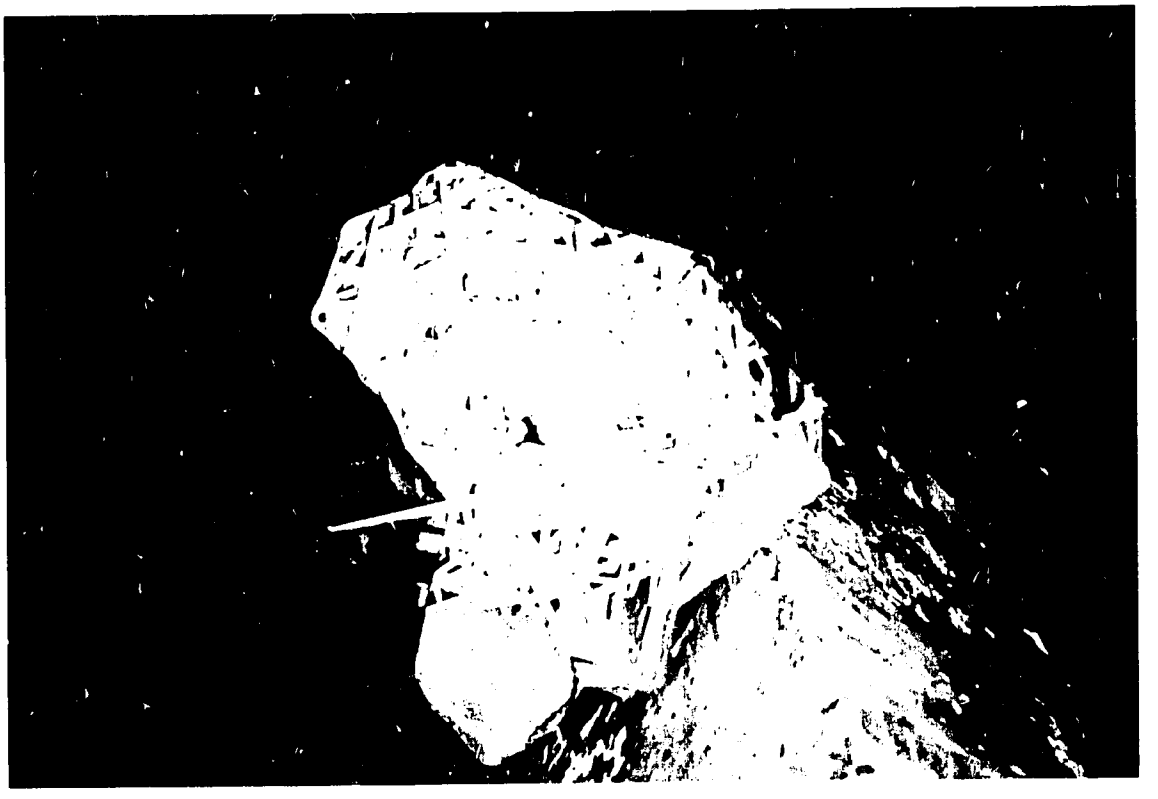
Plastics Factory: Spray Painting Operation



Plastics Factory: Assembly Operation

Plastics Factory: Air Handling/Ventilation System

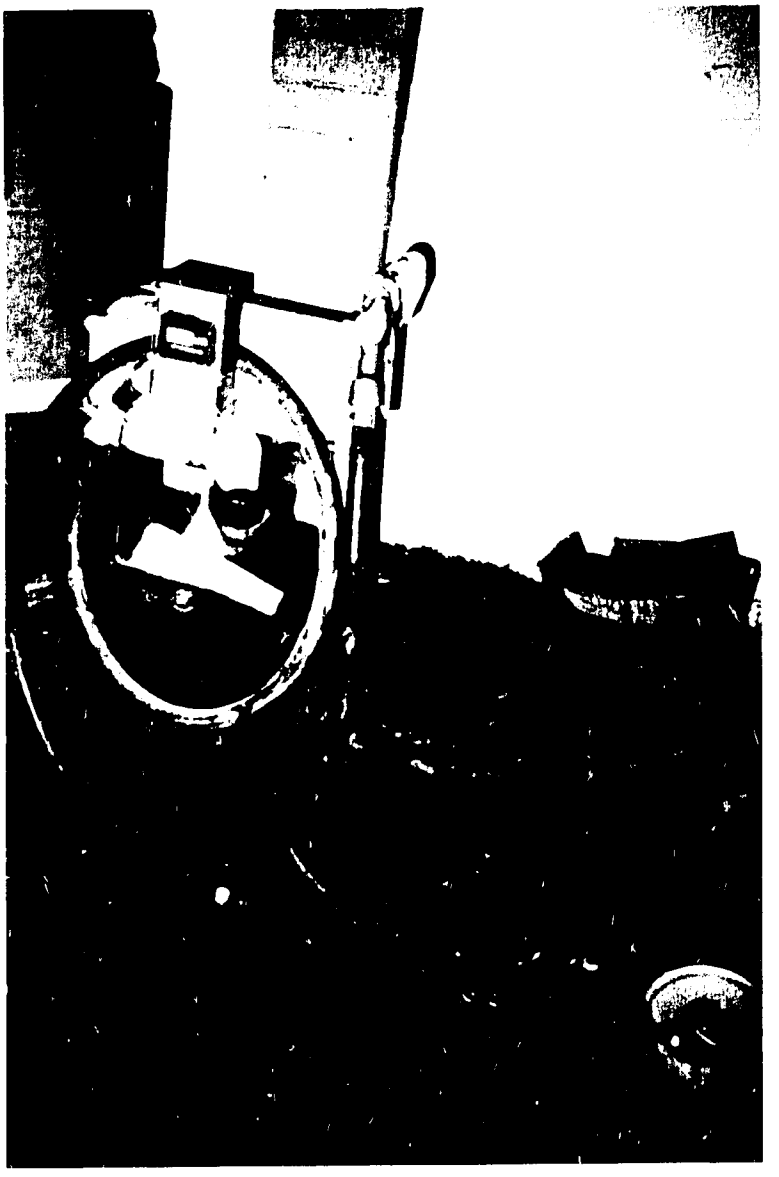
Plastics Factory: Scrubber System



Plastics Factory: Mold Spue for Recycling

Paint Factory: Storage Area

Paint Factory: Mixing Vessel



Paint Factory: Underground Solvent Tank Pump

APPENDIX B

LIST OF DOCUMENTS RECEIVED

ANNUAL REPORT
1993

CEYLON INSTITUTE OF SCIENTIFIC &
INDUSTRIAL RESEARCH
363, BAUDDHALOKA MAWATHA,
COLOMBO 7,
SRI LANKA.

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TECHNOLOGY OFFERS FOR FOOD PRODUCTS

EMACE FOUNDATION

OF

SRI LANKA

EMACE

NGO – Business Partnership for

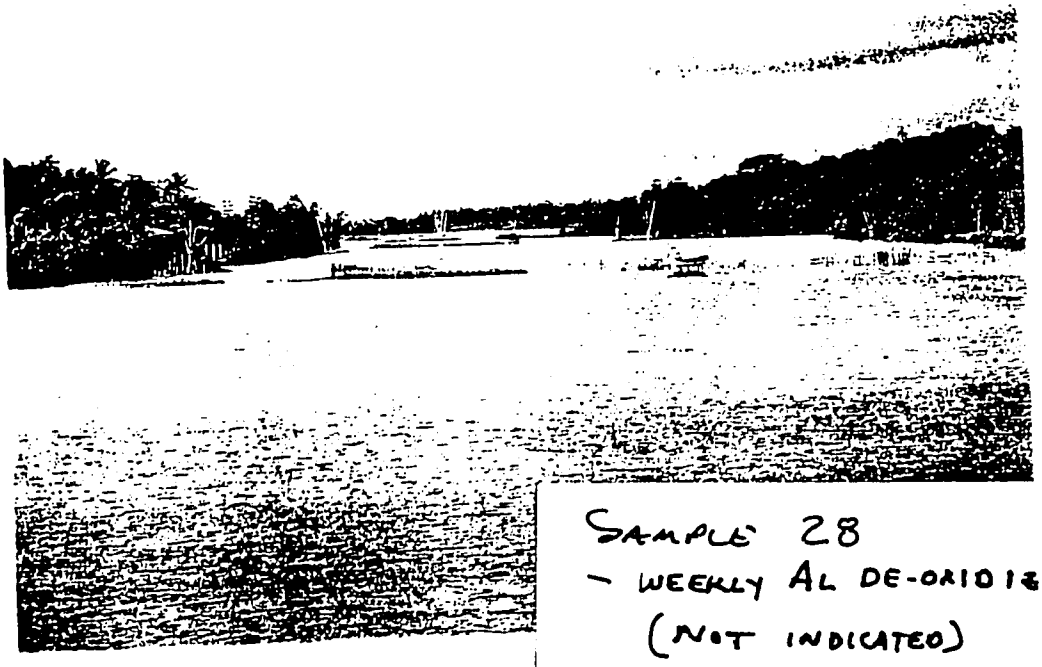
Environmental Protection

Interim Report
Volume 2

METROPOLITAN ENVIRONMENTAL IMPROVEMENT PROGRAM
GOVERNMENT OF SRI LANKA

FEASIBILITY STUDY FOR THE ESTABLISHMENT OF A CENTRAL WASTEWATER TREATMENT PLANT FOR INDUSTRIAL ESTATES/INDUSTRIES AT RATMALANA AND MORATUWA GREATER COLOMBO AREA

February 1994



SAMPLE 28
- WEEKLY AL DE-ANODIZING BATHS (NOT INDICATED)
- CONTRIBUTORS TO G1, G2, G3
- D-1,2,3 = G-1,2,3?

ASSOCIATED ENGINEERING

Sri Lanka-Minnesota Scoping Mission on Institution-Building for Waste Minimization

Final Draft Report

March 16, 1994

project partners:

WEC
NAREPP/IRG
MEIP-Colombo
AEP
World Bank

submitted to:
The World Environment Center

by:
Terry Foecke, WRITAR
Kevin McDonald, MN OWM
Karin Nelson, MTO

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Annex C

Conceptual Plan for Source Management and Control (Waste Minimisation) of Industrial Pollution in Sri Lanka

Environmental Pollution Prevention Project

About the Project

Why Pollution Prevention?

Rapid industrialization and urbanization in developing countries have led to severe pollution: water that is unfit for drinking or bathing, extreme levels of air contamination, and growing quantities of municipal and hazardous wastes that are disposed improperly. Initial efforts to manage urban and industrial pollution have concentrated on "end-of-pipe" treatment which, in many cases, is not only costly but ultimately unsustainable. This is especially true in developing countries where additional pollution treatment would divert ever larger amounts of scarce resources from economic development.

Experience in the United States and other countries has demonstrated that in the long run, pollution prevention through waste minimization and cleaner production is more cost-effective and environmentally sound than traditional pollution control methods. Pollution prevention techniques apply to any manufacturing process, and range from relatively easy operational changes and good housekeeping practices to more extensive changes such as the substitution of toxic substances, the implementation of clean technology, and the installation of state-of-the-art recovery equipment. Pollution prevention can improve plant efficiency, enhance the quality and quantity of natural resources for production, and make it possible to invest more financial resources in economic development.

What is EP3?

The Environmental Pollution Prevention Project (EP3) is a five-year program sponsored by the United States Agency for International Development (USAID) to address urban and industrial pollution and environmental quality in developing countries. The objectives of the program are:

- to establish sustainable pollution prevention programs in developing countries
- to transfer urban and industrial pollution prevention expertise and information
- to support efforts to improve environmental quality.

EP3 was launched in spring 1993 and utilizes three principal resources: a contract with RCG/Hagler Bailly, Inc. and 16 subcontractors, a cooperative agreement with the Water Environment Federation, and an interagency agreement with the U.S. Environmental Protection Agency. Activities in developing countries are initiated through buy-in agreements with USAID country missions. The first country to host EP3 activities was Chile, where an EP3 office was established in fall 1993. Since then, EP3 operations have begun in Tunisia, Egypt, Ecuador and Indonesia. EP3 offices in each country develop partnerships with environmental non-government organizations, government agencies, and industry associations.

APPENDIX C

BUSINESS CARDS OF PERSONS CONTACTED

NDB National Development Bank

R. D. GUNAPALA
Manager
SMI Department

P. O. Box 1825 - 40, Navam Mawatha, Colombo 2.
Tel : 448888, 437701-10, 437350-3, Res : 853934
Telex : 21399 NDB CE Cable : DEVBANK Fax : 440262

NDB National Development Bank

DEEPAL PEIRIS
Senior Executive - Project Engineering
(Environmental Unit)

P. O. Box 1825 - 40, Navam Mawatha, Colombo 2.
Tel : 437701-10, 437350-3, Res : 866316
Telex : 21399 NDB CE Cable : DEVBANK Fax : 440262

NDB National Development Bank

GEMUNU B. B. HERATH
Executive
(Environmental Unit)

[illegible] Navam Mawatha, Colombo 2
Tel [illegible] 437350-3
Telex [illegible] NDB CE Cable DEVBANK Fax [illegible]

C. RICHARD DE SILVA
CONSULTANT
OFFICIAL CO-FINANCING & TRUST FUNDS

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Raghu K. Raghavan
Program Coordinator

USAID

United States
Agency for International Development
Mission to Sri Lanka

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Sustainable development through community based resource management
NGO - Business partnership for Environmental protection

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CHEMITRADE LANKA
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Priya Wickremasinghe
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CHEMITRADE INDUSTRIAL COATINGS (PVT) LTD.

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Lanco

APPENDIX D

CURRICULUM VITAE

DONALD L. BROSKY

EXECUTIVE RESUME SUMMARY

Areas of proficiency are in the fields of wastewater and water processes, and solid/hazardous wastes, but includes all items "environmental". The experience, gained from working 27+ years for two of the most environmentally respected corporations in the US, has led to first looking for recovery and reuse opportunities before initiating control alternatives. Accomplishments include a number of waste minimization audits, compliance audits, published articles on pollution prevention/waste minimization plus numerous internal and outside presentations on these subjects.

CAREER HIGHLIGHTS

-Designing Kings Landing Industrial Wastewater Treatment Plant ($10 million) in 1967.

-Initiating the ultrafiltration experimentation of removing silver from wastewater that culminated in the emulsion washing breakthrough using UF membranes.

-Coordinating the entire environmental control program for Kodak Colorado Division. This included the applied research & development activity. (The program involved identifying the pollutants of concern and then developing processes to recycle or eliminate them from the manufacturing step - proactively.)

-Helping facilitate a 5 year 3M corporate waste minimization program to reduce wastes 7% per year through 1995.

-Working with the 3M corporate "Pollution Prevention Pays" (3P) program to spread cost-effective waste reduction. (3M made 94 cents for each of the 50 million pounds of waste 3P eliminated last year.)

-Training engineers, production workers, and management on waste minimization/pollution prevention, and serving on 3 Plant "Teams" helping them meet their waste reduction goals.

-Performing the first comprehensive Silver Balance around the Photographic Manufacturing processes at 3M Rochester/Honeoye.

-Starting the first hydrocarbon contaminated soil remediation in the State of NJ using agricultural methods.

-The good fortune to have chosen "Sanitary Engineering" as a vocation in 1956, and acquiring knowledge of critical path scheduling in 1963. (Born March 6, 1937;

EXPERIENCE

3/79-NOW 3M Company; Environmental Engineering & Pollution Control
Pollution Prevention Specialist; St Paul MN

(Began 12/89) Presently helping to facilitate a corporate 5 year waste minimization program to reduce wastes 7% per year through 1995. Also developing specific projects to recover plastic, energy, and recyclable metals from wastewater and trash with potential value greater than $15 Million/yr. This work involves training the Plant Waste/Min Coordinators, doing waste minimization/pollution prevention audits; developing accurate documentation of waste, working on "Teams" to accomplish Waste Reduction, and helping to justify changes.

I work with the 3M "Pollution Prevention Pays" program and data to help spread these concepts. Incidentally, this program made 80 cents a pound for each of those 55+ million pounds of waste prevented in 1992.

(Began 4/89) A temporary assignment to 3M Plants in NJ and W VA to find solutions for various wastewater, water, and air pollution problems. I worked with the people at the plants to either start projects that had not been successfully initiated, resume others which had developed unforseen bottlenecks, or complete some that had not been finished because of an untimely death, an unforseen departure and the unavailability of local resources to devote the necessary time to the projects. During this time I started the first hydrocarbon contaminated soil remediation using agricultural methods in the State of NJ.

(Began 4/86) Resident Principal Environmental Engr for the 3M Center; Corporate Headquarters & the major Research and Pilot Plant facility for 3M (5000 researchers and 12500 total employees). Responsible for the Hazardous and Non-hazardous Residuals entering the air, sewers, trash compactors, offsite incinerator, and recycle loops for about 6,000 tons/year of waste and 350 million gallons/year of wastewater. Concepted a Consolidated Recycle/Waste Handling Facility to optimize the disposal of trash and hazardous waste for 3M Center.

The position required close cooperation with the Safety, Ind Hyg, RTK, and other Staff groups; contact and exchanges with Regulatory Agencies and local Govt groups; training of and consulting with the researchers on their specific environmental problems; disposal of especially hazardous material, determination of "unknown" chemicals; developing engineered changes to improve the Spill Response & Handling, Water Reuse, and Disposal Efficiency for this facility as well as mitigate the negative potential problems of adverse publicity and potential chemical releases.

(Began 6/83) Environmental Contact for the 3M Imaging Systems, Graphic Prep, and Dynacolor Manuf Groups. Responsible for the env residuals of 12 Manufacturing plants in 9 States. During this time I performed the first comprehensive Silver Balance around the Photographic Manufacturing processes at Rochester.

(Began 4/82) Supervisor in the Env Eng & Poll Control Organization, responsible for the Division Environmental Contacts serving the Industrial Minerals Products Group, Industrial Tape Group, Packaging Systems Group, Industrial Specialties Group, Abrasives Group, Adhesives Coatings and Sealants Group, and Building Systems & Cleaning Products Group. These Manufacturing Organizations and Plants had the majority of Manufacturing Residuals which became waste in the 3M Corp. This group of 8 Engineers was responsible for 70% of the "Pollution Prevention Pays" submittals made by the EE&PC Organization (70+ people) that year.

(Began 3/79) Division Engineering Contact for various Manufacturing Divisions beginning with Technical Ceramics, Static Control, Industrial Specialties, Telcomm, Electrical Products, and subsequently Photographic Manufacturing, and Dynacolor; total of 18 plants.

5/72-7/78 Eastman Kodak Company; Quality Assurance Division Environmentalist; Windsor CO.

Product Specialist, Technical Services. Responsible for coordinating the total environmental control program for a facility which employed about 3000 people, and manufactured photographic goods and lithographic plates. This included direct contact with production personnel, regulatory agencies, university people, and some interfacing with environmental engineers at other Kodak facilities.

This position was actually a part of the Quality function, and I was additionally responsible for writing the request for - & subsequently directing - the applied environmental research activity (about $300K/yr) which involved removal and recycling techniques to eliminate contaminants and chemicals from the industrial sewer; adding another aerated lagoon, sludge drying beds, and effluent filtration at the waste treatment plant; and also agricultural research activities for effluent irrigation and sludge disposal.

In this position, I received significant experience in coordinating applied research on air pollution control and solid waste recycling approaches, but the main focus was on wastewater. I accomplished the technical supervision for 3-5 engineers and 1-3 technicians (who were administratively in Engineering). Obtained Colorado P.E. license.

9/66-5/72 Eastman Kodak Company; Kodak Park Engineering Division
Project Engineer; Rochester NY

I worked in various Engineering sub groups. In a Development group, responsible for the conceptual design of a 10 million dollar industrial wastewater secondary treatment plant; including evaluating alternatives, coordinating activity on environmental processes unfamiliar to engineers not accustomed to sanitary engineering concepts, providing flexibility in the design to accommodate items which could not be piloted, and the hydraulic design of the entire facility. These duties included preparing the engineer's report which was submitted to the N.Y. State Health Dept. Also did development work on new environmental concepts.

Subsequently took a position in the Utilities group where I was involved in the debugging activity on that secondary treatment plant, designed underground utilities and the subsequent responsibility to assure compatibility with various unique production and research building complexes. I began the preliminary design for a new 30 MGD process water supply, and conducted experimental work on ultrafiltration to concentrate water treatment plant alum sludge. The latter stages of this period I coordinated the wastewater aspects of the new manufacturing facility to be constructed in Windsor, CO. This was the time when we developed the breakthrough in washing emulsions. Received a P.E. license in New York.

1959-1966
Three years of military service, US Navy Civil Engineer Corps; two years of graduate school, John Hopkins University; one year each with a contractor and a consulting engineer.

EDUCATION

Attended Penn State University 1955-1959, graduating in 1959 with a BS Degree in Sanitary Engineering.

Attended Johns Hopkins University from 1962-1964, receiving a MS Degree in Sanitary Engineering in 1966.

OTHER

Chair of WRITAR Board of Directors. WRITAR is the Waste Reduction Institute for Training and Applications Research in Minneapolis MN, and is nationally known in the area of Pollution Prevention Training. I was also one of the 3 finalists for the Visiting McKnight Professorship two years ago at The University of Minnesota - Duluth.