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ECUADOR/ENVIRONMENTAL POLLUTION PREVENTION PROJECT

FINAL REPORT OF THE POLLUTION PREVENTION DIAGNOSIS ASSESSMENT EXPERIENCE

Prepared by:

Fausto Peñafiel **Danilo Díaz**

CORPORACION OIKOS

ACKNOWLEGMENTS

This report documents the EP3 experience regarding the implementation of the Pollution Prevention Diagnosis Assessment among a group of Ecuadorian facilities, so that any positive result could be eventually replied somewhere else This was a very huge effort throughout the overall three-year working period among many people involved such as EP3W, Oikos-E2P3 and Probono/paid consultants This type of team work demands a lot of human behavior cooperation and many times it is not easy to match skills among a group of professionals, however, at the end of the project, Oikos fully recognizes that this was not only an institutional achievement but also a group team effort succeed

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Hopefully all this expertise built throughout the performance of the project could be applied on the rest of the Ecuadorian industry and also abroad

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1 BACKGROUND

As a developing country, Ecuador is just beginning to be concern about environmental protection Enforcement is very weak throughout the country, but because Ecuador is starting to be competitive in the international market, the environmental protection must be mandatory Thus, the USAID mission in country, the US Environmental Protection Agency and Corporacion Oikos (a domestic NGO) together decided to develop the EP3 (Environmental Pollution Prevention Project) model in Ecuador This model has been working in many developing countries and it seems to adequatly encourage local people to start incorporating cleaner production and energy efficiency concepts into the productivity framework These written experiences have been taken from the Ecuador's experience and the reader can extrapolate similar results to other developing countries

The initial approach to start working in Ecuador were based on the Pollution Prevention Diagnosis Assessment (PPDA) model This approach concentrates its effort on leader industry champions that agreed to disseminate positive results among other plants As project matured, it was necessary to adjust to both the long term objectives of the project, and also to EP3's budget constrains Thus the group facility approach was initiated by Oikos in order to assist 23 textiles and 10 tanneries This work was done in the latter part of the project and the results have not yet been documented

This document reports results in progress for the PPDA model and from here a basis for a future work

A key component during this technology transfer process is the role of Corporation Oikos because is the domestic organization that will be pursuing the EP3 approach in the long term Oikos is a non profit organization which main objective is to pursue the transformation of the productive and cultural processes of the society, through a proper technological, scientific and environmental management, so that it does not interfere in the natural processes instead cooperates with the living systems over the earth The word Oikos derives from the Greek language root that means "the big house" or "the house of everybody"

2 OVERVIEW OF ECUADOR's INDUSTRIAL SECTOR

Before starting activities under EP3, it was necessary to analize the industrial sectors in order to better orient the planned work By evaluating real pollution prevention options as well as domestic capabilities and resources, the EP3 seed would produce positive results in the long term

The domestic industry can be summarized as follows

* Industrial development is mainly oriented to local market with a high imported level of raw materials and little opportunity to generate income from exports

* The industrial expansion is horizontal rather than vertical which does not allow the incorporation of all industrial sectors

* There is a lack of competitiveness due to the inefficiency within the processes

* There is a low utilization rate of the installed capacity

The current situation obviously impacts on the environmental problems For example,

* Production process are based on foreign technology an the obsolescent grade is crucial

* There are no relevant figures related to end-of-pipe systems in country

* At this point the enforcement, policies and strategies for environmental issues are just beginning

2 1 KEY INDUSTRIAL SECTORS

The next step was to classify the facilities in order to work in key sectors By searching on previous studies, facilities were clasified under different categories depending upon the type of specific need

In general terms according to the number of facilities, number of workers and total production, for an approximate number of 20,000 small/medium/large size plants over the country, facilities are classified as follows

Type of industries

Type of industry	Percentage (%)
Food processing, beverages and tobacco	18 3
Chemicals, oil refining, plastics, rubber	15 9
Textiles, clothing and leather	14 6
Metal forming, machinery	14
Paper recycling, paper products and printing	11
Non metal products	8 5
Wood and wooden products	7 9
Basic metal industry	5 5
Other manufacture products	4 3

Table 1
Source Oikos-E2P3 research

These sectors are the high-waste-rate producers that deserve special attention concerning environmental protection The wastes rate for each branch depends upon the quality of the wastes

Since water is one of the most important issues for pollution analysis, the industrial sectors with the highest water consumption flow are classified as follows

* Food processing, beverages and tobacco industry
* Textiles, clothing and leather industry
* Wood industry and wooden products
* Paper recycling, paper products, printing
* Chemicals
* Non mineral products (non oil and coal)
* Basic metallic industries

This represents a baseline information to identify most promising sectors for a P2 work

3 THE ECUADOR/EP3 APPROACH WITHIN OIKOS

Since EP3 is a world wide experience, Oikos evaluated previous experiences in other countries to learn from others and adapt to domestic needs The general scope of work for selecting candidates to work with is described as follows

* **Pre-Assessment** covers the steps leading up to an assessment including selecting facilities, negotiating agreements with facilities selected for assessments, and gathering data on facility operations to help focus the assessment team's efforts,

* **Assessment** includes the steps associated with conducting the actual pollution prevention assessment This phase covers the identification and analysis of opportunities and preparation of a report summarizing findings and recommendations,

* **Post-Assessment** includes the activities that in-country staff and consultants are primarily responsible for after an assessment in completed This phase continues indefinitely and is intended to ensure that facilities receive ongoing support in implementing pollution prevention programs

Three evaluation criteria were undertook based on Opportunity, Presence, and Importance for selecting first categories and after appropriated plants This selecting points are described below

* **Opportunity** There should be a significant number of commercially proven and documented pollution prevention opportunities that address significant environmental problems as evidence through government recognition attention, and possibly regulation

* **Presence** There has to be a significant amount of facilities having the potential of being involved in EP3, so that the efforts in country can be displayed to other sectors Medium and small size plants are especially important because they have fewer technical and financial resources to introduce and implement pollution prevention opportunities

* **Importance** Industries should have special significance in the context of sustainable economic growth, rapid industrialization and urbanization, and privatization There should also be some balance between large industrial facilities versus smaller enterprises, there should also be some diversity of business sectors, including manufacturing and service sectors, for example In addition to economic importance, industries may also be important because they are identified with major national environmental problems

For the PPDA model 78 screenings and prediagnosis were performed Additionally, 20 more facilities were contacted however pp options were very few with no significant savings, so that the Oikos-E2P3 team did not go through the screening process From the ones showing relevant options, 16 facilities were finally considered for the PPDA assignment So far all of them have been assisted and the implementation process continues This report intends to document the overall EP3 experience in Ecuador considering successful histories, obstacles for implementing a pollution prevention, domestic economy situation, and future work after the project will be gone

During the last year the group facility approach undertook over 33 facilities This was an interactive effort among the Oikos-E2P3 team, local consultants and plant people The model encourages technicians and managers in plant to find pollution prevention options by themselves rather than give them the solution for their problems This is a time consuming effort since not only local consultants but also technicians in plant have to be trained before being able to find options Results were very successful and Oikos will evaluate cases later on

4 METHODOLOGY AT EACH PLANT

Once a plan was defined the team started moving throughout a sequential steps to achieve objectives

4 1 Outreach phase

It was necessary to display a previous work with the facilities in order to better prepare the field before performing any technical work So that there are some key points to the overall work plan

a) Signing the agreement between Oikos and the facility
b) Setting objectives and defining the calendar of visits for the prediagnostic and diagnostic phases
c) Preparing the work plan for each specific plant

4 2 Setting specific goals

Basically the assessment goal focussed its attention on the following targets

a) Materials waste minimization by undertaking pollution prevention principles
b) Process energy optimization
c) Plan management improvement by processes optimization rules

4 3 Research phase

Research activities are done at each plant during a week The accomplishment of this task requires of the technical assistance of plant's engineers in an interactive effort with the Oikos-E2P3 team Process engineers are the ones that fully know the processes and energy aspects This general technical data contents information on

a) ***Processing field information,*** the engineer involved within the production activities are supposed to have on hand information such as workers and administrative figures, products made during last period, production capacity rise planning, source of water consumption local and imported materials and their cost, yields at each unit operation and processing change projects

b) ***Energy field,*** the engineer involved with energy matter should have on hand, among others, data on electricity bill, electric motors and equipment inventory, compressed air specifications process machinery, boiler specifications, steam line system and lighting system

The Oikos-E2P3 team role as an external facilitator, is important because facilities have to trust on the team before delivering internal information Is it not a matter of just filling out a technical questionnaire, instead several human behavior techniques have to be undertaken before establishing a friendship with the customer There are comments about other previous international programs that did not put attention on human behaviour and once the project was over, there was no local interested in pursuing long term goals

On the other hand, from the Ecuadorian technicians perspective, there are great expectations about having US experts for the technical visits, therefore if for any reason the foreign experts do not succeed on the field work, the credibility of the overall project suffered During this research phase, one of the strenghts of the local team was to work out on the empowerment of the technicians at each facility So that during the diagnosis phase it was easy to match capabilities of the US experts/E2P3-Oikos team and the facility counterpart

Major steps are described on the following table

Research Phase

Step to accomplish activity	Description	Level of effort	Responsible	Additional Comment
1 Identify Companies	Search on local information sources and also rely on local team experience to identify possible candidates to work with	3 days to develop list of candidates	Oikos-E2P3 team	Assumes use of EP3 worldwide experience to select candidates
	Use following criteria to assist in selecting companies - Size of facility - Number of process with toxic raw materials - Extent to which plant is representative of the industry in terms of process age etc - Public perception about the facility - Government perception - Environmental impacts - Willingness of the plant to invest - Financial status - Leader within the sector - Willingness to participate in the project	2 months	Oikos-E2P3 team with help from EP3W	This is a time consuming effort that requires a cross information from different perspectives
2 Contact facilities	Phone contact to identify person to contact introduce project and schedule of visits	2 hours	Oikos-E2P3 team	
	First introduction meeting with make decision person and provide more detailed information about Oikos-E2P3	0 5 days	Oikos-E2P3 team	It is important to handle some knowledge for each facility to better engage this introductory meeting

Step to accomplish activity	Description	Level of effort	Responsible	Additional Comment
3 Determine whether a full assessment is appropriated to be carried out	Collect preliminary data about main unit operations - identify operational units and inputs/outputs - track information on equipment operational procedures materials housekeeping practices, etc	1 day per facility (2-person team)	Oikos-E2P3 team	This preliminary information will allow to properly identify potential pp options At this stage the local team can define if further PPDA work is appropriated
4 Select the most adequate facility	Based on information collected make decision including preliminary schedule for PPDA	0 5 day per facility	Oikos-E2P3 team	Some facilities can be postponed depending upon economical situation in country
5 Prepare the agreement with the facility	Basically the overall EP3 format is used obviously updated to Ecuadorian needs - Require management to commit to a continuing effort to pursue on pollution prevention - Require management to participate in the process - Specify baseline information needed and require facility to identify as much pp options as possible according to facility needs _ Address issue of confidentiality of all delivered information to Oikos-E2P3 - Include workplan action and schedule	3 days per facility	Oikos-E2P3 team	Agreements are filed at Oikos offices
6 Develop work plan and schedule	Based on information collected during initial visit	1 day	Oikos-E2P3 team	Workplan focuses on highest opportunities at each facility
7 Set local/US team	Prepare the US expertise profile that is required for each plant EP3W makes final decision on the experts	2 days per facility	Oikos-E2P3 team	

Step to accomplish activity	Description	Level of effort	Responsible	Additional Comment
8 Performing pre-assessment step	Gather data about the plant based on following hints - Overall history of facility - Unit operations description - Flow diagram - List of main chemicals used input materials production levels waste generation data equipment energy consumption etc This report is sent to EP3W	2 days per facility	Oikos-E2P3 team	Preassessment report is used as baseline information for the PPDA

Table 2
Source EP3W handouts and Oikos research

4 4 Pollution Prevention Diagnostic Assessment

Once major data had been collected and processed, the PPDA's were conducted It has to be pointed out that because of budget constrain's, it was necessary to prioritize candidates to identify the facilities with the best pollution prevention options Additionally, the payback period was consider as a mechanism to present an option as attractive one for the decision making people perspective Attractive options have payback periods of less than two years

In order to better undestand the P2 opportunities with each sector, it was necessary to visit several plants from different sectors Thus 78 facilities were contacted and visited from 23 sectors From these 16 were chosen for PPDA's Table 3 summarizes different sectors and the status of the activity performed

List of facilities under the PPDA model

Industrial sector	Screening & prediagnosis	Diagnosis
Tanneries	4	3
Textiles	13	4
Paint (including resins)	4	
Metal forming	4	
Printing	4	
Galvanizing	3	
Batteries	3	
Paper	6	2
Ceramics	5	2
Plywood	2	
Cement	2	
Car assembly plants	3	2
Plastics	2	
Edible oil	2	1
Sugar mill	5	
Diary	4	
Dry cleaning	2	
Meat processing	2	
Bottling soft beverages	2	
Brewing	1	
Alcoholic beverages	1	
Chemicals	1	
Palm oil extracting	3	1
Total	**78**	**16**

Table 3
Source Oikos-E2P3 research

Pollution Prevention Diagnosis Assessment Phase

Step to accomplish activity	Description	Level of effort	Responsible	Comment
1 Brief assessment in U S prior to flying to Ecuador	Brief US experts based on information Oikos-E2P3 delivered 8 weeks before US experts are supposed to gather complementary information to bring down to Ecuador and share with local team	3 days per facility	EP3W core staff	Pre-assessment report is reviewed by experts
2 Brief assessment team in country prior to beginning assessment	Experts meet at USAID mission in Ecuador to brief the planned work Discuss roles planned activities and schedule among Oikos-E2P3 and US experts Many times the EP3W country manager came to Ecuador to behave as part of the team Address concerns about cultural issues pres-assessment report and potential pollution prevention options already identified during the preassessment	1 day	Oikos-E2P3-US experts	This time is very important to match everybody's point of view
3 Meet with plant manager/owner	Meet with the decision maker at each plant to review goals for the assessment introduce US experts present workplan confirm available information and clarify management concerns	2 hours	The whole team is led by Oikos-E2P3	Usually during the PPDA a person from the facility is designated to work close to the visiting team
4 First walk through facility to review operations	Look the entire facility's operations	4 hours	The whole team is led by Oikos-E2P3	At this point the information on the pre-assessment report is double checked
5 Obtain detailed information	Structure the complete flow diagram (inputs/outputs) and specific information for each individual operation Concentrate on raw materials chemicals energy and water usage Also consider waste quantities and byproducts generated	2 days	Assessment team	As PPDA comes out the final report is started step by step

Step to accomplish activity	Description	Level of effort	Responsible	Comment
6 Identify potential pollution prevention opportunities	US expertise is supposed to identify specific pp options	0 5 days	Assessment team	Once a P2 option is identified by the US experts the local team has to adapt it to local technology otherwise will appear like unrealistic solution
7 Prepare draft report with recommendations	Prepare the draft report by using EP3 format for this type of document Basically the report includes a short background information comprehensive unit operation description detailed pollution prevention recommendations financial benefits of the no/low cost recommendation and critical ratio analysis	4 days	Assessment team	Main objective is to leave in country almost a complete report so that the Oikos-E2P3 team can start with implementation actions
8 Present potential recommendations to general manager	Present findings and recommendations on facility assessment to decision making people and plant manager It is time to clarify questions about the recommendations Usually a debriefing meeting led by the local team is scheduled and US experts provide technical support for any question that may arise	4 hours	Assessment team	After the debriefing meeting there is a verbal commitment to deliver final report to the plant in about two months once the experts will submit the final version to EP3W
9 Finalize report	After feedback from both local team and EP3W the experts have to refine the overall report	Depends on the skills of the expert	EP3W has to put write under final format report	Usually Oikos needs to have on hand the final version to translate it into Spanish version
10 Translation of final report	The idea is to deliver a report written in Spanish version however many plants are skilled in reading on English language therefore for them the two versions are delivered	Translation takes 2 weeks	Oikos-E2P3 team	Before delivering the Spanish version, the Oikos-E2P3 team spend some time double checking technical words and expressions

Step to accomplish activity	Description	Level of effort	Responsible	Comment
11 Preparing the implementation plan	After receiving the final report the facility takes some time in responding about the implementation plan	Usually takes two months however it depends on the facility	Oikos-E2P3 team	This is a delicate effort and it is important for the plants not to feel pushed to do implementation Oikos-E2P3 behaves as facilitator to encourage them to change the process rather than push them

Table 4
Source Oikos-E2P3 research

4 5 Implementation Stage

Initiating any technical assistance in a developing country demands a lot effort since it is not easy to change the inertia This is the same for cleaner production/pollution prevention projects The implementation step is very demanding because all recommendation have to be proved as suitable ones Part of the interactive effort during previous phases was to adapt the US perspective of the foreign experts to local conditions Many times recommendations that worked out in the US never achieved good results in other countries This maybe is due to lack of technology and appropriate information, however, in some other cases the human behaviour of foreign experts was inadequate for the technology transfer process

The local team attempted to learn from past experiences, therefore, the implementation step has been refined and adapted to the needs of the facilities It has been important to keep periodic contacts with the facilities, not as a tracking activity but rather as partner to maintain the motivation It was not good enough just to show to industrialists that by incorporating pollution prevention concepts they could save money on the owner's mentality they prefer looking the income money rather than just saving money It takes time for people to get use to the new concept of "saving money" There are other circumstances surrounding industrial world that will be pointed out later on

The Oikos-E2P3 team displayed a very time consuming effort encouraging people to continue working on the implementation Several times facilities demand engineering advice on different topics depending upon specific needs

The main points are described below

Implementation Phase

Step to accomplish activity	Description	Level of effort	Responsible	Comments
1 Conduct periodical local follow-up	Usually the first follow-up contact takes place once the Spanish version of the final report is ready to be submitted Subsequent follow up take place on a monthly basis either visiting the plant or calling by phone Follow up consists of reviewing the P2 recommendations from the report in order to evaluate what is going to be done what is needed and as the stage comes up achievements that are reached Implementation schedules are adjusted as appropriated depending on each facility and obstacles that may appear	0 5 days per plant	Oikos-E2P3 team	Based on experience in Ecuador the best recommended way is visiting the plant This allows to build close relations through this long term pp effort Follow up continues until end of program to record major achievements and obstacles through the whole project time
2 Provide additional help as appropriate to each plant	The final report is a comprehensive analysis about what should be done and sometimes there are recommendations that implies further research Obviously the E2P3 effort does not have to research everything the main idea is to empower capabilities at each plant in order to pursue further research when need it However most of the times recommendations are fully explained and implementation does not represent any technical obstacles	As needs may appear The Oikos-E2P3 team is periodically refreshing technical aspects	Oikos-E2P3	Since cleaner production concept is starting in Ecuador it is necessary to move back and forward on the pollution prevention principles and some times eventhough the recommendations were clearly exposed during the debriefing meeting it is necessary to reinforce the ideas as the implementation goes on
3 Evaluate company's effort	Periodically the Oikos-E2P3 team evaluates the company's effort	As needs may appear	Oikos-E2P3	
4 Reporting successful results	It is highly recommended to go through a "experiences report" under a case study format So far many plants are ready to start collecting data and refining details	Depends on each plant	Oikos	

Step to accomplish activity	Description	Level of effort	Responsible	Comments
5 Dissemination to appropriate audiences	As fundamental part of the technology transfer process there were several seminars that had been performed with the presence of the US experts Seminars were scheduled as closing activity of the US experts assignment in country on the following fields - Tanneries - Painting process - Paper recycling - Ceramics Edible oil refining - Palm oil extraction Textiles			

Table 5
Source Oikos-E2P3 research

5 ANALYSIS OF FINAL RESULTS

After a three-year period of working under the PPDA model we are able to report the results of the overall experience There are many elements that can be analyzed in order to evaluate strengths and weaknesses so that the model can be improved

For the 16 plants the level of implementation of the recommendations ranges from 25 to 50% depending upon different circumstances at each plant Even though the pollution prevention initiative was fully understood by the plant decision makers, it takes time to be accepted at the technical level For any new idea, it is necessary to work through the process step by step repeating as many times as needed Several areas have been identified as suitable ones for an overall analysis for the whole package of facilities While a plant-by-plant analysis would probably deliver more specific conclusions, the main objective of a project like EP3 is not to concentrate the efforts just in few cases but instead analyze the group results in order to extrapolate results for the whole Ecuadorian industry

5 1 Current domestic economical scenario

The current economic situation is crucial to evaluate the level of implementation interested in major investments for improving the plants The weak Ecuadorian economy has suffered not only because of external factors but also Ecuadorian ones because of internal problems that some of them are out of control Over the past 15 years two main crisis have occurred at the beginning of the 80's and the last one starting on 1992 up to date The key factors that contribute on the current crisis are unstable political situation and excessive foreign debt The latter one probably is the most important and present signals such as

* Speculative investment
* Excessive number of financing institutions
* Decreasing rate of agriculture and industrial activities
* Increasing rate of foreign debt
* Lack of investment in productive activities

In order to have a clear idea it has to be mentioned that during 1986 the goods import rate reaches 9 56% and by 1995 this rate increased up to 19 81% Unfortunately, Ecuador has been spending money on imports rather than improving its internal production rate In theory in such conditions the most recommended attitude to maintain floating the economy is by controlling both the current currency and the Gross internal Rate No matter what happens it is not recommended to press these parameters because a deacceleration economy process can start running Unfortunately during the last years both the GIR and the current currency have suffered a deacceleration process This impacts directly on the exchange rate of the local currency in comparison to the US dollar that is the reference for domestic conditions By controlling the US dollar the Ecuadorian money is periodically deflated This instability causes major worries on financing policies so that interested rates for loans have ranged from 45 to 70% and sometimes higher Regarding financial conditions at the industrial plants there are two options some plants have financial resources but no incentive to invest in production

activities because speculative investments are more attractive other plants do not have own resources and the only way to get money is through the high interest rate loans from financial institutions Obviously getting expensive money it is not an incentive for any production activity

The economic situation already described caused industrial recession, and in approximately 1000 facilities their revenues decreased by 85 9% over the past four years This recessive situation can be averaged to the industrial sector considering that those 1000 plants represent the 80% of the whole activities displayed by the 17000 plants working right now

Tragic results of this scope is that both agriculture and industry have been sacrificed and in both sectors, Ecuador cannot compete This poverty is already causing major effects hundreds of facilities are almost in the bankruptcy stage and others are on the border line because of lack of businesses There are cases of multinational companies that were working for years in Ecuador and because of difficulties they decide to move to neighbors such as Colombia and Chile

In order to have a clear idea about the Ecuadorian crisis Table 6 depicts figures on crisis in different plants

Number of companies closed during 91-96 period

Year	A	B	C	D	E	F	G	H	Total
1991	82	16	199	2	70	336	24	198	927
1992	113	27	330	5	83	516	41	273	1388
1993	631	55	1089	9	407	2221	152	1420	5990
1994	348	40	470	1	226	1052	83	914	3134
1995	787	101	1023	8	408	2948	195	2246	7716
1996	81	25	157	3	53	313	26	256	914
Total	2042	264	3268	28	1247	7386	521	5313	20069

A – Agriculture
B = Mining
C = Industry
D = Electricity
E = Construction
F = Trade
G = Transportation
H = Service & human resources

Table 6
Source EKOS Magazine (December 15 1996)
Preparation Oikos-E2P3

Concerning the facilities that were chosen to work under the PPDA model, it was necessary to search very carefully on the candidates that were most willing to skip economical obstacles in order to move forward

5 2 Implementing recommendations

Even though the country suffered a very delicate economical situation as it was described above, the assisted facilities went through the implementation process depending upon specific needs By looking figures included in Appendix A it is clear that the Oikos-E2P3 effort

concentrated its effort on recommendations that have a short payback period at a low investment Only when no-cost-low investment options were exhausted, then other options were considered The key point was to encourage people to move forward by implementing first the most attractive options The implementation still goes on little by little so that it is not possible to show final results, however, based on actions that have been undertaken by plant managers it is possible to comment in advance some results There are three categories to identify the facilities according to investments

a) Aymesa, Incasa and Ales present an investment need from US$ 200,000 to US$ 500 000 and still remains a future work Due to economical scenario it has not been quite easy to set an investment plan for such huge amounts The general policy is to walk little by little due to the high interest condition for loans

b) Edesa, Palmoriente, Ecuapel require an investment need from US$ 100,000 up to US$ 200,000 to implement some options and still remains a future work The follow up actions still are required because major investment are programmed between 1997-1998

c) Maresa, Sintofil-Pifo, Sintofil-Quito, Recalex, Pint-Tex, Ceramica Andina require investments up to US$ 100,000 for doing the overall pollution prevention work Most of the facilities are textiles and this sector probably is one of the most affected because of the domestic economical situation The crucial problem for them is to survive day by day, however their interest in implementing changes within their plants still needs an encouraging action

d) The last group is comprised of three tanneries that require an investment need of less than US$ 100,000 for the overall work These facilities should be consider in a special manner since tanneries is the group that demands a lot of effort after the PPDA has been done

Comparing scenarios from figures 1&2 investments rates go up to 50% percent in those plants with higher financial capacity and in the small ones the implementation goes step by step For the case of the tanneries there are not updated figures about investments because the owners/managers have also weaknesses on management issues and financial aspects are not well organized

5 3 Obstacles to implementation

Difficulties that appeared during implementation stage come from different sides technical, economical and human behavior Probably the most important is the economical one because money is the driving force for any change During the follow up process a verbal survey was run in order to listen the difficulties that appeared during the implementation action

Technical aspects

As external agents that facilitate a pollution prevention work, the Oikos-E2P3 team identified circumstances that delay any initiative Nevertheless from these experiences it will be possible to extrapolate results for future work The best way to receive an objective comment about the obstacles was by performing a type of informal questionnaire asking different questions It was not possible to prepare a format for this survey because questions vary from plant to plant Main obstacles are pointed out below

* There is not the instrumentation culture in many plants and people think that instruments like flow meters are not required The Oikos-E2P3 team spend time training and encouraging people to install proper instrumentation

* Since main effort was put on wet processes there are some recycling recommendations that were identified One of the problems is the lack of room within the facilities to locate recycling tanks One way is to look for potential locations either outside or on the side of the building or in an adjacent facility however this imply high adequation costs for the facility

* A common factor within plants is the lack of information Once implementation stage start running the Oikos-E2P3 spend time training plant people on preparing information many time short reports were required as part of ongoing responsibilities, however it is not easy to move people from this quite attitude Record keeping would require time Besides planning needs to be scheduled to avoid process break through

* Changes on unit operations imply adjusting procedures and this represents a huge obstacles for human behavior It is required a minimal effort from production staff and this is not easy

* Usually the recommendations require a design, reengineering, construction (purchasing) and installation work under the facility responsibility Once improvements need further investigation, the feasibility of the operation depends upon timing of process operations, and the actual cost of installing accessories like a pumping unit These type of modifications require a significant commitment from production staff and usually they restrict manufacturing flexibility

* In some plants production plans are not well manage and this imply wasting time and resources The pollution prevention action recommend switching from pad operations to continuous operation immediately, this requires only the rearrangement of schedules and rewriting of manufacturing procedures that demand time and trials

* For certain reengineering modifications it is required a proper design that it is not easy available from a qualified design source Many times it necessary to ask quotes abroad rather than relaying on local firms

* Part of the equipment of the recommendations can be built locally and part has to be quoted in place near Ecuador In the case of equipment that is not locally purchased the imports department of the facilities require time for importing Because of internal conditions in country, importing equipment is a mid term assignment that have delayed the implementation actions

* Energy efficiency options as part of the pollution prevention recommendations have required adjustment on the process and also installing extra equipment for the steam line In the plants that have adopted energy efficiency actions installing the proper equipment (for instance heat exchangers) implies readjusting planning production and eventually some downtime has occurred for the machines while they were retrofitted

* Eventhough operations like switching old motors to high efficiency motors is a beneficial improvement, it has been necessary to reschedule operations in order to prior the motors for the initial stage This first step is very long and subsequent stages are expected to be much easier

* Another energy efficiency option is replacing the insulation material around the steam pipe line Even though this is a simple operation it takes time because of the complexity layout od the pipe lines in the facilities it has to be done incrementally, as time permits, by the facility staff

* After a facility has been moving on the processes optimization track, the next step is to look for automation alternative From the experiences of facilities that are thinking on this issue,the cost of equipment to upgrade to automate controls is high However, it is recommended that these facilities walk step by step achieving a gradual automation The main idea of automated controls is to bring the actual parameters to the theoretical values which will reduce costs

Environmental enforcement

The close loop assignment derives on the pollution control alternatives once a previous pollution prevention work has been achieved Thus one of the key points of the E2P3 effort is encouraging people to pursue on control alternatives in a gradual manner Pretreatment options first seem to be the proper approach however some difficulties appeared on track Comments on this are included below

* Ecuadorian enforcement concerning environmental care still is weak even though policies and some standards have been set throughout the ordinances under the municipalities So far facilities have no pressing reasons to improve wet operations at this time because environmental departments at each municipality are not well structured yet

* In the few plants that are willing to move further on control actions, space constrains make difficult considering either pretreatment or treatment systems However, for a couple of municipalities effluent restrictions are coming up so that facilities have to look for solutions

* From the 16 plants 4 for them are considering pollution control alternatives and problems on estimating costs are crucial A direct cost for analyses and a labor cost for sampling and record-keeping will be incurred Establishing an initial sampling protocol for effluent will be both time-consuming and costly, but subsequent monitoring will be much simpler

* As a specific policy it seems to be necessary to workout on an economic incentive for encouraging people to introduce on cleaner production initiatives So far project on water consumption optimization, for instance, are not attractive because the businesses are not subject to sewer charges Incentives on solids wastes and air emissions are highly recommended to be considered by central/local government

Human behavior

A key point during the implementation stage is the human attitude Even though each manager has agreed on pursuing optimization at the plants, medium levels are quite difficult to cooperate From this three-year experience it has to be noted that this technical approach has to be matched with psychological aspects that better allow moving on the implementation Some observations are included below

* Oftentimes neither supervisors nor employee has any desire to participate in this process optimization operation because it is much easier to maintain current practices Human attitude tries to maintain the initial inertial stage

* There is an initial plant resistance to implementing a project without a return because the saving money does not imply "income" and owners percepts as the profit just the income

* As a key element for any investment has been the fact of dealing just with options that present mid term payback periods (less than two years) If the recommendation has long payback beyond two years, justification of the changes for economic reasons is almost impractical

* As a cultural matter, once the US experts were announced as participants for the PPDA, expectations were great on plant people Thus the role of both probonos and paid consultants was very important If for any reason the expertise profile did not satisfy expectations, plants were reluctant on continuing a further work In this cases once people showed insatisfaction of the foreign experts, the implementation was extremely delicate for the Oikos-E2P3 because an extra effort on convincing people once again was necessary to display

APPENDIXES

Implementation status for each plant

APPENDIX A

INDUSTRIAS ALES
EXECUTIVE SUMMARY

Plant Description

This plant produces edible oil by processing soybean, palmiste and palm oil The plant is located in Manta a small port 300 Km north west from Quito Ecuador's capital It employs 600 workers, 3 shifts a day, most of the time 7 days a week Crude soybean is extracted through hexane solvent Crude soybean comes from domestic plantations and also from Argentina and the USA Both local crude soybean and imported crude soybean are refined through Alfa Laval method, bleached and deodorized

Besides edible oil, ALES makes vegetal lard, cloth washing soap and small amount of soap At the time of the PPDA was done also some trials of margerine were performed

The plant uses seawater which is pumped to the desalting plant at a rate of 1,200 m^3 per day An average of 516 m^3 per day (43%) of distilled water is obtained (24 hours/day) The remainder 684 m^3 (57%) is salted water that is pumped back to the sea

Main operations at the facility are

a) Oil extraction via solvents Soybeans are dried at ambient temperature, until a moisture content of 11% is reached Then soybeans are cleaned, milled and warmed The soybean pieces are laminated in small flakes The soybean flakes are feed in an horizontal sealed stainless steel container Since the exhausted soyflakes still have some solvent, they pass throughout an autoclave heated with steam Then the soybean flakes pass to a dryer, from where they go to a screener from where fall to a storage room Finally the dried soy flakes are manually packed and sold for animal feed

Crude soybean oil refining the plant applies the so called **"ALFA LAVAL"** method to refine local and imported soybean crude oil and crude cotton oil The refining is a continuous process

Bleaching To eliminate coloring substances the adsorbent materials are used Therefore refined oil is bleached with bleaching earth commercially named Filtrol and Tonsil The bleached oil is then filtered

Deodorizing The volatile compounds are separated from the bleached oil, making it passes through an overheated steam flow at 750 mm Hg and a temperature of 150 celcius

b) Oil extraction by mechanical means (Palm oil)

Clarification palm oil has less proportion of gums than crude soybean oil It is required to eliminate the impurities such as phospholipids, trace metals and fibers Therefore the crude palm oil is pumped through the oil heater to be heated up to 190 F

Bleaching clarified palm oil is bleached with bleaching earth The bleached oil is then filtered The wasted bleaching earth is discharged to the land field

Deodorizing the oil passes through a series of trays countercurrent to the ascending steam The oil is heated first at 150 celcius and then the temperature raises up to 250 celcius, that is the stabilizing temperature Then the oil is cooled at 45 celcius to allow it to be pumped to the storage tank

Fractioning plant the crystallization allows to separate in a vacuum continuous filter solid stearin from the liquid olein Stearin is used as a raw material to make vegetable lard and soap

Additional operations include the soap making plant, packing line, and storage

Implementation Status

Initially the assessment identified six pollution prevention options that could provide first year savings of 283,000 USD for a one-time investment of 281,000 USD (the investment figure does not include any salary expenses, overhead, taxes or duties) If implemented, these pollution prevention improvements will eliminate the oil discharges on the beaches of Manta, significantly reclaim waste water volume by 87,600 cubic meters per year and thereby reduce operating costs at the water desalination system, and, improve byproduct yields The assessment also identified six long-term, capital intensive pollution prevention changes that would cost 263,000 USD and could save as much as 280,000 USD upon implementation

So far one of the intensive cost investing project implemented by the facility was the installation of a new desalinizing plant, costing about USD 500,000 This technology has allowed to the plant to get water with less than 1-2 ppm hardness The problem of contamination at the drums washing station will be fully solved by the end of 1997, through the installation of a steam washing system instead of the usage of chemicals There are few other initiatives that have been undertaken, however, because of budget constrains other options have been delayed for 1997 and even for 1998

Table on the next page presents the assessment's findings in order of unit operation processes and also the implementation up to date

SUMMARY TABLE OF POLLUTION PREVENTION OPTIONS AND IMPLEMENTATION UP TO DATE

Unit Operation	Pollution Prevention Action	Health and Environmental Benefits	Cost to Implement USD	First Year Financial Benefits USD	Payback Period
1 Final Effluent Dissolved Air Flotation System	Replace with multi stage membrane process	Eliminate oil contamination on beaches of Manta Reduce BOD/COD of discharge	262 000	280 075	11 months
Implementation up to date	Undone instead the facility installed as alternative a new desalting plant, capacity 500m^3/d Total capacity 1 000 m$^{3/d}$ usage 700 m^3/d excess 300 m^3/d is sold US$ 0 86/m^3 for ice making	The needs for first quality water (1 2 ppm solids) are now satisfied	USD 500 000	TBD at the end of 1997	
2 Soy Processing Deodorizer Cooling Tower Discharge	Re route direct to reception traps avoiding mixing with solvent plant waste	To remove the oils from the tower overflow and to recover the protein from the extraction waste	1 000	Combined with the savings above	11 months
Implementation up to date	Done	This goal was achieved by implementing this recommendation	700	under evaluation	
3 Return Drum Washing	Change the sequence of washing to enable reclamation of oil	To remove this oil from the wastewater plant to recover salable oil	0	2 190	N/A
Implementation up to date	Done (a) By september 1997 the whole current system will be changed The washing will be done only with steam avoiding the usage of chemicals (b) Some current cans has been replaced with non reusable	To be evaluated by September 1997			
4 Maintenance Garage	Install oil recovery system	Reduced petroleum hydrocarbons in waste water	14 000	0	N/A
Implementation up to date	The streams of mineral oil and edible oil will be separeted Both streams will undergo specific treatment This measure will be implemented by the end of the year				
	Purchase and install flow barriers to isolate runoff from	To eliminate mixing of TPH oils with vegetable	4 000	0	N/A

Unit Operation	Pollution Prevention Action	Health and Environmental Benefits	Cost to Implement USD	First Year Financial Benefits USD	Payback Period
5 Maintenance Garage	sewer	oils in discharged waste			
Implementation up to date	Undone				
6 Employee Training	Develop and implement a comprehensive housekeeping, spill and emergency plan	To provide all employees with the training and equipment needed to maintain compliance	100	0	N/A
Implementation up to date	Done				
7 Environmental Management Plan	Prepare a 5 year plan that includes environmental concerns	Provides an inte grated approach to business and environment	100	0	N/A
Implementation up to date	Work in progress				

APPENDIX B

CERAMICA ANDINA
EXECUTIVE SUMMARY

Plant Description

Ceramica Andina is a ceramic mill located in Cuenca, a small city 400 Km south from Quito, the Ecuador's capital It is part of a huge ceramic group comprised of five facilities that produces ware and floor ceramic This has been working over the last 30 years and it makes domestic tableware with ceramic 8% porousness About 60 to 80% of the production is exported to Europe, Chile, Argentina and Central America The majority of the raw materials are locally exploited The net production averages 1,200,000 pieces per month This facility works 5 days a week and main operations are pasta preparation, filter press, forming machine, drying process at the bisk kiln, enamel deposition by means of apprpriate machinery and enamel curing at the glost kiln These operations work eight hours per shift, three shifts per day

Major pollution prevention options are concentrated on wet process and also on energy efficiency use at the kilns This facility was chosen for a pollution prevention work because any succesfull experience could eventually be replied in the other plants of the group

The owner is planning a major production expansion and desires to reduce or eliminate raw material and intermediate clay slurry losses, and to improve the performance of existing operations

Implementation Status

The overall assessment identified total losses for about US$ 489,222 per year which includes materials and energy losses There are some pollution prevention options that can save an estimated US$ 397,529 in the first year after implementation for an investment of US$ 159,135 The investment figure does not include plant modifications that may be necessary to install equipment or systems for the project, nor does it include any duties or taxes on items that will need to be imported

Of the 11 actions identified by the assessment, all of them are reasonable appropriated for a short-term investments The pay back period ranges from 1 month to 1 33 years which seems to be very attractive for the decision makers Recommendations try to encourage people to move forward looking for the best results It has to be mentioned that some recommendations are related one to another therefore to achieve the potential savings pointed out on this report it is necessary to follow the suggested sequential order

So far Ceramica Andina has invested USD 63,500 and it has gotten a financial benefit of USD 172,000 per year The simple weighed payback period is 4 4 months, which means that the company has already recuperated its investment

By now they are undertaking two big projects (a) Glost kiln and (b) Bisk kiln The aim is, according with the recommendations, reducing the energy losses It has to be pointed out that E2P3 conclusions on this matter were closed to the conclusions of a previous research done by a Swedish company Those conclusions were ratified during the last follow-up meeting held with plant management people on January 1st 1997 Plant people are working on the loading system that is an inadequate one

Table on the next page ranks the assessment's findings in a sequential order according to the unit operation processes and the recommendations, that have been accomplished

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit Operations	Pollution Prevention Action	Implementation Cost (US$)	Financial Benefits (US$)	Environmental Benefits	Payback Period (months)
1 Plastic and non plastic materials handling	Improve housekeeping practices Fducate material handlers	3 135	6480/year	Reduce raw materials handling losses thus conserving raw materials	5 8 months
Recommendation up to date	Partially done	2 500	2 200	Reduce raw materials handling losses	13 7
2 Raw materials	a) Quality Control raw material analyzer	10 000	TBD at forming stage	Recipe can be predicted material plasticity will be the required one and waste load to the environment will be controlled	TBD at forming stage
	b) Ball mill High share frequency mixing materials rather than Ball milling them	9 000	TBD at forming stage	Recipe can be predicted material plasticity will the required one and waste load to the environment will be controlled	TBD at forming stage
Recommendation up to date	a) Fully done The instrument is used at Ceramica Cuenca and Ceramica Andina b) Work in progress depending upon the quality of the raw materials	10 000	TBD at forming stage		
3 Filter Press	a) Re engineering of the filter press and adjust operating conditions and paste	Re engin 30 000 Filter cloth 10 000	TBD at the forming stage	Rework decreases productivity rises at the forming stage scrap load reduction to the environment	
	b) Solids recuperation and recycling them	TBD	29 624/year	Productivity rises and waste minimization to the environment	TBD at glaze
Recommendation up to date	a) Work in progress b) Fully Done	TBD	20 000	Decrease the load to the environment	
4 Forming machines	Same raw materials recommendation	Quality control analyzer (10 000)		Rework minimization, productivity rise and waste minimization to the environment	1 33 year

Unit Operations	Pollution Prevention Action	Implementation Cost (US$)	Financial Benefits (US$)	Environmental Benefits	Payback Period (months)
		High frequency 9 000			
		Re engineering 30 000			
		Filter cloth 10 000			
		Total 59 000	Total 44 325/year		
Recommendation up to date	Quality Control partially done				
5 Mold drying	Install a white dryer	2 000	TBD at bisk kiln	Productivity rises at bisk kiln station and scrap load reduction to the environment	TBD at bisk kiln
Recommendation up to date	Partially done	1 500	TBD at the bisk kiln	Scrap load to the environment reduction	
6 Bisk Kiln	Same as mold drying recommendation	Same as mold drying recommendation	21 888/year	Productivity rises and scrap reduction to the environment	1 1 month
Recommendation up to date	Fully done		20 000	Scrap reduction to the environment	1 0
7 Finishing	Valuable paste solids recuperation and recycling them	TBD next point	40 154/year	Raw materials savings and waste minimization load to the environment	TBD at glaze
Recommendation up to date	Fully done	TBD next point	30 000	Waste minimization to the environment	
8 Glazing	a) Valuable enamel solids recuperation and recycling them	9 000	40 286/year	Enamel raw material savings and waste minimization load to the environment	
	b) Savings due to the enamel and paste solids recuperation due to the usage of the same equipment as previous point		Total savings due to paste and enamel solids recuperation 110 064/year		1 month
Recommendation up to date	a) & b) Fully done	50 000	100 000	Enamel raw material savings and waste minimization load to the environment	12

Unit Operations	Pollution Prevention Action	Implementation Cost (US$)	Financial Benefits (US$)	Environmental Benefits	Payback Period (months)
9 Glost kiln	Improving load practices	44 000	100 580/year	Total raw material and energy saving Load reduction to the environment	TBD
Recommendation up to date					
10 Bisk kiln and glost kiln Energy saving issues	Improving load practices	88 000 (44 000 comes from previous point)	136 080	Fuel savings and reduction of the impact of associated environmental emissions resulting from hydrocarbons combustion	4 5 months
Recommendation up to date					
11 General considerations	a) Streams separate them				
	b) Oil and grease sealing holes and places where oil can be dropped				
Recommendation up to date	a) & b) Fully done	Minimal cost	N/D	a) Basis to apply pollution prevention program	

APPENDIX C

AUTOMOTORES Y MAQUINAS DEL ECUADOR S.A. (AYMESA) EXECUTIVE SUMMARY

Plant Description

AYMESA is one of the authorized assemblers passenger vehicles and light trucks for General Motors company It is the type of industry that intends to empower also local suppliers so that 30% of components such as carpets, batteries, windows, seats, tires, exhaust system, paint and other minor components come from domestic firms The facility employs 240 production workers and 220 administrative/sales people They work two shifts, eight hours per day, 5 days per week The plant assembles an average of 780 vehicles per month from which 16% are light trucks Almost 40% of its production is exported to neighbors such as Colombia and Venezuela Main sources for pollution are the surface preparation prior to painting and also painting itself Spot welding operations do not appear to have any negative environmental implications

Implementation Status

As it was stated, the major source for pollution or environmental contamination is located in the phosphating process and the storage, mixing, blending, application and disposal of paints Water is used to collect some of these potential paint emissions, and water is a medium for some of the pre-painting processing (phosphating) So far the facility has installed an immersion painting system right after phosphatizing, to improve the protection of the surface against corrosion

The plant's annual consumption of paint and paint thinner are estimated at 21,000 gal and 8,000 gallons respectively Water usage is estimated at 33,600 cubic meters per year All water is discharged directly to a municipal sewer without treatment Reportedly, the sewer is discharged directly to surface waters

The facility also has built a waste treatment plant, capacity 8 m^3/hour, costing about $300,000 There has been additional investments on instrumentation and laboratory equipment to test air emissions of the assembled cars Also it has been done some investments on the energy site, to improve boilers efficiency and lower air emissions to the environment Over the past four years AYMESA has invested about $700,000

Table on the next page, summarizes the pollution prevention opportunities and the implementation up to date The total investment arose up to $221,000 and the facility has saved and also has increase profits by $262,000 per year The pay back period is about 0 8 years

SUMMARY TABLE OF POLLUTION PREVENTION OPTIONS AND THE IMPLEMENTATION UP TO DATE

Unit Operations	Pollution Prevention Action	Cost to Implement STD	Financial Benefits STD	Environmental Benefits	Payback Period
1 Material Receiving	Replace wooden crates with returnable non wooden crates	unknown	unknown	Save wood for more efficient uses	immediate
Implementation up to date	Work in progress Dealing with the international suppliers				
2 Phosphating	Better control of carry over of solutions	none	$9 450/ yr	Less discharge to sewer	immediate
Implementation up to date	Fully done It has been substituted some chemicals at the surface preparation prior to painting section such as chromium The Phosphating process was modified to avoid carry over of solutions	a) Chemicals change $100 000 b) Phosphating process modification $50 000	$30 000 due to carry over reduction plus sales increase due to quality improvement profits rise (1%) $120 000/y		1 year
3 Ovens	Fuel controls	$4 000/ oven	$6 000/yr/oven	fuel savings less emissions	within 2 mo
Implementation up to date	Partially done	$6 000(total)	$5 000($2 500 each)		1 2 years
4 Prime & Finish Painting	Switch to Electrostatic Painting	$103 000	$130 000/ yr	lowered emissions & waste	1 year
Implementation up to date	So far painting process has been modified by 80% so that electrostatic system is not urgent right now	$50 000	$100 000		0 5 years
5 Paint Mixing	Closed mixing system	$20 000	$2 500/yr	Less vapor loss better paint handling	3 9 year
Implementation up to date	Fully done	$15 000	$5 000		3 years

APPENDIX D

CEDAL
EXECUTIVE SUMMARY

Plant Description

The mill produces anodized aluminum structural components for windows, doors and ceilings An average of 33% of their production is exported and 67% is sold to the local market All the raw materials such as aluminum and chemicals are imported mainly from USA, Brazil and Canada The mill employs 158 direct labor workers and 49 administrative Operations are run at three shifts per day, five days a week

The main unit operations include extrusion of the aluminum alloy, and the following chemical treatments (a) degreasing with detergents, to remove grease and dust, (b) caustic etching (also called scalding) in an alkaline bath, (c) neutralizing and deoxidizing in a sulfuric acid bath to remove aluminum oxides, (d) anodizing, (e) dyeing, which involves an electrodeposition of metallic salts, and (f) sealing, which involves a swelling of the aluminum oxide layer due to hydration, and coverage of the pores with metal salts

The anodizing line is semi-automatic, in that the racks of parts are moved along the line, lowered and raised automatically rather than manually, but the movements are under the control of an operator, rather than pre-programmed as they would be in a fully automatic line One rack of parts is dipped in a bath at one time Approximately 62 m2 of parts is hung on each rack

Implementation Status

After the initial PPDA, the pollution prevention options would generate financial benefits estimated at $55,000 in capital cost reductions for a waste water treatment plant, and $ 222,000 in annual operating expense reductions, if all of the options were implemented and all the assumptions were met Total investment for changes proposed by the team amounts to $ 361,000 Additional benefits include increased safety for workers, increased protection for people and ecology of the surrounding community, and a better public image as a good "corporate citizen " Payback times for the recommendations vary between 2 months and 4 years

The direct benefits of the options to the company are reduced volume and toxicity of wastewater, reduced chemical requirements, lower energy requirements, and lower hazardous chemical exposure to workers and to the surrounding environment Reduced wastewater volume and toxicity implies that the capital requirements and operating costs of the wastewater facility that will have to be built in the future will be smaller Since the company is

now planning to construct such a facility, there is an immediate need to thoroughly identify the opportunities for reduction of volume and hazardous constituents in the facility's wastewater

Once the final technical report was delivered to the general manager, it was the beginning of deep changes in the administration of the facility The reason was that the General Manager did not realize how much his company was loosing due to chemical waste and the its impact on the environment

Since then the facility has invested a capital cost of USD 66,020 The estimated financial benefits are USD 53,300 per year, the payback period is 1 24 years, and there is work in progress depending upon economic situation of the facility

Table on the next page summarizes pollution prevention options at CEDAL and the level of implementation of those ones

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit operation	Recommendation	Implementation Costs ($)	Annual Savings ($)	Environmental Benefits	Payback Period
1 Rinsing	Switch to Counter Current and Still Rinsing	5 000	55 000 in capital costs	Reduction in water usage	1 year
Recommendation up to date	The linkage of rinse 4 to rinse 3 to rinse 2 (#2 & #3 acidic)/pre neutralizing, and the linkage of rinse 7 to rinse 6 to rinse 5/pre sealing, have been partially done (about a 20%)	900	10 000	Reduction in water usage	0 09 year
2 Caustic Etch Rinse Bath	Extend Lifetime of Caustic Etch Through Selective Removal of Aluminum	300 000	77 000	Reduction in etchant disposal and chemical use	4 years
Recommendation up to date	Sodium aluminate will be removed by precipitating aluminum and leaving free NaOH to be reused The implementation of this project is well advanced by 30%	50 000	21 000	Reduction in etchant disposal and chemical use	2 3 years
3 Anodizing bath	Extend Lifetime of Anodizing Baths Through Selective Removal of Aluminum	40 000	98 000	Reduction in anodizing bath disposal and chemical use	0 41 years
Recommendation up to date	A resin bed column will be used to adsorb the ANOMAX and the unreacted H_2SO_4 Then those chemicals will adsorbed and reused This project has been partially implemented (about 10%)	4 000	6 000	Reduction in anodizing bath disposal and chemical use	0 66 years
4 Caustic Etch Rinse Bath	Recovery of Sodium Hydroxide from Caustic Etch Rinse Bath	5 000	4 600	Reduction in chemical consumption	1 08 years
Recommendation up to date	This project has been fully implemented	2 000	2 900	Reduction in chemical consumption	0 7 years
5 Draining	Install Additional Drain Boards to Reduce Chemical Losses	90	500	Reduction in chemical losses	2 months
Recommendation up to date	The project has been fully implemented	120	400	Reduction in chemical losses	3 6 months

Unit operation	Recommendation	Implementation Costs ($)	Annual Savings ($)	Environmental Benefits	Payback Period
6 Bath fumes	Control Toxic Fumes and Heat Losses from Process Baths	11 000	29 000	Reduction in energy costs and improvement in worker safety	4 6 months
Recommendation up to date	This project has been fully implemented	9 000	22 000	Reduction in energy costs and improvement in worker safety	4 9 months
7 Cleaning	Recovery of Sodium Hydroxide from Dye Cleaning Operation	Already paid for in option 2	12 300	Increase in etchant life	Reduces option 2 to 3 3 years
Recommendation up to date	This project will be implemented when option 2 is fully implemented				

APPENDIX E

ECUAPEL
EXECUTIVE SUMMARY

Plant Description

Ecuapel S A is a recycled paper mill headquartered in Guayaquil, Ecuador producing tissue paper at a plant in Babahoyo The plant employs 80 production workers and 30 administrative staff, and operates on a 24 hour per day, 360 days per year basis Steam is generated by onsite oil-fired boilers to meet the plant's thermal energy requirements, while electric power is supplied by the local utility which employs fossil fuel power plants

The crucial component is water which is pumped through a pump from the river nearby at a rate of 2,700 gallons per minute Then water is fed into a pool, from where it is pumped to the plant through a pump at a net rate of 1,300 gallons per minute A total weight of 857 tons of raw waste is mixed with water at a 70% moisture content Paper fiber stream is fed to the forming machine, which has a station of moisture extraction by vacuum and a moisture drying station by steam, being the final moisture content of 8% The finished product is then rolled and sent to another mill for the additional cutting operation

The owner desires to increase the facility's production through improvements in plant operations namely, elimination of fiber losses, reduced condensed steam leaks, improved steam generation efficiency and reduced energy (steam and electrical power) consumption New wastewater discharge regulations will require wastewater to be treated prior to release to the river which flows past the plant A reduction in production water use will directly reduce the size and cost of the treatment facility

Implementation Status

The overall assessment conducted at the Ecuapel facility identified a total of eight waste minimization and pollution prevention options that together can save around US $636,849 in the first year for an investment of US $188,500 Five energy saving options were also available in this plant an annual savings of $341,450 can be attained for a capital investment of about $288,700 The investment figure does not include plant modifications necessary to install the new projects

Six of the potential projects identified in the assessment were short term savings options with payback periods of 6 months or less, four projects had approximately a year to two year payback period, and three projects had either no payback or could not be predicted The short-term projects entail reduction in steam losses, boiler operation improvements, instrumentation upgrades and recovery of fibers lost in the wastewater discharge The intermediate term projects included wastewater recovery, installation of high efficiency motors and pulp reactor modifications

These proposed process improvements are critical in providing the means for Ecuapel to reduce its material losses, decrease utility costs and achieve other desired cost reduction goals

So far Ecuapel S A has recuperated about 90% of the fiber losses An approximate of 182 MT of raw fiber/month are recuperated Purchases of USD 25,880/month are saved It has been installed a recovery system, that includes a deinking unit coupled to line 2 but shortly will be coupled to line 1 as well The total capital investment and operating capital cost amounted up to date USD 102,000 and for the rest of the year there is an additional budget of USD 100,000 Total savings reach USD 29,308/month, from which 85 6% are raw material savings

Table on the next page summarizes the assessment's findings for each of the unit operation lines and the recommendations up to date

SUMMARY TABLE OF RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit operation	Pollution Prevention Recommendation	Implementation Cost (USD)	Annual Savings (USD)	Environmental benefits	Payback period (months)
1 PM 2 Pulp reactor	Add baffles to improve efficiency of pulping	5 000	2 349	Reduce electrical power requirements	24
Recommendation up to date	Fully done	7 000	3 000		28
2 PM-1 & 2 grit system	Provide grit dewatering chambers	5 000	None	Control the flow of water and debris	None
Recommendation up to date	To be placed between the river and the main pump Project to be fixed in August 1997				
3 PM 1 Sidehill system	Add fiber recovery system	60 000	365 000	Reduce fiber losses thus conserving raw materials used as input and reducing amount of fiber carried out in effluent waste water stream	2
Recommendation up to date	A fiber recovery system has been installed	5 000	70 000		1
4 PM 2 Sidehill system	1 Add fiber recovery system 2 Add sidehill/DAF unit	1 $ 5 000 2 $ 50 000	1 $ 67 000 2 $ 100 500	Reduce fiber losses thus conserving raw materials used as input and reducing amount of fiber carried out in effluent waste water stream	1 0 9 2 6
Recommendation up to date	1 Fully done 2 The DAF unit has already been installed	1 $ 5 000 2 $ 40 000 (There were imported only certain key parts The tank and the whole installation was made at the plant)	1 $ 70 000 2 $ 130 000		2 7

Unit operation	Pollution Prevention Recommendation	Implementation Cost (USD)	Annual Savings (USD)	Environmental benefits	Payback period (months)
5 PM-1 & 2 vacuum pump seal water	Recover the seal water from both vacuum systems for re use in the process	3 500	2 000	Recover process water for re use rather than discharge to waste treatment Will save on treatment plant size	21
Recommendation up to date	Project done Water consumption was reduced by 30 6% in PM 1 and by 42 % in PM 2	2 000	1 700		14
6 PM-1 & 2 Miscellany	Miscellaneous instruments alarms systems	TBD	TBD	Increased process control safety and reduced risk of overflows	TBD
Recommendation up to date	Work in progress				
7 Final effluent	Install sand filter on final effluent	60 000	None	Comply with regulatory demands and facilitate water recycling	None
Recommendation up to date	Once all the recommendations were implemented Ecuapel plans to install a waste treatment plant It will be a cell flotation system type capacity 2 000 gpm	Waste treatment plant quotation USD 600 000	None	Close loop water recycling No load to the environment and comply with regulatory demands	
8 Steam loss prevention	Insulation and steam trap program	5 200	30 200	Reduce the pollutant load caused by wasted consumption of bunker fuel	2
Recommendation up to date	Fully done	6 000	35 000		2
9 Boiler performance monitoring	Test the boiler for optimal burn conditions and adjust if necessary	4 500	17 600	Reduces fuel waste smoke particulates and carbon monoxide	3
Recommendation up to date	Fully done	2 000	10 000		2 4
10 Improved instrumentation for both dryers	Schedule the production runs to maximize the energy utilization	18 500	44 000	Reduction of air emissions	5
Recommendation up to date	Automation will be considered within the budget of 1998				

Unit operation	Pollution Prevention Recommendation	Implementation Cost (USD)	Annual Savings (USD)	Environmental benefits	Payback period (months)
11 Motor upgrade program	Repair replace older motors to improve efficiency	131 000	129 650	Reduce overall energy consumption	12
Recommendation up to date	There were bought and installed 8 high efficiency motors	35 000	32 000		13
12 Load management computer	Improve the operation of the plant by computerized load control	130 000	120 000	Reduce emissions at the facility	11
Recommendation up to date	Automation will be considered within the budget of 1998				
13 Recommendations summary	Various raw materials recovery water reuse and energy conservation methods	477 200	878 350	Reduce air water and solid waste generation	6 5
Recommendations up to date summary	Various raw materials recovery water reuse and energy conservation methods	102 000	351 700	Reduce air water and solid waste	3 5

APPENDIX F

EDESA
EXECUTIVE SUMMARY

Plant Description

Ecuatoriana de Sanitarios S A (EDESA) is a factory located in Quito, Ecuador that makes ceramic plumbing fixtures On an annual basis, it produces 850,000 major bathroom items, such as seats, tanks, wash basins and bidets The mill uses clay (70% national and 30% imported), silica, feldspar, limestone, and other minor components They mix the raw materials with water to make a slurry called slip The variability of the raw materials makes it difficult to control the density of the slip within the desired ranges This requires numerous (7) inspections for quality control Then the slip is pumped to the casting department to fill the molds Filling each mold requires an excess slip (approximately 2% by weight) While this should be recycled to the appropriate slip reservoir, this is rarely done as effectively as desired Value-added raw material is wasted into the treatment system

The parts are dried (without heat) to approximately 14% Further drying is done in chambers warmed by waste heat from the cooling stage of the firing kilns People should carefully control temperature, humidity, and air flow to prevent excessive internal stress during the firing stage After final firing, the products are ready for shipping

Implementation Status

The overall assessment identified six waste minimization and pollution prevention options that can save an estimated US$ 641,155 in the first year after implementation for an investment of US$ 1,040,000 The investment figure does not include plant modifications that may be necessary to install equipment or systems for the project, nor does it include any duties or taxes on items that will need to be imported

Of the six items identified by the assessment, two were short-term investments which would have a combined cost of US$ 280,000 and combined savings of US$ 258,000 in the first year after implementation The assessment identified one intermediate-term investment which would cost US$ 300,000 to implement, with savings of US$ 192,500 in the first year after completion of the work The assessment further identified two long-term, combined investment options which would cost US$ 265,000, with an estimated savings potential of US$ 115,055 in the first year after completion of the work The assessment also identified one long-term investment option which would require a capital cost of US$ 200,000, and provide estimated savings of US$ 75,000 in the first year after implementation

Over the last two years EDESA undertook significant administrative changes The company was bought by another international corporation Therefore the Oikos-E2P3 team spent a series of meetings with the new staff in order to update them about key points of the PPDA Also it was necessary to remark the importance of implementing the recommendations that came out from the full diagnostic

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So far EDESA has invested a capital money of USD 150,000 Annual savings of around USD 255,000 with a pay back period of 0 6 years have been estimated By August 1997 the company will switch from dry process to wet process The budget for this process change is USD 174 000 Besides, a new boot will be installed at the end of the drying operation in order to collect the fine dust and reuse it again

To fully implement the whole automation system suggested by E2P3, the company has taken into account a preliminary budget of over USD 1,000,000, to be progressively invested during the coming four years Table on the next page ranks the assessment's findings in order of the unit operation processes and evaluates the projects that already have been implemented, additionally those projects included for the second term of 1997 and the ones considered within the budget of 1998 have been included

SUMMARY TABLE OF RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit Operations	Pollution Prevention Recommendation	Implementation Cost (US$)	Annual Savings (US$)	Environmental Benefits	Payback Period (Years)
1 Plastic materials handling	Improved housekeeping practices	165 000	84 448	Reduce raw material handling losses thus conserving raw materials	2 0
Recommendation up to date	There has already been installed an ABB automatic conveying system to feed the plastic materials into the blungers Also the weighing is done electronically The system is still in progress toward improvement	100 000	75 000	It has been reduced raw material handling losses	1 3
2 Non-plastic material handling	Improved housekeeping practices	100 000	30 607	Reduce raw material handling losses thus conserving raw materials	* 2 3
Recommendation up to date	The greatest pollution is generated at the milling drying processes and conveying the plastic materials to the blungers therefore it was decided to switch from the dried process to the wet process	174 000	TBD once the project is in full operation (September 1997)		
3 Slurry processing area	Improved housekeeping practices	300 000	192 500	Reduce product raw material and water losses thus conserving these raw materials and reducing energy requirements that enables lower air emissions from the generating source	1 6
Recommendation up to date	This project has been partially implemented and dirty slurry made up of plastic materials is recovered and reused it again	40 000	80 000	Reduce plastic materials waste	0 5
4 Pasta processing	Improved housekeeping practices	170 000	54 300	Improved processing technique	3 1
Recommendation up to date	It has been partially implemented because as it was explained in #2 recommendation up to date the company will switch from dry process to wet process	40 000	30 000		1 3

Unit Operations	Pollution Prevention Recommendation	Implementation Cost (US$)	Annual Savings (US$)	Environmental Benefits	Payback Period (Years)
5 Casting room - Waste pasta recovery	Improved housekeeping practices	40 000	19 000	Reduce raw material and water losses with reduced energy requirements that enable lower emissions from generating source	** 1 0
Recommendation up to date	Done pasta coming out from the casting room is recuperated and reused it	10 000	25 000	Raw materials and waters losses have been reduced	0 4
6 Paste recovery - waste treatment plant	Improved housekeeping by recovering pasta that is now being discarded into waste treatment plant and reusing it in manufacturing process	240 000	239 000	Recovery of waste pasta reduction of solids in waste stream and reduction of waste put into waste treatment plant	1 0
Recommendation up to date	The budget of 1998 includes a close loop system through which pasta will not be drained to the waste treatment plant but instead will be recycled to the whole system	TBD	TBD		

* When combined with previous option

** When combined with following option

APPENDIX G

INDUSTRIA CARTONERA ASOCIADA S.A.
EXECUTIVE SUMMARY

Plant Description

Industria Cartonera Asociada S A (INCASA) is a recycle paper mill located in Quito, Ecuador which produces paper, paper board and egg cartons The plant employs 160 production workers and 40 administrative staff, and operates on a 24-hour day, 290-days per year basis Steam is generated by onsite (Bunker C) oil-fired boilers to meet the plants thermal energy requirements, and the electrical power is supplied by the local utility grid and is based on fossil fuel-fired powerplants

The crucial component is water which is pumped through a pump from the public line Then water is fed into a pool, from where it is pumped to the plant through a pump at a net rate of 1,300 gallons per minute A total weight of 600 tons per year are planned to process, an average of 25 tons per day and per machine is reached Paper fiber stream is fed to the forming machine, which has a station of moisture extraction by vacuum and a moisture drying station by steam The finished product is then rolled and sent to another mill for the additional cutting operation

The owner desires to increase the facility's production through improvements in plant operations and elimination of fiber losses, reduced steam leaks, improved steam generation efficiency and reduced energy (steam and electrical power) consumption

Implementation Status

The overall assessment conducted at the INCASA facility identified a total of six waste minimization and pollution prevention options that together can save around US$ 741,500 in the first year for an investment of US$ 586,000 The investment figure does not include plant modifications necessary to install the new projects or any duties or taxes The existing 25% duty on imported new electric motors has, however, been included in the economic evaluation It is estimated that the import duty on the motors would be about US$ 27,500

Five of the potential projects identified in the assessment were short-term savings options with pay-back periods of 8 6 months or less, the sixth was an intermediate-term project with a 21-month pay-back period The short-term projects entail reduction in steam losses, recovery of fibers lost in the waste-water discharge, recovery of fibers lost due to poor housekeeping practices and more efficient electrical motors for lines 1 and 2 The intermediate-term project involves the replacement of two old boilers with one large new boiler

These proposed process improvements are critical in providing the means for INCASA to reduce its material losses, decrease utility costs or achieve other desired cost reduction goals

From a follow up management action many projects were identified which have been accomplished by INCASA Those with a total capital expenditure of US$ 520,000 and savings of US$ 520,000 per year, within fiber losses savings for US$ 39,000 USD/year, production capacity rise for US$ 97,200/year and fuel savings for US$ 31,500/year It was obtained a weighed pay back period of 37 months

Table on the next page summarizes the assessment's findings for each of the unit operation lines and the current investments and savings obtained, those data resulting from the Oikos-E2P3 follow up activities up to date

SUMMARY TABLE OF RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit Operations	Pollution Prevention Action	Implementation Costs	Financial Benefits	Environmental Benefits	Payback Period (Months)
1 Line 1 5-roll paper machine	Replace electrical motors with premium efficiency motors	US$ 55 600	US$ 79 600	Reduce electric power requirements reduce emissions (e g CO_2 SO_2 NOx particulates) from power generation plant	8 4
Recommendation up to date	Planned to be done progressively in the mid term Main obstacle source financial difficulties				
2 Line 2 Fourdrinier machine	Replace electrical motors with premium efficiency motors	$ 40 200	$ 56 500	Reduce electrical energy usage resulting in reduced emissions from power generation plant	8 5
Recommendation up to date	Planned to be done progressively in the mid term due to financial difficulties				
3 Lines 1 & 2 paper machines	Improve housekeeping practices	$ 50 000	$138 000	Reduce fiber losses thus conserving raw materials used as input and reducing amount of fiber carried out in effluent waste water stream	4 3
Recommendation up to date	Planned to be done under a time demand quality control plan that should be done in different steps This is a time demanding effort				
4 Line 1 & 2 paper machines	Screen fibers from the water effluent going into the creek	$ 250 000	$324 000	Reduce fiber losses thus conserving raw materials used as input and reducing amount of fiber carried out in effluent waste water stream	9 3
Recommendation up to date A full project to save fiber waste has been implemented	Fully done	* Secondary Pulper $ 25 000 * Selectifiers cleaning system $ 15 000 * Rotative screen $ 10 000 * Static screen	Savings $ 39 000/y + Production capacity increase $ 97 200/y Total incomes $ 136 200/y	Reduce fiber losses and rise production capacity by 25% thus optimizing raw materials usage and minimizing wastage to the environment	30

Unit Operations	Pollution Prevention Action	Implementation Costs	Financial Benefits	Environmental Benefits	Payback Period (Months)
		$ 20 000 * New press system $ 270 000 * Total capital investment $ 340 000			
5 Utilities Steam	Repair steam piping leaks repair or replace steam traps and insulation on steam lines insulate steam lines	$ 40 000	$ 55 600	Reduce or eliminate steam leaks to save water reduce energy/fuel requirements thus reducing emissions from boiler/s	8 6
Recommendation up to date	Planned to be done in a near future				
6 Utilities Steam	Replace two old boilers with one large new boiler	$ 150 000	$ 87 000	Increased boiler operating efficiency enables fuel savings and reduces emissions from boiler/s	21
Recommendation up to date	Fully done	$ 180 000	$ 60 000	Efficiency grow up to 85%	36

APPENDIX H

MARESA
EXECUTIVE SUMMARY

Plant Description

This is an automotive assembly plant located 15 miles north from Quito, Ecuador The plant assembles automobiles from kits that are shipped to Quito Once parts have been assembled the vehicle bodies are prepared for painting in a wet dip process After priming, undercoating, and painting, the bodies move to the assembly line where the workers create the vehicle The pre-cleaning and wet dip processes generate most of the water waste Workers manually wash the bodies with a Zinc-base detergent They hose-off the detergent and all goes to the drain The vehicle bodies then go through a series of dip tanks alkaline cleaner, dip rinse, phosphate coating, dip rinse and, chrome passivation MARESA plans to switch to a non-chromium passivation system but there is not a final decision on this At the final coating area, there is a manifold to deliver the most used colors to the spray guns The facility uses a thinner of unknown composition to clean up and flush all lines Together with the isopropyl alcohol, they generate approximately 55 gallons per day of waste solvent

Implementation Status

Pollution prevention opportunities were identified in seven unit operations, namely, material receiving, phosphating, ovens, finish painting, paint mixing, deionized water, and cooling water The total one-time cost to implement all of the measures has been estimated to be about $153,000 and is expected to create annual financial benefits of $147,450 The bulk of the initial investment as well as the expected annual benefits would stem from switching to electrostatic painting This measure alone would lead to an annual gain of $89,000

The phosphating process and the storage, mixing, blending, application and disposal of paints pose a significant environmental problem About 20,400 cubic meters of water (costing $42,000) are used annually to collect paint emissions, and as a medium for some of the pre-painting processing (phosphating), yet all effluent is discharged directly to the San Antonio municipal sewer without treatment The measures recommended in this report would likely reduce the volume and virulence of the plant's discharges This could lead to significant potential savings in wastewater treatment facilities which may be required as environmental regulations in Ecuador are more strictly enforced

The facility has invested USD 47,000 to implement a 86% of the recommendations of and it has saved USD 46,200 The payback period is one year Table on the next page summarizes the recommendations and the implementation stage up to date

SUMMARY TABLE OF POLLUTION PREVENTION OPPORTUNITIES UP TO DATE

Unit Operations	Pollution Prevention Action	Cost to Implement STD	Financial Benefits STD	Environmental Benefits	Payback Period
1 Material Receiving	Replace wooden crates with returnable non wooden crates	unknown	unknown	Save wood for more efficient uses	Immediate
Implementation up to date	Under research dealing with the international suppliers				
2 Phosphating	Better control to carry over solutions	none	$9 450/y	Less discharge to sewer	Immediate
Implementation up to date	Partially done	none	$3 000/y	Less discharge to the sewer	Immediate
3 Ovens	Fuel controls	$20 000 for 5 ovens	$33 500)/y	fuel savings reduced emissions	within 2 mo
Implementation up to date	Partially done	$ 25 000/Y	$20 000	Fuel savings reduced emissions	1 3 years
4 Finish Painting	Switch to Flectrostatic Painting	$103 000	$89 000)/y	lowered emissions & waste	1 year
Implementation up to date	Needs more research for Ecuadorian conditions				
5 Paint Mixing	Closed mixing system	$20 000	$4 500	Less vapor loss better paint handling	4 5 years
Implementation up to date	Partially done	$10 000	$2 000		5 years
6 Deionized Water	Reduced usage and waste	25	40 000 gal*$0 25= $10 000/y	Save of DI Chemicals and water use	Immediate
Implementation up to date	Partially done	none	$ 10 000/y		Immediate
7 Cooling water	Install more efficient cooling tower	$10 000	$100 000 gas * $0 01 = $1 000	Water saving	
Implementation up to date		$12 000	$1 200	Water saving	Immediate

APPENDIX I

PALMORIENTE

EXECUTIVE SUMMARY

Plant Description

Palmoriente is a crude palm oil extracting mill located in Francisco de Orellana (El Coca) town, Ecuador An average of 8363 19 MT per moth of fresh palm fruit bunches were processed from July 1995 to July 1996 An average yield of 20 99%, on a fresh fruit bunch basis, of crude palm oil was reached for this period, which represents 1755 25 MT per month of crude palm oil An average of 329 55 MT per month of palm kernel with no shell included were produced during this period, which represents an average of 3 29% on the FFB basis The facility policy is pursuing better industrial practices in order to increase the extraction yields up to Costa Rican, Colombian and Malaysian rates, which are supposed to be the highest ones over the world for this type of industry

The facility employs 62 workers and 11 administrative The operations are run from July to December, 2 shifts per day, and from January to June, 3 shifts 7 days a week, 8 hours/shift Water is pumped from the river nearby and then softened for the boilers An average of 9,600 m^3 of water per month is pumped for the process Effluent from the plant is discharged to a series of 10 oxidation ponds to undergo biological oxidation and final discharge to the Coca River

Main unit operations are **Cleaning and loading**, fresh fruit bunches are dumped into metalic baskets, and reloaded into a sterilizer, **Sterilization**, fresh fruit bunches are subjected to live steam under a pressure of 35 to 45 psi for 45 minutes, 130 °C in
an horizontal retorts, **Stripping**, sterilized bunches are fed continuosly into a rotary drum stripping machine, **Digestion**, this operation converts the fruit into an oil mash suitable for mechanical pressing, **Pressing**, the oil mash is fed continuously into a worm screw press for extraction of crude oil (deoiled fibrous material is used as fuel for the steam boilers which in turn, by operating steam turbines, produce electricity), **Clarification**, this operation takes place within a series of stainless steel tanks by injecting steam, **Drying**, the crude palm oil falls into a dehydration stainless steel tank to receive steam injection, **Storage,** none antioxidants are added to the final crude palm oil
to prevent oxidation

Implementation Status

There are some pollution prevention options that can save an estimated US$ 943,771 in the first year after implementation for an investment of US$ 460,000 The investment figure includes purchasing equipment or systems for the project, however does not include any duties or taxes on items that will need to be imported

Of the 7 actions identified by the assessment, all of them are reasonable appropriated for short-term investments The pay back period ranges from 10 days to 11 months which seems to be very attractive for the decision making level Recommendations try to encourage people to move forward looking for the best results It has to be mentioned that some recommendations are related one to another therefore to achieve the potential savings pointed out on this report it is necessary to follow the suggested sequential order

It has to be mentioned that the facility decided to implement most of the recommendations in a progressive fashion so that for the first semester of 1997 the capital investment will reach USD 198,500 that will be distributed as follows USD 100,000 for a full automation system of three autoclaves, USD 52,000 to build two new autoclaves, which will replace the old ones, USD 45,000 for a new horizontal settling tank (clarifier) and the remainder used to configure the diesel plant with an automatic control to switch from the steam turbine to the diesel plant when a break down appears A major investment will be accomplished by late 1998 since plans have been delayed because of internal adjustments

Table on the next page ranks the assessment's findings in order of the unit operation processes and a major capital investment until September 1997 and future plans

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit Operation	Pollution Prevention Recommendation	Implementation Cost (US$)	Annual Benefits (US$)	Environmental Benefits	Payback Period (months)
1 Harvesting	Use a net to dump 800 Kg of FFB to catch the bunches and the loosened fruits and 70 HP with a hydraulic crane	135 000	242 485	This will avoid the 3% loosened fruits on the ground that eventually will increase the organic load on the ground	7
Recommendation up to date	Fully implemented by 1998				
2 Sterilization	1 Build nine additional trolleys to diminish the dead time between cycles 2 Install an automatic system with PI Cs and electric valves rather than pneumatic ones for the sterilization system	49 000	200 164	By improving sterilization there will be less amount of useless organic material	3
Recommendation up to date	a) Several quotations have been asked to different suppliers b) Two new sterilizers are being built The full system will be installed by 1998	Sterilizers $ 52 000 Automation $ 100 000	To be evaluated in October 1997 right after the new autoclaves and the automation system have been installed	The expected environmental and production benefits will be achieved	
3 Excess fruit removal	Install equipment to cut bunches and recuperate the fruit automatically	30 000	31 302	By increasing the stripping capacity by 3 75% the organic load to the environment will be reduced	11 5
Recommendation up to date	Will be fully implemented by 1998				
4 Oil recovering	1 Replace the screener by a double screen layer rotary screener 2 Replace the horizontal settling tank with a vertical tank with a stirrer 3 Replace the sand cyclone 4 Eliminate the rotary brush strainer 5 Eliminate the pumps that maintain the dynamic pressure on the centrifuges by creating a static pressure on top of the sludge tank 6 Replace the Alfa Laval centrifuges with start up (horizontal) type centrifuges 7 Improve the design of the fat pit	89 000	245 420	Lower the oil losses in the sludge that has to be discharged as effluent	4 5

Unit Operation	Pollution Prevention Recommendation	Implementation Cost (US$)	Annual Benefits (US$)	Environmental Benefits	Payback Period (months)
Recommendation up to date	1 Full project to be installed by later 1998 2 It has been quoted and it will be installed the new vertical settling tank (clarifier) in November 1997 (so far tank is being made) 3 This project will be installed in November 1997 4 This project has already been done 5 About this project nothing has been defined yet 6 It has not been decided wether or not the Alfa Laval centrifuges will be replaced by the start type centrifuge 7 This project was done	Project #2 is the most cost investing of all this group $ 45 000	Financial benefits will be possible to be evaluated in October 1997 right after all the projects have been accomplished	Losses will be evaluated in September 1997	
5 Drying	1 Replace the current dryer by a vacuum system 2 Install a stirrer to avoid burning the oil on the surface of the coil and to avoid crude oil stearin separation during storage 3 Store at a maximum of 40 50 Celsius	30 000 (dryer) 16 000 (agitator)	41 688 (dryer) 25 212 (agitator)	There is not direct impact on the environment however this will reduce the free fatty acids load that will receive a penalty at the refinery plant	9 (dryer) 8 (agitator)
Recommendation up to date	Projects #1 and #2 will be considered in the budget of 1998 Project #3 already has been done			To be evaluated once the project has been implemented in 1998	
6 Power generation	Run turbines at maximum capacity to meet all demands Configure diesel plant with an automatic control to switch from the steam turbine to the diesel plant once a break down occurs	1 000	34 500	It is an energy efficiency practice that impacts on the overall environmental sense because it is a better utilization of the energy sources	10 days
Recommendation up to date	Project done	1 500	37 000	A better energy usage has been achieved	15 days
7 Empty bunches pressing	Cut the empty bunches and press them in a 75 kW monoscrew press to extract a mixture of oil water	110 000	123 000	Reduce the oil content in the empty bunches that currently are thrown into the fields as fertilizers	11
Recommendation up to date	This project will be done in 1998			To be evaluated in 1998	

APPENDIX J

TEJIDOS PINTEX
EXECUTIVE SUMMARY

Plant Description

This is a textile mill located in Quito It produces poly/cotton (50/50) bedcloth fabrics Cotton is purchased from local suppliers Polyester fibers are imported from Brasil, Mexico and the USA The average monthly production is 660,000 meters The plant employs 400 workers and 50 administrative Weaving, preparation prior to dyeing and dyeing and printing processes are run five days a week, three shifts a day plus 8 hours on Saturday

Main unit operations are **(a)** Quenching and washing, **(b)** Continuous desizing with a solution containing water and detergent (then follows rinsing of desizing), **(c)** Bleaching and rinsing in the same machine, **(d)** Thermosetting in rama to avoid fabric shrinkage, **(e)** Dyeing in a Foulard dyeing machine (next comes the rinsing of dyeing), **(f)** Drying, **(g)** Thermosetting to give adequate texture, softness and size, **(h)** Finishing, **(i)** Polimerizing to give a special finishing, **(j)** Calendering to give brightness, and **(k)** Cutting, folding and packaging

Implementation Status

The first seven recommendations summarized in the below Table provide a total estimated fuel savings of $65,600/year, an estimated chemical savings of $5,500/year, a reduced electricity savings of $3,700/year and a projected avoided wastewater treatment investment of $235,000 and an avoided annual operating cost of $23,500/year The total capital investment to achieve these savings is estimated to be less than $30,000 Two recommendations provide capital investment for energy savings with payback of less than 4 years The remaining eight recommendations provide potential pollution prevention options that could result in cost savings but, insufficient information was available to determine the cost and savings These recommendations are considered valuable and certainly worth further study by the facility to evaluate potential savings

Note, that many discrepancies in information received from facility operators during the pre-assessment and assessment interviews were identified Unfortunately, the facility was unable to validate the majority of the data provided with standard measurement calibrations and operating information All recommendations are based on the what appeared to be the most reasonable data and good engineering assumptions used for other similar types of operations The authors strongly recommend that the facility independently review the assumptions, make appropriate measurements, as suggested, and re-evaluate cost and savings estimates based on better qualified data

By November 20th 1997, the facility will be implementing four major recommendations, summarized underneath the identified opportunity Pintex has made a total investment of USD 23,985 Savings for US$ 4,924 per month (US$ 59,008 per year) with an weighted average payback period of 5 months have been reached This statement is supported by the letter-report prepared by Pintex people which is attached to this follow-up report The remainder recommendations are either under research for implementation feasibility or the investment is under consideration Nevertheless the main reason why the facility has not undergone a full opportunities recommendation is due to financial problems rather than technical ones

The facility has stated as highly motivating and positive the work done by the project E2P3 and suggest that it should be completed with financing aid, which means possibility to get loans at low interest rates for environmental projects

SUMMARY TABLE OF POLLUTION PREVENTION OPPORTUNITIES AND IMPLEMENTATION UP TO DATE

Unit Operation	Pollution Prevention Recommendation	Benefit	Implementation Cost (US$)	Estimated Savings	Payback Period
1 Management System	Establish Standard Operating Procedures	Is essential to implementation of existing recommendations and further evaluation of process improvements	2 000	Indeterminate	Indeterminate
Implementation up to date	By mid 1997 a handbook of SOP might be ready				
2 Rinsing	Reuse rinse water from latter stages of wash operation	Reduce water use by 163 m^3/day	2 000	US$2 400 per year in well water pumping, US$100 000 and 10 000 in future WWTF capital and annual operating costs respectively	10 months
Implementation up to date	Water usage reduction done		552	US$ 184 per month (US$ US$ 2 206 per year)	3 months
3 Bleaching	Reuse final overflow from bleach washing in desizing	Reduce water use by 100 m3/day chemical cost savings energy savings better fabric cleaning	20 000	US$2 000 per year in chemical costs US$37 000 per year in energy costs future WWTF capital and annual operating savings of US$75 000 and 7 500 respectively	6 months
Implementation up to date	Fully done		Practically no investment was required	USD 1 143 per month (US$ 13 714 per year) in chemical savings	Immediate
4 Desizing	Optimize desize operation	Reduce water use by 50 m3/day possible chemical savings	Further study needed most improvements require minimal cost	US$800 per year in pumping costs US$35 000 and 3 500 in future WWTF capital and annual operating costs respectively	Immediate
Implementation up to date	TBD by mid 1997				

Unit Operation	Pollution Prevention Recommendation	Benefit	Implementation Cost (US$)	Estimated Savings	Payback Period
5 Bleaching	Optimize bleaching operation	Slightly reduce water use and caustic discharge chemical cost savings	2 000	US$3,500 per year in chemicals	7 months
Implementation up to date	Planned by mid 1997				
6 Washing	Optimize washing operation	Reduce water use by 37 m3/day	Further study needed most improvements require minimal cost	US$500 per year in well water pumping US$9 700 per year in energy costs US$25 000 and 2,500 in future WWTF capital and annual operating costs respectively	Immediate
Implementation up to date	Planned by mid 1997				
7 Printing	Optimize Print Operation	Reduce energy consumption and pigment loss	2 000	$18 900 reduced diesel cost	<1 month
Implementation up to date	Research is undertaken to define recommendation feasibility				
8 Drying	Install vacuum slot de watering device	Reduce energy consumption by reducing water load to dryers	35 000-40 000	$10 500 per year	<3 5 years
Implementation up to date	Undone due to financing problems However the reuse of the steam condensate of the Rama ARTOS was done		Cost to implement the reuse of the steam condensate US$ 17 873	Current energy savings due to steam condensate reuse US$ 2 978 per month (US$ 35 736 per year)	6 months
9 Energy management	Replace old motors with high efficiency motors	Reduce electricity consumption	50 000	$14 000 per year	4 years
Implementation up to date	Undone due to financing problems				
10 Dyeing bath chemical mixing	Improve dye bath chemical mixing	Reduce dye spotting	200	Indeterminate	Indeterminate
Implementation up to date	Fully done		Negligible	Indeterminate	
11 Dyeing	Maximize dye exhaustion	Reduce dye waste	None	Indeterminate further study needed	Indeterminate
Implementation up to date	Feasibility is under research				

Unit Operation	Pollution Prevention Recommendation	Benefit	Implementation Cost (US$)	Estimated Savings	Payback Period
12 Finishing	Apply finish in dry operation	Reduce finish waste	TBD	Indeterminate further study needed	Indeterminate
Implementation up to date	Under research				
13 Manual Cleaning	Manual clean printing equipment	Minimize chemical waste	None	Indeterminate further study needed	Indeterminate
Implementation up to date	Undone since dead time will affect productivity				
14 Softening water process	Evaluate process water softening	Reduce detergents required reduce water use minimize fabric spotting Increase boiler efficiency reduce fuel costs	100 000	US$9 000 in chemicals possible increased profit margin in other markets	Indeterminate
Implementation up to date	Investment is under consideration				
15 Water Management	Institute a water monitoring program	Essential to strategic planning	6 000	Indeterminate (potential benefits could be great)	Indeterminate
Implementation up to date	Fully done		5 557	US$ 618 per month (US$ 7416 per year)	9 months
16 Printing	Evaluate a computer based color matching system	Less chemical waste	10 000	Indeterminate further study needed	Indeterminate
Implementation up to date	Investment is under consideration				
17 Management Process	Substitute chemicals/change processes (when appropriate)	Improved environmental compliance reduced wastewater treatment burden	Indeterminate	Indeterminate further study needed	Indeterminate
Implementation up to date	Research on track				

APPENDIX K

RECALEX
EXECUTIVE SUMMARY

Plant Description

This is a textile mill located in Quito The facility produces poly/cotton (65/35), polyester 100%, acrylic 100%, nylon 100%, knit fabrics In a near future the blend acrylic/cotton (50/50) will be produced Besides acrylic fiber and nylon thread are made An average of 75% cotton is purchased from local suppliers and 25% cotton is imported from the USA Nylon fiber is imported from Brasil, acrylic fiber is imported from Spain polyester fiber comes from Mexico and Spain The average monthly dyeing capacity is 165 metric tons (1,980 MT/year), for which a 23,000 m^3/month of water might be consumed The current average fabric dyeing is 65 MT, which means a 39 4% of the dyeing installed capacity

The plant employs 18 workers and 6 administrative Main unit operations are **(a)** Batch desizing with a solution at 85 °C containing water and detergent, **(b)** Optic and chemical bleaching at 90 °C is carried out in the same bath, **(c)** Dyeing is carried out in a jet over flow (8 1 liquor ratio), jet not overflow (12 to 15 1), open three sections rama (12 1), closed rotative barca(10 1), two smalls open barca (12 1) and autoclave (15 1) dyeing machines
None of the solutions used for desizing and bleaching are reused The water rinsings are not reused as well

Implementation Status

This assessment identified 16 pollution prevention opportunities that should be seriously considered by Recalex Many of the savings can be realized by simply improving operating procedures and standardizing operations Seven recommendations require small to medium capital investments in standard equipment used in similar textile dyeing operations, however, six of these recommendations yield a payback of less than 1 year An additional five recommendations are considered indeterminate payback because sufficient information and time were not available to adequately assess the savings and payback

The final recommendation has a substantial capital cost associated with installing wastewater treatment system Implementing the other 15 recommendations will significantly decrease the cost of this system once pretreatment/treatment installation will be required by the municipality

So far the facility has invested USD 34,500 to implement part of the recommendations It has obtained a financial benefit of USD 97,500 a year The load to the environment may be reduced by 20% It would be confirmed once some tests on BOD, COD, TSS, and SS will be done on the effluent Table on the next page summarizes implemenation stage up to date

SUMMARY TABLE OF POLLUTION PREVENTION OPPORTUNITIES AND IMPLEMENTATION UP TO DATE

Unit Operation/Recommendation	Health and Environmental Benefit	Cost to Implement	Estimated Savings First Year	Payback
1 Standard Operating Practices and Audit Measure time temperature bath volume chemical use water use fuel use water effluent	Comparison of actual vs theoretical use of water chemicals and fuel indicated significant differences Necessary prerequisite to optimizing process and reducing production costs	Labor to measure practices and calculate values	Indeterminate	Indeterminate
Implementation up to date	Partially done The facility s Owners have become aware of the differences between the previous data and those collected on the basis of instrumentation			
2 Install flow meters on incoming and effluent water stream (2)	Determining actual water use is necessary for properly scaling treatment equipment	$250 $1 500 each	Indeterminate	Indeterminate
Implementation up to date	Partially done	$250	30% water savings in volume Since water is pumped from a well water this resource is costless hence no monetary savings were estimated The only savings are the pumping savings (USD 500/year)	Immediate
3 Install pre treatment system for water fed to boiler	Reduce reported 10% rework due to inconsistent water Reduce time and quantity of boiler blowdown Increase efficiency of boiler	$35 000	$83 000	<6 months
Implementation up to date	Work in progres	$15000	$55000	3 3 months
4 Return steam condensate back to boiler	Reuse of waste heat	< $200	$4 500	< 1 month
Implementation up to date	Done	$150	$3000	0 6 months
5 Install heat exchangers in Beck Machines and rotary machines	Greater heat transfer efficiencies achieved with indirect heat Reduce fuel costs	$4 500	$4 500	1 year
Implementation up to date	Rejected The planning of the plant is to replace the beck machines			
6 Recover heat from heated baths effluent	Reduce fuel loading and boiler demand	$15 000 $20 000	$11 000 $14 000	1 3 1 5 years
Implementation up to date	Included in the budget of 1998 first semester			
7 Improve housekeeping and maintenance Fix leaking pipes Install hoses with automatic shut offs	Reduce water and steam use	$75 00	$6 700	< 1 month
Implementation up to date	Partially done	$100	$5000	0 2 month

Unit Operation/Recommendation	Health and Environmental Benefit	Cost to Implement	Estimated Savings First Year	Payback
8 Insulate Steam Delivery System Pipes/manifold	Current energy efficiency of steam delivery is approximately 28% With simple procedures like insulating pipes the efficiency could be increased to 35% resulting in reduced fuel consumption	indeterminate	$5 000	6 months typical
Implementation up to date	Partially done	$7 000	It has been achieved a savings of 10% on fuel consumption ($8 000/year)	10 5 months
9 Install Mixing Tanks for Dyeing Machines	Prevent rework of fabric batches due to spotting	$1 000/machine	$24 000	< 3 months
Implementation up to date	Partially done	$2 000	$12 000	2 months
10 Install Process Controllers on Dyeing Machines	Improve efficiency of operation Reduce production costs	$26 000	Indeterminate	Indeterminate
Implementation up to date	Work in progress			
11 Institute quality control on product (washfast/color)	Provides ability to determine effectiveness of process changes	$200	Indeterminate	Indeterminate
Implementation up to date	To be implemented in the early 1998			
12 Dyeing Process Optimization Reduce water for CIP (85 m3/ton) Modify dye sequences to achieve BIP (60/70 m3/ton)	Decrease water use by over 60% Reduce pumping costs Increase productivity by reducing dye sequence time (cost savings indeterminate)	$10 000	$5 700	<1 75 years
Implementation up to date	Work in progress	$10 000	4 000	30 months
13 Optimize Dye Processes to Reduce Chemical Use	Decrease chemical use and BOD and COD loadings to sewer system	$ 0	$30 000 $44 000	< 1 month
Implementation up to date	Partially done	$0	$10 000	
14 Replace black sulfur dye with reactive dye	Replaces hazardous material with less hazardous one Simplify process Eliminate sulfides in effluent	$ 0	Avoided cost of treating sulfides	0
Implementation up to date	Partially done	$0	It would be evaluated after the waste treatment plant is running	
15 Instrumental Match Prediction	Reduce variety of chemicals purchased More time for quality control Achieve greater economy of scale in chemical purchasing Reduce ordering/administration time	$10 000	Indeterminate	Indeterminate
Implementation up to date	Included within the budget of 1998			
16 Install Effluent treatment system	Eventually will be required by municipality	$200 000+	Indeterminate	Indeterminate
Implementation up to date	Rejected			

APPENDIX L

ECUATORIANA DE CURTIDOS SALAZAR EXECUTIVE SUMMARY

Plant Description

This facility manufactures cattle hide leather for shoes, garment, and hand bags The leather is predominantly shoe upper leather in all commercial thicknesses The poorer grades of the large hides and skins are vegetable tanned for sole leather The leather is tanned by the chrome tanning process for shoe uppers

The plant has 9 main unit operations **(a)** Raw Stock the tannery receives fresh, unsalted hides and skins daily, **(b)** Hide Preparation raw materials, as received, are trimmed to remove ears, tails, and shanks (ECS cuts the hides into sides and soaks them as soon as practical), **(c)** Soaking salt cured bovine hides are soaked to remove the salt, dirt, and soluble hide substances, **(d)** Unhairing is done in a conventional lime/sulfide system, after hair removal, the hides are fleshed, trimmed, and split (thin trimmings and other limed trimmings are sold for glue manufacture), **(e)** Deliming and Bate limed hides are treated with ammonium sulfate and an enzyme to remove the lime and bring the hide to a neutral pH, **(f)** Chrome Tanning the reaction of the hide protein with chromium salts to make the hide non biodegradable is the actual tanning, **(g)** Coloring and Fatliquoring the chrome tanned leather, is cut to the desired thickness, treated with vegetable tannins, specialty chemicals, dyes, and leather lubricants to develop the desired mechanical and esthetic characteristics of the leather, **(h)** Drying the leather may be dried by air drying under tension, vacuum drying or hang drying, **(i)** Finishing dried leather is coated with a resin, wax, or lacquer for esthetic and protective coating, these finishes are then top-coated with an organic based solvent lacquer for esthetics and protection

Implementation Status

Overall Pollution Prevention Assessment identified nine pollution prevention options that can save, in the first year, as much as $94,510 for an investment of at most, $105,000 (the investment figure does not include any salary, overhead, taxes, or duties, and, as of November 1994, $1 US = 2,250 Sucres) If implemented, these pollution prevention changes will reduce the amount of chromium sulfate used in tanning by 20 tons per year and dramatically reduce chromium from the effluent, reduce salt purchases by 100 tons per year and virtually eliminate chloride from the effluent, reduce water consumption by 15,000 m3 per year, reduce toxic organic solvent emissions by 30 tons per year, and, reduce the chemicals needed to treat wastewater The recommendations will not negatively impact Ecuatoriana de Curtidos Salazar's current compliance status with existing environmental norms in Ecuador

By now a 22 % of the recommendations has been implemented By the second term of 1997 it is expected to have at least 70% of the recommendation to be implemented
Table on the next page shows the main pollution prevention options and those that have been implemented up to now and the ones that will be implemented in the second term of 1997

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit Operations	Pollution Prevention Action	Cost to Implement US$	Financial Benefits /yr US$	Environmental Benefits ($)	Payback Period
1 Chrome Tanning	Recycle chrome	$20 000	$35 740	Eliminates Cr+3 in the liquid effluent	8 months
Implementation up to date	Work in progress				
2 Unhairing	Partial recycling of solutions	$5 000*	$3 230	Decreases water use reduces lime use and helps treatment	1 5 years
Implementation up to date	Work in progress				
3 Soaking	Recover salt	$5 000*	$3 040	Significantly reduces chlorides in the effluent by eliminating 35 tons of salt	1 6 years
Implementation up to date	By now the tendency is the usage of fresh hides				
4 Coloring and fatliquoring	Change from overflow rinsing to fill and dump batch rinsing	$5 000	$10 500	Decreases water consumption and allows for better treatment at sewage treatment plant	6 months
Implementation up to date	Done	$1 000	$2 000		6 months
5 Coloring and fatliquoring	Change to a central automated process feed and control system	$60 000	$30 000	Reduces use of special chemicals and improves product quality	2 0 yrs
Implementation up to date	Undone				
6 Deliming	Recover the bate wash water for reuse in soaking	$5 000	$6 000	Reduces water use and improves treatment at sewage treatment plant	10 months
Implementation up to date	Work in progress				
7 Finishing	Replace organic based finishes with water based finishes	TBD	TBD	Reduces toxic solvent emissions by 30 tons per year	TBD
Implementation up to date	Undone				

Unit Operations	Pollution Prevention Action	Cost to Implement US$	Financial Benefits /yr US$	Environmental Benefits ($)	Payback Period
8 Finishing	Replace existing spray guns with high volume low pressure spray guns	$5 000	$5 000	Reduces overspray of paints lacquers and finishes	1 yr
Implementation up to date	Undone	0 00			
9 Steam generation	Regulate flows at condensate return tank minimizing hot water loss	0 00	$1 000	Reduces on site fuel consumption and reduces water use	Immediate
Implementation up to date	Done	None	$1 000		Immediate

* Both must be performed in a concurrent manner as $10 000 costs is divided equally

APPENDIX M

SINTOFIL - PIFO
EXECUTIVE SUMMARY

Plant Description

The mill produces dyed cloth The overall production is distributed as follows 64% cotton made (100% cotton), 16% polyester-cotton blend (50%, 50%) and 20% polyester made (100% synthetic) Average monthly production of cloth is 58 MT of cotton cloth, 16 MT of polyester-cotton cloth 50% blend and 23 MT of polyester cloth (average of June-July-August quarterly 1995 production) The plant grows its own cotton, whereas 90 % synthetic fiber is imported from USA and 10% of synthetic fibers are purchased from a local synthetic fiber producer

The mill employs 40 production workers The whole plant works three shifts a day, 5 days a week, plus one shift of 10 hours on saturdays The main unit operations are thread making, preparation and sizing, weaving (only plain weavers), dyeing, finishing and packing

Implementation Status

The assessment resulted in the identification of 11 recommendations which, if implemented, could reduce the plant's water consumption and its chemicals and energy expenditures, lower the capital cost of its future wastewater treatment system by $300 000 and the effluent treatment cost by US$20 000/year, and reduce the water pumping cost by USD 6,000/year The potential savings in the cost and operation of the effluent treatment system, which result from a substantial reduction in the plant's effluent flow, should be of particular interest given that Sintofil must meet current wastewater discharge regulations
The recommendations included in this report are summarized in the Table on the next page

Without considering potential energy and effluent treatment savings, the recommendations given in this report could yield US$92 000 in yearly savings and could be implemented with a minimal initial investment

The whole recycling operation will be implemented once the Sintofil-Quito facility has been re-allocated at Sintofil-Pifo facility

Regarding recommendations on bleaching and mercerizing (#4, #5 and #6), the facility has gotten a savings of USD 55,000, with little investment Also the facility has switched to the

usage of high fixation reactive dyes, by which means the facility has raised the productivity by 12 5% and lowered the water usage by 26% The load to the environment may be lowered by this means The facility is making an attempt to lie its effluent within the municipality regulations Effluent characterization will be carried out in a near future

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit operation Recommend #	Pollution prevention action	Estimated Implementation cost (US$)	Estimated financial benefit (US$)	Environmental benefits	Payback period
1 Scouring	Recycle scour rinse water for desizing operations	US $1 000	Recommendations # 1& 3 lower the cost of the effluent treatment plant by $300 000 save $20 000/yr in effluent treatment and $6 180/yr in pumping cost	Recover process water for re use rather than discharge to wastewater treatment	
Implementation up to date	All the recycling is planned to be implemented once the Sintofil Quito facility has moved to the sintofil Pifo facility place				
2 Mercerizing	Recycle mercerizing rinse water for caustic scouring rather than recuperating caustic through water evaporation	US $1 000	Savings achieved by reducing sodium hydroxide consumption US$ 6 000/year	Recover process water for re use rather than discharge to wastewater treatment Reduce effluent flow	2 months
Implementation up to date	Same as before				
3 Bleaching	Recycle bleaching rinse water for scouring operations	US $1 000	See recommendation #1	See recommendation #1	
Implementation up to date	same as before				
4 Bleaching	Do not bleach sulphur dyes	None	Recommendations # 4 5 & 6 yield a combined savings of US$ 70 200/year	Reduces the effluent load	Immediate
Implementation up to date	Partially done	$0	$20 000	The BOD and COD has been reduced by 10%	Immediate

Unit operation Recommend #	Pollution prevention action	Estimated Implementation cost (US$)	Estimated financial benefit (US$)	Environmental benefits	Payback period
5 Mercerizing	Do not mercerize light shades on cotton and polyester/cotton	None	See recommendation # 4	See recommendation # 4	
Implementation up to date	Partially done	None	USD 15 000	Same as before	
6 Mercerizing	Do not mercerize heavy shades sulphur dyeing on cotton and polyester/cotton	None	See recommendation # 4	See recommendation # 4	
Implementation up to date	Partially done	None	USD 20 000	Same as before	
7 Dyeing	Use high fixation (90%) reactive dyes on cotton and polyester/cotton fabrics	Cost is 12 5% higher than using regular reactive dyes	Increases productivity by 15%	Reduce pollution due to decrease of dye load in the effluent	
Implementation up to date	Partially done	USD 1575/month USD 18900/year	The current productivity of 101 Kg/hour went up to 110 Kg/hour The 12 5% high fixation dye cost rise has been recuperated on the basis of productivity increase (15%) and water savings for about 26% due to less amount of water used in the removal of non fixed dye The final outflow is about 5 liters/second	The load to the environment has decreased	
8 Removing clear	Replace sodium hydrosulfite with sodium carbonate		US$ 16 080/year	Lowers consumption of sodium hydrosulfite and sodium hydroxide Decreases hazardous waste generation	Immediate
Implementation up to date	Some trials have been planned to be carried out in the second term of 1997				
9 Steam traps	Reduce fuel consumption Unquantified energy savings	TBD (To be defined)	TBD	Reduces energy use and air emissions	
Implementation up to date	Fully done	A reduction on steam losses has been quantified are within			

Unit operation Recommend #	Pollution prevention action	Estimated Implementation cost (US$)	Estimated financial benefit (US$)	Environmental benefits	Payback period
		the margin of 90%			
10 Steam system	Evaluate the use of insulation	TBD	TBD	Reduces energy use and air emissions	
Implementation up to date	An insulation plan is being carried out	The investment may be feasible to be evaluated at the end of the second midterm of 1997	The savings may be evaluated once the insulation plan has ended		
11 All processes	Monitor and document all processes upsets determine the root cause of upsets	None	TBD	Reduce chemicals and energy consumption reduce emissions by improving production efficiency	
Implementation up to date	Work in progress				

APPENDIX N

SINTOFIL-QUITO
EXECUTIVE SUMMARY

Plant Description

This plant produces dyed cloth of 100% polyester (60% of the product mix) and polyester/cotton 50/50 blend (40% of the product mix) using disperse dyes and fiber reactive dyes The wet section works three shifts, 6 days a week and 22 days per month Sintofil grows its own cotton, whereas 90 % synthetic fiber is imported from USA and 10% of synthetic fibers are purchased from a local synthetic fiber producer

All the dyeing processes are done by batches The main unit operations are Spinning, weaving, pre-dyeing (polyester/cotton blend is rinsed and de-sized with enzymes, afterwards scoured with hot alkaline detergents to remove wax and other non-cellulosic materials, then rinsed to eliminate residual detergents Bleaching is done with hydrogen peroxide, mercerizing is not likely for the blend), dyeing and finishing (final heat setting, calendering)

Nine dyeing units have been installed **(a)** Soft flow-4 tubes dyeing unit (Thiss), to dye only polyester 100%, **(b)** Soft flow-3 tubes dyeing unit (Thiss), to dye only Polyester 100%, **(c)** Horizontal Soft flow-2 tubes dyeing unit (Thiss), for the special purpose of dyeing polyester/cotton blend mostly 50/50, **(d)** Closed barca high temperature dyeing unit (3 ropes), for dyeing polyester/cotton blend, **(e)** Long Horn soft flow-2 tubes, to dye polyester/cotton blend and 50% of the time to dye polyester 100%, **(f)** Closed atmospheric barca-4 ropes, to dye towels and the rest of the time to dye polyester/cotton blend, **(g)** Jigger high temperature dyeing unit, to dye only polyester 100% cloth, **(h)** Garment dyeing-washex, to dye only garments made on cotton 100%, **(i)** Autoclave dyeing unit-Boeninger, to dye thread 100% polyester

Implementation Status

The assessment resulted in the identification of 5 recommendations which, if implemented, could reduce the plant's water consumption and its chemicals and energy expenditures, lower the cost of its future wastewater treatment system and the effluent treatment cost, improve productivity and work safety Table on the next page summarizes implementation stage

The facility has switched to the usage of high fixation reactive dyes on poly/cotton fabric The cost went from USD 42,000 per year up to USD 47,250 per year While the productivity increase from 324 MT per year up to 374 MT/year of poly/cotton blend The production increase by this means was of 50 MT of fabric per year, which means a sales increase of USD 21,875 per year The pollution load may have decrease thanks to the high fixation of the dyes on the cloth It has been implemented a good program of steam traps maintenance By this means it was evaluated a yearly savings of USD 7,200

Since a decision has been made to move part of the Quito plant to Pifo, the long-term pollution prevention work under E2P3-Oikos will concentrate mainly on the Pifo facility However Sintofil is conscious of the pollution problems at the Quito plant and is interested in implementing measures that will achieve a reduction in the facility's waste stream

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit operation	Pollution Prevention Action	Implementation Cost (US$)	Estimated financial benefit (US$)	Environmental benefits	Payback period
1 Dyeing	Use high fixation (90%) reactive dyes on cotton and polyester/cotton fabrics	Cost is 12 5% higher than using regular reactive dyes	Increases productivity by 15%	Reduce pollution due to decrease of dye load in the effluent Reduce effluent flow	
Implementation up to date	Partially done	USD 5 250 plus	50 MT This means a sales rise of USD 62 500 per year Profit USD 21 875 per year		Immediate
2 Steam traps	Reduce fuel consumption Unquantified energy savings	TBD (To be defined)	TBD	Reduce energy use and air emissions	
Implementation up to date	Partially done It was estimated an energy savings of 2% by this means	USD 2 500	USD 7 200 per year	Energy usage has been reduced and also air emissions	4 2 months
3 Steam system	Evaluate the use of insulation		TBD	Reduces energy use and air emissions	
Implementation up to date	To be considered for the second term of 1997				
4 All processes	Monitor and document all process upsets determine root cause of upsets	None	TBD	Reduce chemical and energy consumption reduce emissions by improving production efficiency	
Implementation up to date	Partially done	None	The production planning is a good one starting with the light shades and going progressively to the dark shades	Once the plant has moved to the Pifo s facility place This variable will be evaluated	
5 Material handling	Improve handling procedures for caustic soda	Minimal		Greater Work safety	
Implementation up to date	Partially done	Almost nil	1% losses due to spillage and miss measuring USD 132 /year savings	Safety to the workers and precision in production	

APPENDIX O

TENERIA SAN JOSE
EXECUTIVE SUMMARY

Plant Description

The environmental audit at Teneria San Jose was conducted from May 8th through May 12th, 1995 The plant is located in Ambato, Ecuador It is a leather tannery that produces shoe leather for the upper portion of shoes from hides obtained from local dairy cattle The facility has an installed processing capacity of 3,200 hides per month, and was operating at 70% of capacity during the team's visit The company employs 25 workers and 6 administrative personnel It works 1 5 shifts per day and 5 5 days per week

The plant has 9 main unit operations **(a)** Raw Stock the tannery receives fresh, unsalted hides and skins daily, **(b)** Hide Preparation raw materials, as received, are trimmed to remove ears, tails, and shanks (ECS cuts the hides into sides and soaks them as soon as practical), **(c)** Soaking salt cured bovine hides are soaked to remove the salt, dirt, and soluble hide substances, **(d)** Unhairing is done in a conventional lime/sulfide system, after hair removal, the hides are fleshed, trimmed, and split (thin trimmings and other limed trimmings are sold for glue manufacture), **(e)** Deliming and Bate limed hides are treated with ammonium sulfate and an enzyme to remove the lime and bring the hide to a neutral pH, **(f)** Chrome Tanning the reaction of the hide protein with chromium salts to make the hide non biodegradable is the actual tanning, **(g)** Coloring and Fatliquoring the chrome tanned leather, is cut to the desired thickness, treated with vegetable tannins, specialty chemicals, dyes, and leather lubricants to develop the desired mechanical and esthetic characteristics of the leather, **(h)** Drying the leather may be dried by air drying under tension, vacuum drying or hang drying, **(i)** Finishing dried leather is coated with a resin, wax, or lacquer for esthetic and protective coating, these finishes are then top-coated with an organic based solvent lacquer for esthetics and protection

Implementation Status

As a result of the pollution prevention audit numerous opportunities to reduce pollution were identified, several showing a direct cost savings associated with reduction in chemical purchases Overall, the project identified eight pollution prevention options that can save $14,443 for an investment of $77,000 The true benefit of implementing the pollution prevention measures identified are not immediately translatable into cost savings because the plant pays nothing for its water supply and has no current wastewater treatment requirements, where the most significant cost reductions would normally be reflected A summary of recommendations is given in the Table on the next page presenting pollution prevention actions their cost, environmental benefit and payback period and also the implementation up to date

Teneria San Jose is right at the point of decisions By now is deciding wether it may invest in a rotative filter, costing USD 13,000 or to install a cheap plastic frame, as it was suggested by E2P3 Also by this time it will be decided to go on with the contractor to start the building of the whole system

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit Operations	Pollution Prevention Action	Cost to Implement US$	Financial Benefits US$	Environmental Benefits	Payback Period
1 Final Conditioning System	Remove chrome and protein	$20 000	None	Reduces BOD Cr N TSS O&G in final effluent	None
Implementation up to date	Work in progress				
2 Coloring and Fat-Liquoring wastes	Segregate wastes Concentrate other wastes for recycling	$3 500	None	Allow recycling of other waste streams	None
Implementation up to date	Partially done	$2 000	None	Allow recycling of other waste streams	None
3 Bating and Deliming	Recover bate and liming rinses for reuse or as make up in beamhouse soak or wash	$7 000	$1 000	Recycles large volume of water either directly or in another department	7 years
Implementation up to date	Work in progress				
4 Chrome and Pickle Liquor Recycling	Recover each solution for reuse conserving materials and cleaning wastestream	$7 500	$10 536	Eliminates chrome discharge improves process control	7 months
Implementation up to date	Work in progress				
5 Beamhouse Soak and Wash	Reduce water consumption, remove dilution from unhairing waste stream	$15 000	None	Reduces water consumption, recovery of unhairing waste salt recovery	None
Implementation up to date	Partially done	None	Negligible	Reduces water consumption	None
6 Beamhouse Settling Basin	Remove flesh hair and debris presently discharged	$12 000	None	Reduces discharge of solids	None
Implementation up to date	Undone				
7 Unhairing Solution Recycling	Collect clean and reuse the unhairing solutions	$15 000	$2 907	Reduce discharge of BOD TSS as much as 90 %	5 years
Implementation up to date	Work in progress				
8 Sulfide oxidation	Destroy sulfides in unhairing wastes before protein coagulation	$12 000	None	Eliminates sulfide and protein from waste stream	None
Implementation up to date	Undone				

APPENDIX P

CURTIDURIA SUALU
EXECUTIVE SUMMARY

Plant Description

The environmental audit of Curtiduria Suarez, S A was conducted from May 13th through May 18th 1995 The plant is located in Ambato, Ecuador It is a leather tannery that produces shoe leather for the upper portion of shoes from hides obtained from beef cattle The facility processes approximately 84,000 hides per year

The plant has 9 main unit operations **(a)** Raw Stock the tannery receives fresh, unsalted hides and skins daily, **(b)** Hide Preparation raw materials, as received, are trimmed to remove ears, tails, and shanks (ECS cuts the hides into sides and soaks them as soon as practical), **(c)** Soaking salt cured bovine hides are soaked to remove the salt, dirt, and soluble hide substances, **(d)** Unhairing is done in a conventional lime/sulfide system, after hair removal, the hides are fleshed, trimmed, and split (thin trimmings and other limed trimmings are sold for glue manufacture), **(e)** Deliming and Bate limed hides are treated with ammonium sulfate and an enzyme to remove the lime and bring the hide to a neutral pH, **(f)** Chrome Tanning the reaction of the hide protein with chromium salts to make the hide non biodegradable is the actual tanning, **(g)** Coloring and Fatliquoring the chrome tanned leather, is cut to the desired thickness, treated with vegetable tannins, specialty chemicals, dyes, and leather lubricants to develop the desired mechanical and esthetic characteristics of the leather, **(h)** Drying the leather may be dried by air drying under tension, vacuum drying or hang drying, **(i)** Finishing dried leather is coated with a resin, wax, or lacquer for esthetic and protective coating, these finishes are then top-coated with an organic based solvent lacquer for esthetics and protection

Implementation Status

The overall assessment identified ten pollution prevention options that can save in the first year as much as $82,917 for an investment of about $104,250

The true benefit of implementing the pollution prevention measures identified are not immediately translatable into cost savings because the plant pays nothing for its water supply and only marginal requirements for wastewater treatment A summary of recommendations is given in Table on the next page presenting the pollution prevention action, its cost, environmental benefit and payback period

The following was used to calculate the "first year savings" column heading in the table on the next page, "Summary of Pollution Prevention Options" To calculate this value, sum the

increase in the revenues and the decrease in expenses and subtract the cost to make the change For example, sum (those that apply)

- the first year savings from reductions in raw materials purchased
- increased production or the sale of unnecessary production equipment
- reductions in capital cost for end-of-pipe equipment and facilities reduced or not purchased
- reductions in direct and indirect labor costs

Then subtract (those that apply)

- capital costs of any necessary acquisitions
- costs of new raw materials
- increases in labor and training costs
- increase in direct or indirect labor and expenses

Because of lack of information there are not updated figures about the implementation stage This facility is going through a change process since some financial problems appear and probably the business is moving to other owners However the Oikos-E2P3 team is expecting results after obstacles will be overcoming

SUMMARY TABLE OF POLLUTION PREVENTION RECOMMENDATIONS AND IMPLEMENTATION UP TO DATE

Unit Operations	Pollution Prevention Action	Cost to Implement US$	Financial Benefits US$	Environmental Benefits	Payback Period
1 Final Conditioning System	Remove chrome and protein	$22 000	None	Reduces BOD, Cr N TSS O&G in final effluent	None
2 Coloring and Fat-Liquoring wastes	Segregate wastes, concentrate other wastes for recycling	$3 500	None	Allows recycling of other waste streams	None
3 Bating and Deliming	Recover bate and liming rinses for reuse or as make-up in beamhouse soak or wash	$14 000	$25 000	Recycles large volume of water either directly or in another department	7 Months
4 Chrome and Pickle Liquor	Recover each solution for reuse conserving materials and cleaning waste stream	$7 500	$20 133	Eliminates chrome discharge improves process control	4 months
5 Beamhouse Soak and Wash	Reduce water consumption remove dilution from unhairing waste stream	$15 000	$25 000	Reduces water consumption recovery of unhairing waste, salt recovery	7 months
6 Beamhouse Settling Basin	Remove flesh hair and debris presently discharged	$15 000	None	Reduces discharge of solids	None
7 Unhairing Solution Recycling	Collect clean and reuse unhairing solutions	$15 000	$12 784	Reduces discharge of BOD, TSS as much as 90 %	14 months
8 Sulfide Oxidation	Destroy sulfides in unhairing waste before coagulation	$12 000	None	Eliminates sulfide and protein from waste stream	None
9 Solvent Finishing	Convert solvent to aqueous systems	$250	None	Eliminates VOC source from water and air	None