TORONTO

WORKS AND EMERGENCY SERVICES
INDUSTRIAL WASTE AND STORMWATER QUALITY

A Guidance Manual To Pollution Prevention Plan

An opportunity to reduce pollution at source, stop valuable resource losses and improve corporate image

Final Draft

PREFACE

This guidance manual has been prepared to give a general guideline to industries in developing their Pollution Prevention Plan. The manual is developed based on the documents from United States Environmental Protection Agency, Environment Canada, and other internet resources.

This guidance is to be used only as a reference material. For the purpose of meeting the City of Toronto Municipal Code Chapter 681 (Sewer Use By-law 457-2000) requirements, use the forms and the guidelines accompanying the forms. The City will make available generic forms & guidelines and some sector specific forms and guidelines as and when they are ready.

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FOREWORD

Industrial waste generation in the Toronto area has increased significantly in the past decade. This waste discharged to our water, land and air represents loss of valuable raw materials and a practical threat to human, wildlife and aquatic health and the environment.

Pollution prevention is a priority for Environment Canada. As s.90 (1.1) of the Canadian Environmental Protection Act (CEPA) stipulates, the Minister shall give priority to pollution prevention actions in developing proposed regulations or instruments respecting preventive control actions in relation to CEPA-toxic substances. Part 4 of CEPA gives the Minister of the Environment the authority to require the preparation and implementation of pollution prevention plans for CEPA-toxic substances (substances on Schedule 1 of CEPA).

The City of Toronto is one of the first municipalities in Canada to incorporate pollution prevention planning requirements into the Sewer Use By-law. Eleven metals and twenty-seven organic compounds/group of compounds are addressed in the By-law. Part 5 of the By-law will require the companies that discharge these chemicals to submit a detailed pollution prevention (Pollution Prevention) plan every six years as well as a Pollution Prevention plan summary every two years.

Beneficial use of biosolids

As part of its commitment to protecting our natural environment, the City of Toronto has explored alternate technology that will allow it to end incineration of biosolids by December of 2000 (For updated information, please check the website). The Environmental Assessment process identified biosolids beneficial use as a preferred alternative to incineration.

Understanding wastewater

Wastewater (also called sewage) is the mixture of liquid and solid materials that residents and businesses flush down their toilets combined with the liquid waste (known as effluent) discharged from industrial facilities (or liquid waste). This material flows through a network of pipes known as the sanitary sewer system. The wastewater can pose a health risk and must be treated. The natural environment does have the capacity to remove some of the contamination for the water. However, Toronto's highly concentrated urban population contributes too much organic and inorganic material and disease-causing bacteria for the wastewater to be accommodated by the existing natural system (land and lakes, etc.). Treatment of our wastewater, therefore, is an essential process that prevents contamination and destruction of our waterways, our drinking water sources, and our natural water resources.

Where does the wastewater go?

When wastewater is drained down a sink, toilet or a floor drain, it travels through a network of pipes maintained by the community works departments to much

larger trunk sewers maintained by Works and Emergency Services. The sewer systems are built to follow the natural slope of the lands surrounding the major river systems in the city (the Humber River, Don River and Highland Creek. This design allows gravity to do most of the work of transporting the wastewater to one of four wastewater treatment plants. To handle low-lying areas, which do not have enough gravity flow to the plants, pumping stations have been constructed to move the wastewater into the plants.

The waste collection and distribution system

In most of Toronto there are two separate sewer systems. A sanitary sewer system collects wastewater from homes and businesses, carrying flows to the sewage treatment plants. The storm sewer system transports rainwater to the rivers and Lake Ontario without treatment. In some older parts of the community of Toronto, these sewer systems are combined. That is to say, that the sewer system allows the flow of stormwater as well as sanitary flows in two separate channels. During heavy rains, run-off water from the streets overwhelms the combined sewer pipes and the water overflows, allowing a mixture of rainwater and untreated sanitary sewage to flow directly into the rivers and eventually, the lake. This is only a partial explanation: the overflows are designed to reduce volumes reaching the treatment plant so that the plant will not be overwhelmed by a volume of water and have a bypass situation to avoid flooding.

To reduce these problems, Works and Emergency Services has implemented a program to separate combined sewers, and initiate the building of interception tunnels and detention tanks. The community of Toronto has also implemented a roof downspout disconnection program for its residents to reduce the amount of rainwater in the combined system. In addition the programs of water conservation and stormwater pond construction further reduce both the volume of water in the system and the amount of contamination in the water.

To learn more about the wastewater treatment process, and the biosolids program, visit the City of Toronto and follow the links to Water Pollution Control Projects.

http://w3.city.toronto.on.ca/involved/index.htm

Objective of Pollution Prevention

The objective of pollution prevention planning is to help reduce pollution at source, which affects the sludge quality at the city's treatment plants. By improving sludge quality, more uses and application may be found for the material, thusly improving the beneficial use program. This plan compliments the City Council's decision to end sludge incineration. The City of Toronto's initiative to make Pollution Prevention a part of the By-law is supported by the Ontario Ministry of the Environment and Environment Canada.

This document came about due to the new City of Toronto's Sewer Use By-law, which requires industries to prepare pollution prevention plans. It is intended as a guidance document for industries to fulfill the by-law requirements to develop a Pollution Prevention Plan. It summarizes the benefits of a pollution prevention program and suggests ways to incorporate pollution prevention in industry policies and practices. The manual describes procedures for conducting preliminary assessments to identify waste reduction or elimination options. It also describes

how to use the pre-assessment results to prioritize wastes for pollution prevention options.

The guide is designed to help industries/businesses in the Toronto area that are covered by the scope of the by-law and require a Pollution Prevention Plan. It describes how to identify, assess, and implement pollution prevention options. This is a generic document intended for companies in all business areas. You are in the best position to develop a Pollution Prevention program that best suits your circumstances. This guide only addresses the basic steps involved, and industries should go beyond this framework to make the program successful. References at the end of the document and other resources may help you expand your efforts.

The pollution prevention plan and plan summary forms are prepared separately. A generic set of forms will be prepared for all business. Sector specific forms will also be prepared and made available to businesses. These include forms for dental, photo mini-labs, service stations, health care, etc.

This guide has been submitted to the management of the Water & Wastewater Services Division and for peer review at the Industrial Waste & Stormwater Quality office. Users are encouraged to duplicate portions of this document as needed to implement a pollution prevention program. The document is available on the City of Toronto's website at: http://w3.city.toronto.on.ca/involved/wpc/nbylaw.htm

It is important to note, compliance with relevant environmental and health and safety regulations and by-laws is the responsibility of each individual business.

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CHAPTER 1

FACTS ON POLLUTION PREVENTION

Benefits of Pollution Prevention:

The key benefits of Pollution Prevention are:

- reduced operating costs
- reduced risks of liability
- enhanced company image in the community
- public health and environmental benefits

A company with an effective pollution prevention plan may reduce production cost and may have a significant competitive edge. Pollution Prevention makes good business sense. A business that has a good Pollution Prevention Program is usually a well-run efficient business. A good success story from Canada is reproduced here as an example. You can also visit the site using the link at the end of the story.

Reduced Operating Costs

An effective pollution prevention program can yield cost savings that may more than offset program development and implementation costs. Cost savings are particularly noticeable when the costs resulting from treatment, storage, and disposal of wastes are allocated to the production unit, product, or service that produces the waste. (Refer to Total Cost Assessment in Chapter 3).

The potential areas of cost savings are:

Material cost – use of production and packaging procedures that consume fewer resources thereby creating less waste.
Waste management costs may be reduced by implementation of pollution prevention
Production costs – look for opportunities for optimization of material handling, inventory control, equipment maintenance etc.
Energy costs – may reduce as pollution prevention measures are implemented in various production lines.
Future cleanup costs - reducing the wastes today can reduce cleanup costs.

Reduced Risk of Liability

You may decrease your risk of both civil and criminal liability by reducing the volume and the potential toxicity of the gaseous, liquid, and solid discharges from your facility. You should look at all types of waste, not just those currently defined as hazardous. Waste handling affects public health and property values in communities surrounding the production and disposal sites.

Improved Company Image

As the quality of the environment becomes an issue of greater importance to society, your company's policies and practices for controlling waste increasingly influence the attitudes of your employees and of the community at large. Community attitude will be more positive towards companies that operate and publicize a thorough pollution prevention plan

Public Health & Environmental Benefits

Reducing hazardous waste discharged would reduce ecological damage and risk to human health.

What is Pollution Prevention?

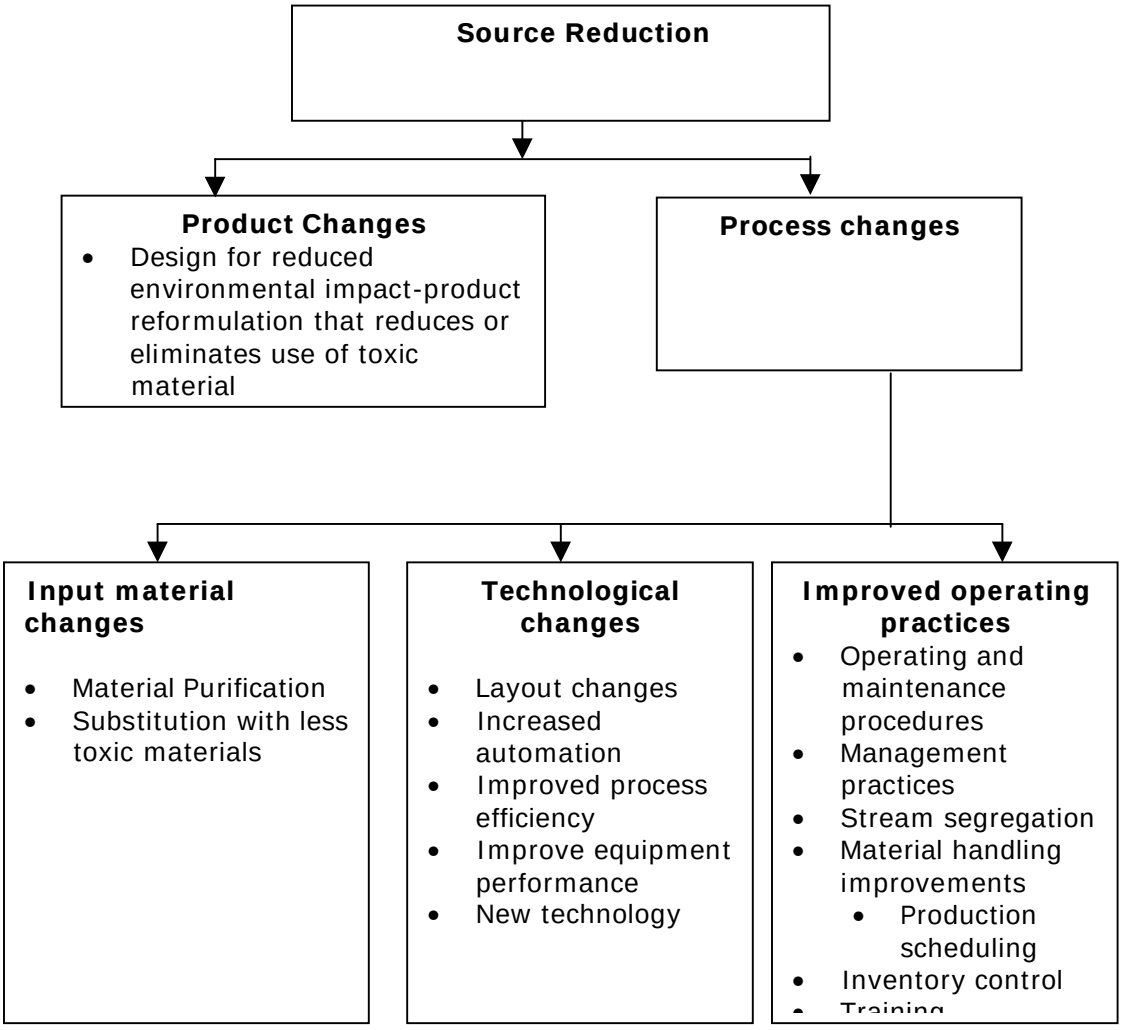
Pollution prevention is the maximum feasible reduction, preferably elimination, of all toxic wastes and the wastes listed as subject pollutants in the City of Toronto Municipal Code Chapter 681 (Sewer Use By-law 457-2000), generated at production, usage, or storage sites. It involves judicious use of resources through source reduction, energy efficiency, reuse of input materials, and raw material substitution with more environmentally friendly products. There are two general methods of source reduction that can be used: product changes and process changes.

1. ***Change product and production processes to reduce pollution at the source.***

2. ***Redesign products to minimize their environmental impact.***

These methods reduce the volume and toxicity of production wastes and of end product waste during its life cycle and disposal. Figures1 identifies some of the source reduction methods.

Figure 1: Source Reduction Methods



The following process changes are pollution prevention measures because they reduce the amount of waste created during production:

Examples of material changes:

- Reduce or eliminate the use of toxic materials
- Stop use of heavy metal paints/ pigments/coatings.
- Use a less hazardous/ toxic solvent for cleaning. Explore aqueous cleaning.
- Purchase raw materials free of trace quantities of hazardous or toxic impurities.

Examples of technology changes:

- Redesign equipment and piping to reduce the volume of material contained, cutting losses during batch or colour changes or when equipment is drained for maintenance or cleaning.
- Change to mechanical stripping/ cleaning devices to avoid solvent use.
- Change to a powder-coating system.
- Install a hard- piped vapour recovery system to capture and return vaporous emissions.
- Use motors that are more efficient.
- Install speed control on motors to reduce energy consumption.

Examples of improved operating practices:

- Operator training.
- Cover solvent tanks when not in use
- Segregate waste streams to avoid cross-contamination of hazardous and non -hazardous waste or two non-compatible wastes.
- Improve control of operating conditions (e.g. flow rate, temperature, pressure, residence time, and stoichiometry).
- Improve maintenance scheduling, record keeping, or procedures to increase efficiency.
- Optimize purchasing and inventory maintenance methods for input materials. Purchasing in quantity can reduce costs and packaging material if care is taken to ensure that materials do not exceed their shelf life. Reevaluate shelf life characteristics to avoid unnecessary disposal of stable items.
- Stop leaks, drips & spills.
- Turn off electrical equipment such as lights and copiers when not in use.
- Place equipment so as to minimize spills and losses during transport of parts or materials.
- Use drip pans and splashguards.

What is not Pollution Prevention?

Pollution control measures taken after the waste is generated are not considered as pollution prevention. Refer to Box 2 for examples of procedures that are waste handling, not pollution prevention, measures.

The following are not pollution prevention measures:

- **Off-site recycling:**

  Recycling of metal bearing sludge in a smelting operation is an excellent waste management option. However, it creates other by-products that create water pollutants during sludge generation. It also creates pollution during transportation and recycling operation.

- **Waste treatment:**

  Waste treatment essentially transfers waste from one medium to another medium and is not pollution prevention. Examples of waste treatment include incineration, precipitation & filtration, cyanide destruction, ion exchange for metal recovery (where the recovered metal is not reused in the process).

- **Concentrating hazardous or toxic waste to reduce volume:**

  Volume reduction of waste by operations such as evaporation, dewatering, filtration does not reduce the generation of pollutants though they are good treatment options.

- **Dilution of waste to reduce concentration:**

  Not only is dilution of waste to reduce toxicity/ hazard of the waste is a bad treatment option; it is not permitted by the City of Toronto's By-law. It is definitely not pollution prevention.

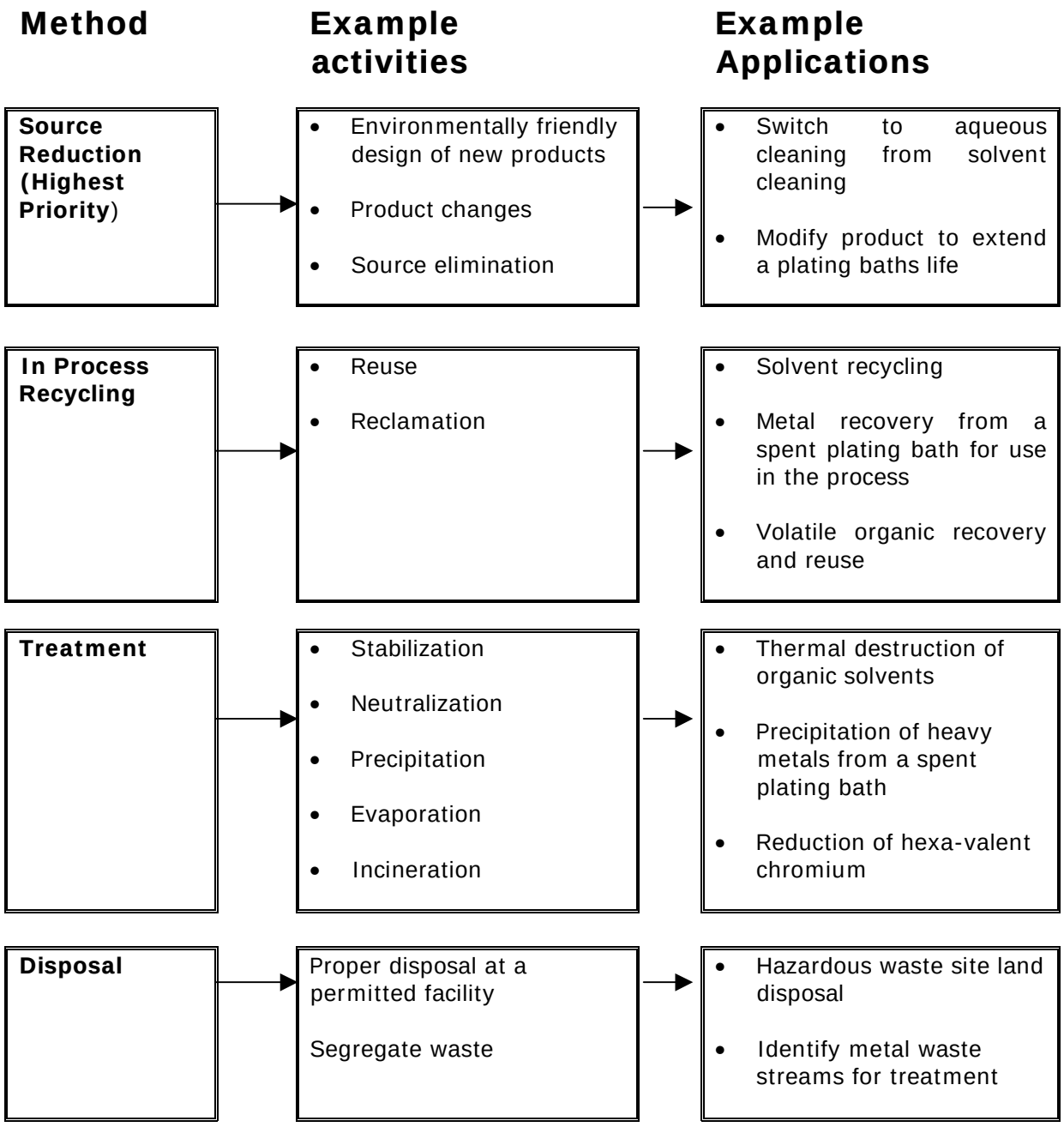
- **Transfer of hazardous or toxic waste from one medium to another:**

  Most of the waste treatment options to date transfer the waste from one medium to another. This is generally dictated by the respective regulations/ by-laws and the economics of off-site disposal. The water is treated to meet the local by-law because the solids can be disposed of as hazardous waste. The hazardous waste for off site disposal or recycling is concentrated to meet the recycler requirements or to reduce disposal costs. This is certainly not pollution prevention

Environmental Management Options Hierarchy

Following figure summarizes methods in Environmental Management System Hierarchy with examples for each method. At the top of the hierarchy is source reduction, which should be the number one priority for any business. End of the pipe treatment and disposal are at the bottom when considering waste management options.

Figure 2

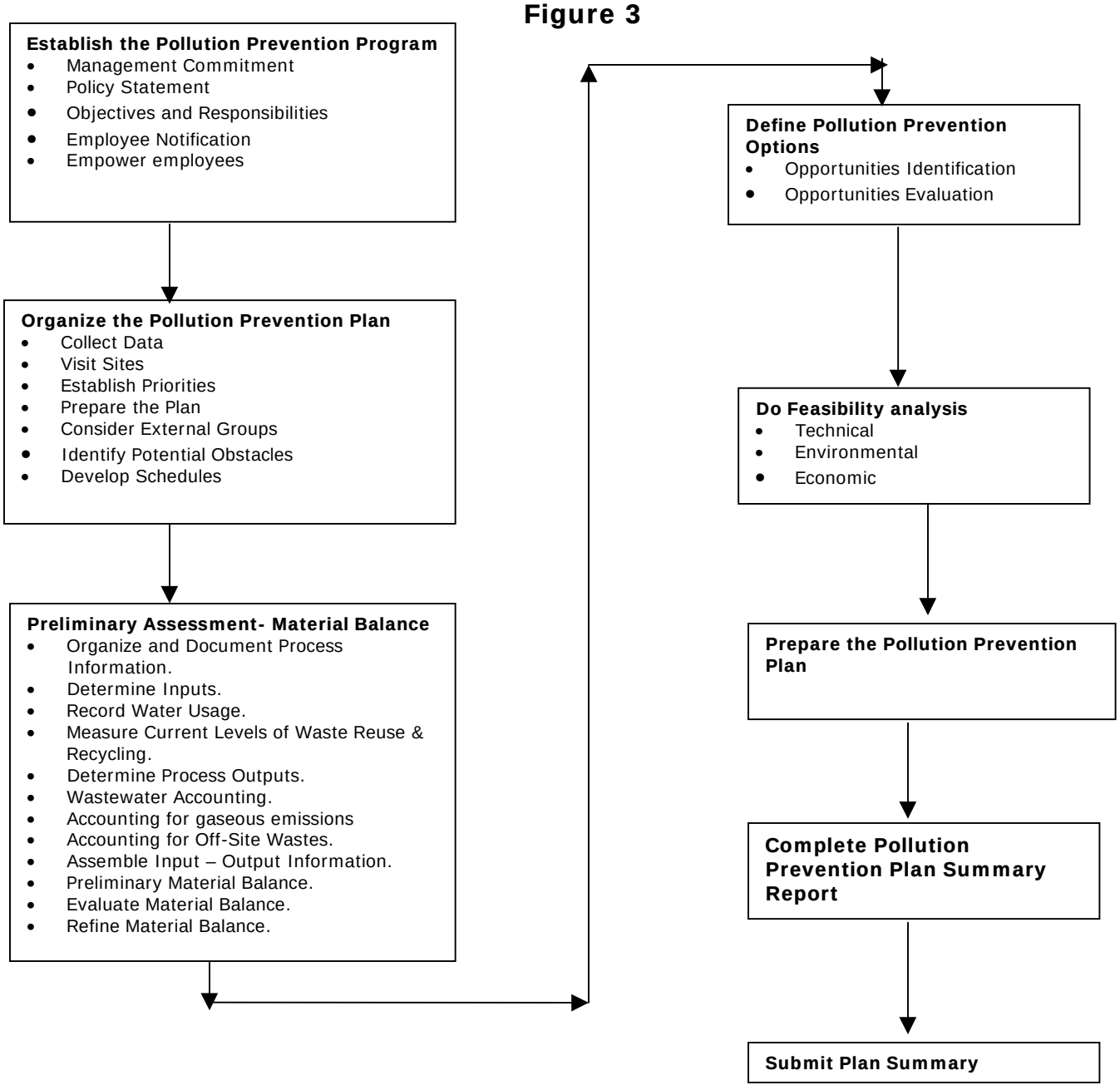


CHAPTER 2

GUIDELINES FOR DEVELOPING A POLLUTION PREVENTION PLAN

Pollution prevention planning is a comprehensive and continual evaluation of how you do business. It is very important to integrate pollution prevention with other business aspects. The following steps will be useful in setting up a pollution prevention plan.

Figure 3



Establish The Pollution Prevention Plan

Management Commitment

Top management support is essential to ensure that pollution prevention becomes an organizational goal. It may be necessary to gather preliminary information, which helps demonstrate to senior management that pollution prevention opportunities exist and should be explored. Once senior management decides to establish a pollution prevention program, they should convey it to all the employees and other stakeholders through a formal policy statement.

Policy Statement

The policy statement should state why a pollution prevention program is being established, what is to be accomplished in qualitative terms, and who will do it.

The policy should illustrate:

- Clear definition of pollution prevention through subject pollutant substitution, production process modification, product reformulation, improvements in operations and maintenance, and in-process recycling of production materials.

- How your organization encourages reduction or elimination in the use of subject pollutants by research and development, financial decisions, employee training, or other business practices.

The policy may refer to your organization's involvement with other environmental initiatives such as ISO 14001, energy and water conservation, environmental management systems, and initiatives to reduce hazardous wastes.

Objectives and Responsibilities

In developing a Pollution Prevention Plan, it is important to establish goals, objectives, and schedules that are consistent with the pollution prevention policy statement and your organization's culture.

As a minimum, the Pollution Prevention Plan should incorporate the objective to reduce the generation of wastes and the release of pollutants. Setting goals will be done differently by various organizations. The goals may be qualitative and/or quantitative. Quantitative goals are preferred as they are specific, measurable, and provide a clear guide to the program's expectations. Goals should be flexible and adaptable.

The Pollution Prevention Team overseas the program through its planning, implementation, and evaluation stages. The team should consist of representatives from all parts of the organization. The team will assess the organization's operations and suggest possible pollution prevention projects. Projects could include measures to reduce hazardous wastes, installation of more efficient rinsing system, technology substitution, or housekeeping practices.

The program leaders will need to establish goals that state the long-term direction for the pollution prevention program. Well-defined goals will help to focus effort and build consensus. Goals should be consistent with your company's pollution prevention policy and, in fact may

have been stated in general terms in the policy statement. Now, they need to be stated more specifically.

When beginning the goal-setting process, consider starting from a zero-discharge perspective. The ideal solution would involve 100% utilization of resources, eliminating disposal costs and regulatory compliance needs. This may not be an achievable goal with available technology. However, the zero-discharge goals encourage an attitude of continually striving for improvement. The goals should be flexible and adaptable. Periodic goal-achievement review and adjustment will keep your program active and visible. Your corporate pollution prevention policy and goals should be integrated in a formal planning document.

Employee Notification

Demonstrate how and when employees, company-wide, may be notified and involved in:

- Pollution prevention planning process (goals, targets and timelines).
- Pollution prevention activities and which materials are subject pollutants.

Employees must be notified four - six months before pollution prevention plans are completed.

Empower Employees

Encourage and empower employees to participate in the pollution prevention planning. It is important to emphasize your company's commitment to pollution prevention. A positive atmosphere produces the best results. Employees feel committed to pollution prevention when they are encouraged to:

- Help define company goals and objectives.
- Review processes and operations to determine where and how toxic substances are used and hazardous wastes generated.
- Recommend ways to eliminate or reduce waste generation at source.
- Design or modify forms and records to monitor materials used and waste produced.
- Find ways to involve suppliers and customers.

Organize The Pollution Prevention Plan: Pre - Assessment

Collect Data

Data collection is an important aspect of this assessment and will help the team review data that is already available and begin ways to process that data. The data and site visits will enable the Pollution Prevention team to establish priorities and procedures for detailed assessments. Depending on the nature and size of your industry, much of the data needed for a pollution prevention program may be collected as a normal part of plant operations or in response to existing regulatory requirements. The worksheets in Appendix A can be used for assessment. They can be modified to suit your particular industry. The information collected through these worksheets can be transferred to the forms in Appendix D and E to meet the by-law requirements.

Due to the transfer of pollutants from one medium to another during processing, an all media approach involving air, water, and solid waste emissions and releases would be most appropriate. This involves all waste streams, identifying their sources and quantifying the true

costs of pollution control, treatment, and waste disposal. There are a number of information sources to consider.

Regulatory Reports – The City of Toronto documents sanitary sewer results for most of the industries and the data is available on request. As per Regulation 347 of the Ontario Ministry of Environment (MOE), each hazardous waste generator is required to fill in a manifest for the transportation, transfer, and disposal of subject wastes. This report can be used for material balance.

Engineering/ Operating and Business Records – Shipping manifests provide the volumes of the waste shipped, but they lack chemical analysis, specific source, and the time when the waste was generated. The plant design and operating data can provide this information. The records from purchasing, inventory & records management, accounting, and training can provide the data needed for pre-assessment. These records themselves may provide opportunities for pollution prevention.

The data sources are summarized in the following table

DATA SOURCES

Regulatory Information:
- Waste shipment manifests
- Waste, wastewater & air analysis
- Environmental audit reports
- Certificate of Approval from the Ministry of the Environment

Process information:
- Process flow diagram
- Design and actual material and heat balances:
  - Production processes
  - Pollution control processes
- Operating manuals and process descriptions
- Equipment lists
- Equipment specifications and data sheets
- Piping and instrument diagrams
- Equipment layouts and logistics

Raw Material/ Production Information:
- Product composition and batch sheets
- Material application diagrams
- Material safety data sheets
- Product and raw material inventory records
- Operator data logs
- Operating procedures
- Production schedules

Accounting Information:
- Waste handling, treatment & disposal costs
- Water and sewer costs including surcharges
- Costs for non-hazardous waste disposal
- Operating & maintenance costs
- Department cost accounting reports

Other Information:
- Environmental policy statement
- Standard procedures
- Organization charts

Visit Sites

In order to best utilize resources of time, staff, and money wisely, the Pollution Prevention team will need to prioritize the processes, operations, and wastes that will be addressed during the subsequent detailed assessment phase. During that phase, they can target the most important waste problems, moving on to lower priority problems as resources permit. The pre-assessment site visits may provide more information needed to accomplish this prioritization and to designate the detailed assessment teams, who will be selected for their expertise in specific areas.

Establish Priorities

Assigning priorities to processes, operations, and materials will focus the remainder of the pollution prevention plan development effort. The priorities set at this stage will guide the selection of areas for detailed assessment. Areas may be targeted based on the volume of waste produced or the cost of waste disposal. Regulatory concerns may also guide the prioritization. The **Option Rating Weighted Sum Method,** illustrated in Appendix B, can be used during the pre-assessment and detailed assessment phases.

Typical considerations for prioritizing waste streams for further study include:

- Compliance with current and anticipated regulations
- Cost of waste treatment, disposal, and pollution control
- Potential environmental and safety liability
- Quantity of waste
- Hazardous properties of the waste
  (including toxicity, flammability, corrosivity, and reactivity)
- Potential for pollution prevention
- Potential for removing bottlenecks in production or waste treatment
- Potential recovery of valuable by-products
- Available budget for the pollution prevention assessment program and projects
- Minimizing waste water discharges
- Reducing energy use

Prepare the plan

With the information collected during pre- assessment, the Pollution Prevention Team can develop a detailed plan. This plan will address the extent to which external organizations will be involved, define pollution prevention program objectives, identify potential obstacles and solutions, and define the data collection and analysis procedures that will be used.

A summary of the points that should be addressed in a plan:

- Corporate policy statement and management support for pollution prevention
- Description of Pollution Prevention planning team make up with authority and responsibility defined
- Plan to communicate the plan to employees and stakeholders
- Plan to communicate the successes and failures of the plan within the organization
- Description of the processes that produce, use or release subject pollutants, and products under consideration
- List of treatment, disposal, recycling facilities, and transporters currently used
- Preliminary review of the cost of pollution prevention activities at your facility
- Current and past pollution prevention activities at your facility
- Evaluation of the effectiveness of past and ongoing pollution prevention activities
- Criteria for prioritizing activities for pollution prevention projects
- Selection of Pollution Prevention options and implementation of options
- Reporting progress on Pollution Prevention
- Revisit the plan for continuous improvement

Contacting External Groups

At this stage, the Pollution Prevention Team should consider soliciting input from outside the company. These can include the community, other organizations, suppliers, consultants, and other businesses in the same field.

Identify Potential Obstacles

The potential obstacles in developing and implementing pollution prevention plans include: economic, technical, regulatory, and institutional.

Economic: The Pollution Prevention Team should recognize that some of the economic factors might need to be addressed later. It is a good idea to broadly define the procedures now for dealing with them later. Cost-benefit analysis procedures should be defined. Many proposed options will have start up costs. Refer to “Total Cost Assessment” (TCA) as it applies to pollution prevention in Chapter 3. Limited financial resources for capital investments may also be a problem.

Technical: Information will be needed on alternative procedures that should be considered, how to integrate them in the production processes, and what side effects are possible. Information resources could be a problem. A list of potential sources is included in Appendix E. Limited flexibility in manufacturing process may pose another technical barrier. A proposed Pollution Prevention option may involve modifying the workflow or product, installing new equipment, or work shut down. Involve design and maintenance personnel in the planning stage. Product quality or customer requirements might cause resistance to change.

Regulatory: Regulations may be an obstacle for some options. Changing to a different raw material may require permits and approvals from the Ministry of the Environment.

Institutional: As with any new program, general resistance to change within the organization may arise. These can result from lack of awareness of corporate goals and objectives, individual or organizational resistance to change, lack of commitment, poor communication, labour contracts, or inflexible organizational structure. These can be overcome with education and outreach programs.

Develop Schedules

The final aspect of your Pollution Prevention Plan is to list the milestones within each stage from detailed assessment through implementation and assign realistic target dates.

This phase deals with execution of the pollution prevention plan. Detailed assessments will focus on specific areas targeted by the preliminary assessment. During this process, the team may identify some options that can be implemented quickly and with little cost or risk. It is likely that many options will be complex and will require in-depth analysis.

Preliminary Assessment- Material Balance

Organize and Document Process Information

Analyzing process information involves preparing material and energy balances as a means of analyzing pollution sources and opportunities for eliminating them. Such a balance is an organized system for accounting for the flow, generation, consumption, and accumulation of mass and energy in a process. The purpose of a material balance is to identify the amount of subject pollutants wasted to air, water, or land.

A material balance is a precise account of the inputs and outputs of an operation. The material balance can be for a plant, a process, or an operation. Note that infrequent outputs (e.g., occasional dumping of an electroplating bath) may be as significant as continuous daily discharges.

Determining Inputs

- Inputs to a process or an operation should include the subject pollutants and may include other raw materials, chemicals, water, air, and power. The inputs to the process and to each operation need to be quantified.
- As a first step toward quantifying raw material usage, examine purchasing records to get a general idea of the sort of quantities involved.
- In many situations, the unit operations where raw material losses are greatest are raw material storage and transfer. Look at these operations in conjunction with the purchasing records to determine the actual net input to the process.
- Make notes regarding raw material storage and handling practices. Consider evaporation losses, spillages, leaks from underground storage tanks, and vapor losses through storage tank pressure-relief vents, and contamination of raw materials. Often these problems can be rectified very easily.
- Record raw material purchases, storage, and handling losses in a table to derive the net input to the process/operation.

Once the net input of raw materials to the process has been determined, you can proceed with quantifying the raw material input to each operation.

If accurate information on raw material consumption rates for individual unit operations is not available, measurements should be taken to determine average figures.

Measurements should be taken for an appropriate length of time. For example, if a batch takes one week to run, measurements should be taken over a period of at least three weeks; these figures can be extrapolated for monthly or annual figures.

NOTE: Some quantification is possible by observation and simple accounting procedures.

For solid raw materials, ask the warehouse operator how many sacks are stored at the beginning of the week or before unit operation; then ask again at the end of the week or unit operation. Weigh a selection of sacks to check compliance with specifications.

For liquid raw materials such as water or solvents, check storage tank capacities and ask operators when a tank was last filled. Tank volumes can be estimated from the tank diameter and tank depth. Monitor the tank levels and the number of tankers arriving on-site.

The energy input to a unit operation should be considered at this stage; however, energy use deserves a full assessment in its own right. For pollution prevention assessment purposes, make note of the energy source and whether or not waste reduction could reduce energy cost. If energy usage is a particularly prominent factor, you should consider recommending that an energy assessment be undertaken.

Input data should be recorded on your process flow diagram or in tabular form.

Some operations may receive recycled wastes from other operations. These also represent input.

Recording Water Usage

The use of water, other than for a process reaction, should be covered in all pollution prevention assessments. The use of water to wash, rinse and cool is often overlooked, although it represents an area where waste reductions can frequently be achieved simply and cheaply.

For each operation, consider the following:

- What is water used for in each operation? Cooling, gas scrubbing, washing, product rinsing, dampening stockpiles, general maintenance, safety quench, etc.
- How often does each action take place?
- How much water is used for each action?

Record water usage information in a tabular form.

Using less water can be a cost-saving exercise. Consider the following points while investigating water use:

- Tighter control of water use can reduce the volume of wastewater requiring treatment and result in cost savings. In the extreme, it can sometimes reduce volumes and increase concentrations to the point of providing economic material recovery in place of costly wastewater treatment.
- Attention to good housekeeping practices often reduces water usage and the amount of wastewater passing to drains.
- The cost of storing wastewater for subsequent reuse may be far less than the treatment and disposal cost.
- Counter-current rinsing and rinse water reuse are useful tips for reducing water consumption.

Measuring Current Levels of Waste Reuse/Recycling

Some wastes lend themselves to direct reuse in production and may be transferred from one unit to another (e.g., Use of alkaline rinsewater from one operation to neutralize acidic rinses from other operations?). Others require some modifications before they are suitable for reuse in a process. These reused waste streams should be quantified.

If reused wastes are not properly documented double counting may occur in the material balance, particularly at the process or complete plant level i.e.: a waste will be quantified as an output from one process and as an input to another.

The reuse or recycling of wastes can reduce the amount of fresh water and raw materials required for a process. When looking at the inputs to operations, consider the opportunities for reusing and recycling outputs from other operations.

Quantifying Process Outputs

To calculate the second half of the material balance, the outputs from operations and the process as a whole need to be quantified.

Outputs include primary product, byproducts, wastewater, gaseous wastes (emissions to atmosphere); liquid and solid wastes requiring storage and/or off-site disposal, and reusable or recyclable wastes.
The assessment of the amount of primary product or useful product is an essential factor in process or unit operation efficiency. If the product is sent off-site for sale, the amount produced is likely to be documented in company records. However, if the product is an intermediate to be input to another process or unit operation, the output may not be so easy to quantify. Production rates will need to be measured over a period. Similarly, the quantification of any byproducts may require measurement.

Accounting for Wastewater

On many sites, significant quantities of both clean and contaminated water are discharged to a sewer or watercourse. In many cases, this wastewater has environmental implications and treatment costs are incurred. In addition, wastewater may wash out valuable unused raw materials from the process areas.

It is extremely important to know the quantity and makeup of the wastewater that is going down the drain. The wastewater flow, from each operation as well as from the process as a whole, needs to be quantified, sampled, and analyzed.

- Identify the effluent discharge points to determine where the wastewater leaves the site. Wastewater may go to an effluent treatment plant or directly to a public sewer or watercourse. One factor often overlooked is the use of several discharge points -- it is important to identify the location, type, and size of all discharge flo*ws.*
- Identify where flows from different operations or process areas contribute to the overall flow. In this way, it is possible to piece together the drainage network for the site. This can lead to startling discoveries of what goes where!
- Once the drainage system is mapped, it is possible to design a sampling and flow measurement program to monitor the wastewater flows and strengths from each operation.
- Plan your monitoring program thoroughly and try to take samples over a range of operating conditions such as full production, start-up, shut-down, and wash-out. In the case of combined storm water and wastewater drainage systems, ensure that sampling and flow measurements are carried out in dry weather.
- For small or batch wastewater flows, it may be physically possible to collect all the flow for measurement using a pail and wristwatch. Larger or continuous wastewater flows can be assessed using flow measurement techniques.

  The sum of the wastewater generated from each operation should be approximately the same as that input to the process. As indicated before, double counting can occur where wastewater is

reused. This emphasizes the importance of understanding your operation and its interrelationships.

Analyze the wastewater from each process to determine which subject pollutants from Table 1 of the by-law are present in the waste discharges. Parameters with an impact on the environment require further monitoring to determine their significant impacts.

Typically, parameters should be measured depending on the raw material inputs. For example, an electroplating process is likely to use nickel and chromium. The metal concentrations of the wastewater should be measured to ensure that the concentrations do not exceed discharge regulations, but also to ensure that raw materials are not being lost to drain. Measure all subject pollutants used in the process.

Take samples for laboratory analysis. Composite samples should be taken for continuously running wastewater. The composite sample represents the average wastewater conditions over the time period. Where significant flow variations occur during the discharge period, consider varying the size of individual samples in proportion to flow rate to ensure that you obtain a representative composite sample. For batch tanks and periodic drain-down, a single-spot grab sample may be adequate (check for variations between batches before deciding on the sampling method).

Accounting for Gaseous Emissions

To arrive at an accurate material balance, some quantification of gaseous emissions associated with the process may be necessary.

It is important to consider the actual and potential gaseous emissions associated with each unit operation from raw material storage through product storage.

Gaseous emissions are not always obvious and can be difficult to measure. Where quantification is impossible, estimations can be made using theoretical values.

- Record the quantified emission data in tabular form and indicate both estimated figures and actual measurements.
- Are there certain times when gaseous emissions are more prominent? Is there a link to temperature?
- Is any pollution control equipment in place?
- If gas scrubbing is practiced, what is done with the spent scrubber solution? Could it be converted to a useful product?

Accounting for Off-Site Wastes

Your process may produce wastes that cannot be treated on-site. These need to be transported off-site for treatment and disposal. Wastes of this type are usually non-aqueous liquids, sludge or solids. Often, wastes for off-site disposal are costly to transport and treat. Minimizing these wastes yields direct cost benefits.

Measure the quantity and note the composition of any wastes associated with your process that need to be sent off-site for disposal or recycling.

Ask several questions during the data collection stage:

- Where does the waste originate?
- Can the manufacturing operations be optimized to produce less waste?

- Can alternative raw materials be used that would produce less waste?
- Is there a particular component that renders the whole waste hazardous? Can this component be isolated?
- Does the waste contain valuable materials?
- Wastes for off-site disposal need to be stored on-site before dispatch. Does storage of these wastes cause additional emission problems? For example, are solvent wastes stored in closed tanks?
- How long are wastes stored on-site?
- Are stockpiles of solid waste secure or are dust storms a regular occurrence?

Assembling Input and Output Information for Unit Operations

The total of what goes into a process must equal the total of what comes out. Prepare a material balance at a scale appropriate for the level of detail required in your study. For example, you may require a material balance for each unit operation, or one for a whole process may be sufficient.

Preparation of a material balance is designed to result in a better understanding of the inputs and outputs, especially waste, of a unit operation so that areas where information is inaccurate or lacking can be identified. Imbalances require further investigation. Do not expect a perfect balance -- your initial balance should be considered as a rough assessment to be refined and improved.

- Assemble the input and output information for each unit operation, and decide whether all the inputs and outputs need to be included in the material balance. For example, this is not essential where the cooling water input to a unit operation equals the cooling water output.
- Standardize units of measurement (liters, tons, etc.) on a per day, per year, or per batch basis.
- Summarize the measured values in standard units by reference to your process flow diagram. You may need to modify your process flow diagram following the in-depth study of the plant.

Deriving a Preliminary Material Balance for Unit Operations

Now, you can complete a preliminary material balance. For each unit operation, use the data developed in the steps above and construct the material balance. Display your information clearly. The following diagram shows one way of presenting the material balance information:

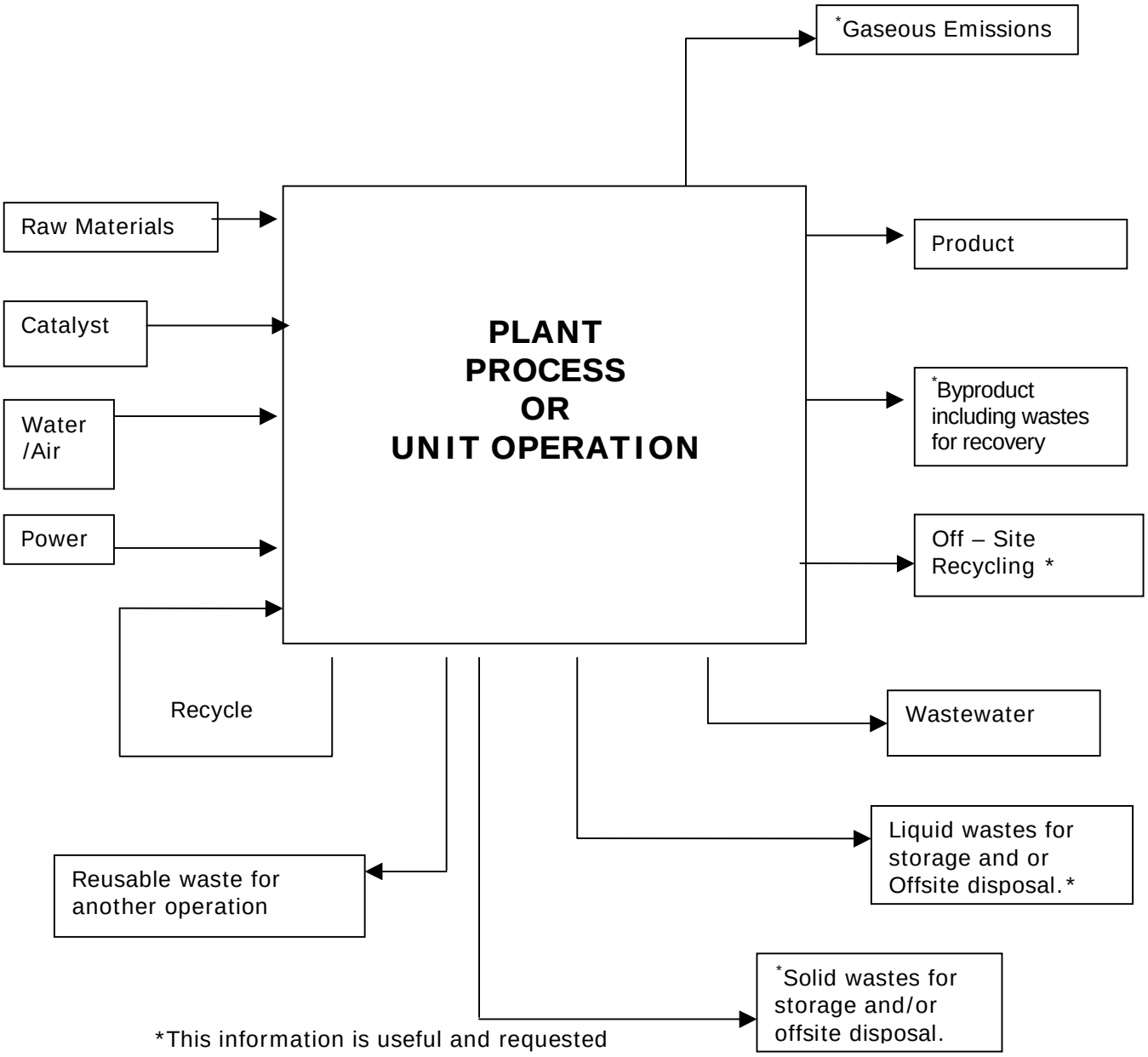


Figure 4

Note that a material balance will often need to be carried out in weight units since volumes are not always conserved. Where volume measurements have to be converted to weight units, take account of the density of the liquid, gas, or solid concerned.

Once the material balance for each unit operation has been completed for raw material (subject pollutant) inputs and waste outputs, it might be worthwhile repeating the procedure with respect to each contaminant of concern. It is highly desirable to carry out a water balance for all water inputs and outputs to and from unit operations because water imbalances may indicate serious underlying process problems such as leaks or spills. The individual material balances may be combined to give a balance for the whole process, a production area or factory.

Evaluating the Material Balance

Review the individual and sum totals making up the material balance to determine information gaps and inaccuracies. If you do have a significant material imbalance, further investigation is needed. For example, if outputs are less than inputs look for potential losses or waste discharges (such as evaporation). Outputs may appear to be greater than inputs if large measurement or estimating errors are made or inputs overlooked.

At this stage, you should take time to re-examine the unit operations to attempt to identify where unnoticed losses may be occurring. It may be necessary to repeat some data collection activities.

Remember that you need to be thorough and consistent to obtain a satisfactory material balance. The material balance not only reflects the accuracy of your data collection but also, by its very nature, ensures that you have a sound understanding of the processes involved.

Refining the Material Balance

Now you can reconsider the material balance equation by adding those additional factors identified in the previous step. If necessary, estimates of unaccountable losses will have to be calculated.

Note that, in the case of relatively simple manufacturing plants, preparation of a preliminary material balance and its refinement can usefully be combined. However, for more complex pollution prevention assessments two separate steps are likely to be more appropriate.

Remember, the inputs should ideally equal the outputs but in practice, this will rarely be the case and some judgment will be required to determine what level of accuracy is acceptable.

In the case of high-strength or hazardous wastes, accurate measurements are needed to design waste reduction options. It is possible that the material balance for a number of unit operations will need to be repeated. Again, continue to review, refine, and where necessary, expand your database. The compilation of accurate and comprehensive data is essential for a successful pollution prevention assessment and subsequent waste reduction action plan. You cannot reduce what you do not know is there.

Summary of developing a Pollution Prevention Plan

- Quantify all process inputs (subject pollutants).
- Establish the net input of raw materials and water to the process, having taken into account any losses incurred at the storage and transfer stages.
- Document any reused or recycled inputs.
- Document for consideration all notes regarding raw material handling, process layout, water losses, and obvious areas where problems exist.
- The pollution prevention assessment team should collate all information required for evaluating a material balance for each unit operation and for a whole process.
- Quantify actual and potential wastes. Where direct measurement is impossible, use estimates based on stoichiometric information.
- Arrange the data in clear tables with standardized units. Throughout the data collection phase, the assessors should make notes on actions, procedures, and operations that can be improved.

Pollution Prevention Opportunities- Identification and Evaluation:

Pollution Prevention Opportunities – Identification

- Encourage employees to submit pollution prevention ideas
- Consult outside sources for technical information

Pollution Prevention Opportunities – Evaluation

Evaluate pollution prevention options:

- 'subject pollutant' is reduced or eliminated
- no cross media transfer i.e. no new environmental impacts arise from adopting pollution prevention options

Evaluate options which are technically, environmentally, and economically feasible. Base the pollution prevention options evaluation on feasibility criteria such as:

- worker health and safety
- capital equipment cost
- labour requirements
- utility requirements
- effect on productivity
- cost savings potential
- product / process compatibility
- availability of technology

- increased market share
- advertising opportunities

Different waste reduction measures require varying degrees of effort, time, and financial resources. They can be categorized into two groups:

Group 1 Obvious waste reduction measures, including improvements in management techniques and housekeeping procedures that can be implemented cheaply and quickly. (Low cost/no cost)

Group 2 Long-term reduction measures involving process modifications or process substitutions to eliminate problem wastes.

Increased reuse/recycling to reduce waste falls between the immediate and the more substantial waste reduction measures.

Examining Obvious Waste Reduction Measures

It may have been possible to implement obvious waste reduction measures already, before embarking on obtaining a material balance (refer back to step 3). Now consider the material balance information in conjunction with visual observations made during the whole of the data collection period. This may pinpoint areas or operations where simple adjustments in procedure could greatly improve the efficiency of the process by reducing unnecessary losses.

Use the information gathered for each unit operation to develop better operating practices for all units. Improved operation, better handling, and generally taking more care can often achieve significant waste reductions. The following list of waste reduction hints can be implemented immediately with no or only small extra cost.

Specifying and ordering materials

- Do not over-order materials especially if the raw materials or components can spoil or are difficult to store.
- Try to purchase raw materials in a form that is easy to handle, for example, pellets instead of powders.
- Buy in bulk for better efficiency and cost savings.

Receiving materials

- Demand quality control from suppliers by refusing damaged, leaking, or unlabeled containers.
- Undertake a visual inspection of all materials coming to the site.
- Check that a sack weighs what it should and the volume ordered is the volume supplied.
- Check that composition and quality are correct.

Material storage

- Install high-level control on bulk tanks to avoid overflows.
- Dyke tanks to contain spillage.
- Use tanks that can be pitched and elevated, with rounded edges for ease of draining and rinsing.
- Dedicated tanks, receiving only one type of material, do not need to be washed out as often as tanks receiving a range of materials.
- Ensure drums are stored in a stable set-up to avoid damaging them when not in use.

- Implement a tank-checking procedure. For example, dip tanks regularly and label clearly to avoid discharging a material into the wrong tank.
- Use covered or closed tanks to reduce evaporation losses.

Transfer and handling of materials and water

- Minimize the number of times materials are moved on-site.
- Check transfer lines for spills and leaks.
- Check whether flexible pipe work is too long.
- Catch drainings from transfer hoses.
- Plug leaks and fit flow restrictions to reduce excess water consumption.

Process control

- Design a monitoring program to check the emissions and wastes from each unit operation.
- Perform maintenance on all equipment regularly to help reduce fugitive process losses. Document the information.
- Feedback on how waste reduction is improving the process motivates the operators. It is vital that employees are informed of the ultimate goal of actions taken.

Cleaning procedures

- Minimize the amount of water used to wash out and rinse vessels -- on many sites, indiscriminate water use contributes a large amount to wastewater flows. Ensure that hoses are not left running by fitting self-sealing valves.
- Investigate how wash water can be contained and used again before discharged to drains. Also, do the same for solvents used to clean; these can often be used more than once.

  Tightening up housekeeping procedures can reduce waste considerably. Make simple, quick adjustments to your process to achieve a rapid improvement in process efficiency. Where such obvious reduction measures do not solve the entire waste disposal problem a more detailed consideration of waste reduction options will be needed.

Targeting and Characterizing Problem Wastes

Use the material balance for each unit operation to pinpoint the problem areas associated with the process.

The material balance exercise may uncover the origin of wastes with high-treatment cost or may indicate which wastes are causing process problems in which operations. The material balance should be used to determine priorities for long-term waste reduction.

At this stage, it may be worthwhile to consider the underlying causes to why wastes are generated and the factors behind them such as poor technology, lack of maintenance, and non-compliance with company procedures.

To ascertain the exact concentrations of contaminants, additional sampling and characterization of wastes and more in-depth analysis may be necessary. List wastes in order of priority for reduction actions.

Segregation

Segregation of wastes can offer enhanced opportunities for recycling and reuse with resultant savings in raw material cost. Concentrated simple wastes are more likely to be of value than dilute or complex wastes.

Mixing wastes can enhance pollution problems. If a highly concentrated waste is mixed with a large quantity of weak, relatively uncontaminated effluent, the result is a larger volume of waste requiring treatment. Isolating the concentrated waste from the weaker waste can reduce treatment cost. The concentrated waste could be recycled/reused or may require physical, chemical, and biological treatment to comply with consent discharge levels, whereas the weaker effluent could be reused or may only require settlement before discharge.

Therefore, waste segregation can provide more scope for recycling and reuse while reducing treatment cost.

Review your waste collection and storage facilities to determine if waste segregation is possible. Adjust your list of priority wastes accordingly.

Developing Long Term Waste Reduction Options

Waste problems that cannot be solved by simple procedural adjustments or improvements in housekeeping practices will require more substantial long-term changes.

It is necessary to develop possible prevention options for the waste problems. Process or production changes that may increase production efficiency and reduce waste generation include:

- Changes in production process -- continuous versus batch
- Equipment and installation changes
- Changes in process control -- automation
- Changes in process conditions -- retention times, temperatures, agitation, pressure, catalysts
- Where appropriate, use of dispersants in place of organic solvents
- Reduction in the quantity or type of raw materials used in production
- Raw material substitution through the use of wastes as raw materials or the use of different raw materials that produce less waste or less hazardous waste
- Process substitution with cleaner technology

Implement waste reuse if materials of sufficient purity can be concentrated or purified. Technologies such as reverse osmosis, ultra-filtration, electrodialysis, distillation, electrolysis, and ion exchange may enable materials to be reused and reduce or eliminate the need for waste treatment.

Where waste treatment is necessary, consider a variety of technologies. These include physical, chemical, and biological treatment processes. In some cases, the treatment method can also recover valuable materials for reuse. Another industry or facility may be able to use or treat a waste that you cannot treat on-site. It may be worth investigating the possibility of setting up a waste exchange bureau as a structure for sharing treatment and reuse facilities.

Consider also the possibilities for product improvement or change yielding cleaner, more environmentally friendly products, for existing products and new products in development.

Technical, Environmental, and Economic Evaluation of Waste Reduction Options

To determine which options should be developed to form a waste reduction action plan, each option should be considered in terms of environmental and economic benefits.

Technical Evaluation

Typical technical evaluation criteria:

- Will it reduce waste?
- Is the system safe for the employees?
- Will the product quality be improved or maintained?
- Is there sufficient space at the facility?
- Are the new equipment, materials, or production procedures compatible with our current production operation procedures?
- Is additional labour required?
- Do we have the utilities needed to run the equipment?
- How long will the production be stopped during system installation?
- Will the vendor provide acceptable service?

Environmental Evaluation

It is often taken for granted that reducing a waste will reap environmental benefits. This is generally true; however, there are exceptions. For example, reducing one waste may lead to pH imbalances or another waste that is more difficult to treat, resulting in a net environmental disadvantage.

In many cases, the benefits may be obvious, such as the result of removing a toxic agent from an aqueous effluent by segregating the polluted waste or changing the process to prevent the waste. In other cases, the environmental benefits may be less tangible. Creating a cleaner, healthier workplace will increase production efficiency, but this may be difficult to quantify.

For each option, a series of questions should be asked:

- What is the effect of each option on the volume and degree of contamination of process wastes?
- Does a waste reduction option have cross-media effects? For example, does the reduction of a gaseous waste produce a liquid waste?
- Does the option change the toxicity, degradability, or treatability of the wastes?
- Does the option use more or less non-renewable resources?
- Does the option use less energy?

Economic evaluation

Undertake a comparative economic analysis of the waste reduction options and the existing situation. Where benefits or changes cannot be quantified (e.g.: reduction in future liability, worker health and safety costs), some form of qualitative assessment should be made.

Economic evaluations of waste reduction options should involve a comparison of operating cost to determine where cost savings can be made. For example, a waste reduction measure that reduces the amount of raw material lost to drain during the process results in reduced raw material cost.

Raw material substitution or process changes may reduce the amount of solid waste that has to be transported off-site. Thereby, reducing the transport cost for waste disposal.

In many cases, it is appropriate to compare the waste treatment cost under existing conditions with those associated with the waste reduction option.

The size of treatment plant and the treatment processes required may be altered significantly by the implementation of waste reduction options. It is important to consider this in an economic evaluation.

- Calculate the annual operating cost for the existing process, indicating waste treatment, and estimate how these would be altered with the introduction of waste reduction options. Tabulate and compare the process and waste treatment operating cost for both the existing and proposed future waste management options. In addition, if there are any monetary benefits (e.g.: recycled or reused materials or wastes), subtract these from the total process or waste treatment cost.
- Now that you have determined the likely savings in terms of annual process and waste treatment operating cost associated with each option, consider the necessary investment required to implement each option. Looking at the payback period for each option can assess investment. Payback period is the time taken for a project to recover its financial outlay. A more detailed investment analysis may involve an assessment of the internal rate of return (IRR) and net present value (NPV) of the investment based on discounted cash flows. Analyzing investment risk allows you to rank options.
- Consider the environmental benefits and the savings in process and waste treatment operating cost along with the payback period for an investment, to decide which options are viable.

Developing and Implementing an Action Plan: Reducing Wastes and Increasing Production Efficiency

Consider the immediate reduction measures identified, along with the long-term waste reduction measures. These measures should form the basis of the waste reduction action plan. Discuss your findings with staff members and develop a workable action plan.

Prepare the ground for the waste reduction action plan. Precede its implementation by an explanation of the objectives behind undertaking a pollution prevention assessment: *Waste prevention makes sense*.

It is necessary to convince those who must follow the new procedures that the change in philosophy from end-of-pipe treatment to waste prevention makes sense and will improve efficiency. Around the site, have posters that emphasize the importance of waste reduction for minimizing production and waste treatment/disposal costs and, when appropriate, for improving the health and safety of company personnel.

Set out the intended action plan within an appropriate/realistic schedule. Remember, it may take staff time to feel comfortable with a new way of thinking. Therefore, it is good to slowly but consistently implement waste reduction measures to allow everyone time to adapt to these changes.

Set up a monitoring program to run alongside the waste reduction action plan so that actual improvements in process efficiency can be measured. Relay these results back to the workforce as

evidence of the benefits of waste reduction. Adopt an internal record keeping system for maintaining and managing data to support material balances and waste reduction assessments.

Likely, there will be significant information gaps or inconsistencies during the pollution prevention assessment investigations. You should concentrate on these gaps and explore ways of developing the additional data. Is outside help required?

A good way of providing waste reduction incentives is to set up an internal waste-charging system. Those processes that create waste, either in great volume or of the difficult, or expensive-to-handle type, can contribute to the treatment cost on a proportional basis. Another method of motivating staff is to offer financial rewards, for individual waste-saving efforts, drawn from the savings gained by implementing waste-reduction measures.

Pollution prevention assessments should be a regular event. Attempt to develop a specific pollution prevention assessment approach for your own situation, keeping abreast of technological advances that could lead to waste reduction and the development of "cleaner" products. Train process employees to undertake material balance exercises.

Training people who work on the process to undertake a pollution prevention assessment may help to raise awareness in the workforce. Without the support of the process operators, waste reduction actions may be ineffectual – your employees really can make a difference to process performance.

CHAPTER 3

ECONOMIC ANALYSIS OF POLLUTION PREVENTION PROJECTS

Although businesses may invest in pollution prevention because it is the right thing to do, or because it enhances their public image, or it is required by the law, the viability of many pollution prevention investments rests on sound economic analysis. In essence, companies will not invest in a pollution prevention project unless that project successfully competes with alternative investments. This chapter explains the basic elements of an adequate cost accounting system and how to conduct a comprehensive economic assessment of investment options.

TOTAL COST ASSESSMENT

Business accounting systems do not usually track environmental costs so they can be allocated to the particular production unit that created those wastes. Without this sort of information, companies tend to lump environmental costs together in a single overhead account or simply add them to other budget line items. As a result, companies do not have the ability to identify those parts of their operations that cause the greatest environmental expenditures or the products that are most responsible for waste production. This chapter provides some guidance on how accounting systems can be set up to capture this useful information better.

Economic assessments typically used for investment analysis may not be adequate for pollution prevention projects. For example, traditional analysis methods do not adequately address the fact that many pollution prevention measures will benefit a larger number of production areas than do most other kinds of capital investment. Second, they usually do not account for the full range of environmental expenses companies often incur. Third, they usually do not accommodate a sufficiently long time horizon to allow full evaluation of the benefits of many pollution prevention projects. Finally, they provide no mechanism for dealing with the probabilistic nature of pollution prevention benefits, many of which cannot be estimated, with a degree of certainty.

There are four elements of **Total Cost Assessment** (TCA): expanded cost inventory, extended time horizon, use of long-term financial indicators, and direct allocation of costs to processes and products. The first three apply to feasibility assessment, while the fourth applies to cost accounting. TCA provides substantial benefits for pre-implementation feasibility assessments and for post-implementation project evaluation.

Much of the information in the chapter is from a report prepared for USEPA by Tellus Institute. The report can be obtained from N.J Department of Environmental Protection. A TCA software can be downloaded from Government of BC website. (http://www.tcabc.org/Introduction.html).

EXPANDED COST INVENTORY

TCA includes not only the direct cost factors that are part of most projects cost analysis but also indirect costs, many of which do not apply to other types of projects. Besides direct and indirect costs, TCA includes cost factors related to liability and certain less –tangible benefits.

TCA is a flexible tool that can be adapted to your specific needs and circumstances. A full-blown TCA will make more sense for some businesses than others. In either case, it is important to remember that TCA can happen incrementally by gradually bringing each of its elements to the investment evaluation process. For example, while it may be quite easy to obtain information on direct costs, you may have more trouble estimating some of the future liabilities and less tangible costs. Perhaps your first effort should incorporate all direct costs and as many indirect costs as possible. Then you might add those costs that are more difficult to estimate as increments to initial analysis, thereby highlighting to management both their uncertainty and their importance.

Direct Costs

For most capital investments, the direct cost factors are the only ones considered when project costs are being estimated. For pollution prevention projects, this category may be a net cost, although several of the components of the calculation will represent savings. Therefore, confining the cost analysis to direct costs may lead to the incorrect conclusion that pollution prevention is not a sound business investment.

Capital expenditures

- Buildings
- Equipment and Installation
- Utility Connections
- Project Engineering

Operation and Maintenance Expenses or Revenues

- Raw materials
- Labour
- Waste disposal
- Water and energy
- Value of Recovered Material

Indirect Costs

For pollution prevention projects, unlike more familiar capital investments, indirect costs are likely to represent significant net savings.

- Administrative Costs
- Regulatory Compliance Costs
    - Permitting
    - Record-keeping and Reporting
    - Monitoring
    - Manifesting
- Insurance
- Workman's Compensation
- On-Site Waste Management
- On-Site Pollution Control equipment Operation

  All these costs can be significant. They are considered hidden in the sense that they either are allocated to overhead rather than their source (production process or product) or are altogether omitted from the project financial analysis. A necessary first step in including these costs in economic analysis is to estimate and allocate them to their source.

Liability Costs

- Penalties
- Fines
- Personal injury
- Property Damage
- Cleanup Costs

Reduced liability associated with pollution prevention investments may also offer significant savings net savings to your company. Potential reduction in penalties, fines, cleanup costs, and personal injury and damage claims can make prevention investments more profitable, particularly in the long run.

In many instances, estimating and allocating future liability costs is subject to high degree of uncertainty. It may, for example, be difficult to estimate liabilities from actions beyond your control, such as accidental spill by a waste hauler. It may also be difficult to estimate future fines and penalties that might arise from non-compliance with regulatory standards that do not yet exist. Similarly, personal injury and property damage claims that may result from consumer misuse, from disposal of waste later classified as hazardous, or from claims of accidental release of hazardous waste after disposal are difficult to estimate. Allocation of future liabilities to products or production

processes also presents practical difficulties in cost assessment. Uncertainty, therefore, is a significant aspect of a cost assessment and one that top management may be unaccustomed to or unwilling to accept.

It is possible to find alternative ways to address liability costs in project analysis. For example, in the narrative accompanying a profitability calculation, you could include a calculated estimate of liability reduction, cite a penalty or settlement that may be avoided, or qualitatively indicate without attaching dollar value the reduced liability risk associated with the pollution prevention project.

Less Tangible benefits

A pollution prevention project may also deliver substantial benefits from an improved product and company image or from improved employee health.

- Increased Sales Due to
  - Improved product quality
  - Enhanced company image
  - Consumer trust in green products
- Improved supplier-Customer Relationship
- Reduced Health Maintenance Costs
- Increased Productivity Due to Improved Employee Relations
- Improved Relationships with Regulators

These benefits remain largely unexamined in environmental investment decisions. Although they are often difficult to measure, they should be incorporated into assessment whenever feasible. At the very least, they should be highlighted for managers after presenting the more easily quantifiable costs that can be allocated.

Expanded time horizon

Since many of the liability and less-tangible benefits of pollution prevention will occur over a long period of time, it is important take an economic assessment look at a long time frame, not the three to five years typically used for other types of projects. Of course, increasing the time frame increases the uncertainty of the cost factors used in the analysis.

Long-term financial indicators

When making pollution prevention decisions, select long term financial indicators that account for:

- All cash flows during the project
- The time value of money

Three commonly used financial indicators meet these criteria: Net Present Value (NPV) of an investment, Internal Rate of Return (IRR), and Profitability Index (PI). Another commonly used indicator, the payback period, does not meet the two criteria mention above and should not be used.

Direct allocation of costs

Few companies allocate environmental costs to the products and processes that produce these costs, without direct allocation. Businesses tend to lump these expenses into a single overhead account or simply add them to other budget line items where they cannot be segregated easily. The result is an accounting system that is incapable of:

1. Identifying the products or processes most responsible for environmental costs.

2. Targeting prevention opportunity assessments and prevention investments to the high environmental cost products and processes.

3. Tracking the financial savings of a chosen prevention investment.

TCA may help you remedy each of these deficiencies. Like much of the TCA method, implementation of direct cost allocation should be flexible and tailored to the specific needs of your company. To help you evaluate the options available to you, the discussion below introduces three ways of thinking about allocating your costs:

- Single pooling
- Multiple pooling and
- Service centers

The discussion is meant as a general guidance and explains some of the advantages and disadvantages of each approach. Please refer to USEPA publications, general accounting texts, and financial specialists for more detail.

Single Pool Concept:

With the single pool method, the company distributes the benefits and costs of pollution prevention across all of its products and services. A general overhead or administrative cost is included in all transactions.

Advantages: This is the easiest accounting method to put into use. All pollution costs are included in the general or administrative overhead costs that most companies already have, even though they may not be itemized as pollution costs. It may therefore not be a change in accounting methods but rather an adjustment in the overhead rate. No detailed accounting or tracking of goods is needed. Little additional administrative burden is incurred to report the benefits of pollution prevention.

Disadvantages: If the company has a diverse product or service line, pollution costs may be recovered from products or services that do not contribute to pollution. This has the effect of inflating the costs of those products or services unnecessarily. It also obscures the benefits of pollution prevention to the people who have the opportunity to make it successful – the line manager will not see the effect of preventing or failing to prevent pollution in his area of responsibility.

Multiple Pool Concept

The next level of detail in the accounting process is the multiple pool concepts, wherein pollution prevention benefits or costs are recovered at the department or other operating unit level.

Advantages: This approach ties the cost of pollution more closely to the responsible activity and to the people responsible for daily implementation. It is also easy to apply within an accounting system that is already set up for departmentalized accounting.

Disadvantages: A disparity may still exist between responsible activities and the cost of pollution. For example, consider a department that produces parts for many outside companies. Some customers need standard parts, while others require special preparation of the parts. This special preparation produces pollution. It is reasonable to allocate the benefit or cost for this pollution prevention project across all of the parts produced.

Service Center Concept

A much more detailed level of accounting is the service center concept. Here, the benefits or costs of pollution prevention are allocated to only those activities that are directly responsible.

Advantages: Pollution costs are accurately tied to the generator. Theoretically, this is the most equitable to all products or services produced. Pollution costs can be identified as direct costs on the appropriate contracts and not buried in the indirect costs, affecting competitiveness on other contracts. Pollution costs are more accurately identified, monitored, and managed. The direct benefits of pollution prevention are more easily identified and emphasized at the operational level.

Disadvantages: Considerable effort may be required to track each product, service, job, or contract and to recover the applicable pollution surcharges. Added administrative costs may be incurred to implement and maintain the system. It may be difficult to identify the costs of pollution when pricing an order or bidding on a new contract. It may be difficult to identify responsible activities under certain circumstances such as laboratory services where many small volumes of waste are generated on a seemingly continuous basis.

SUMMARY

Choosing long-term financial indicators, which consistently provide manager with accurate and comparable project financial assessments, allows prevention-oriented investments to compete successfully with other investment options. Finally, directly allocating costs to processes and products enhances your ability to target prevention investments to high environmental cost areas, routinely provides the information to do TCA analysis, and allows managers to track the success of prevention investments. Overall, the TCA method is a flexible tool, to be applied incrementally, as your company's needs dictate.

CHAPTER 4

DESIGNING ENVIRONMENTALLY COMPATIBLE PRODUCTS

STAGES IN LIFE CYCLE ASSESSMENT

Environmentally compatible products minimize the adverse effects on the environment resulting from their manufacture, use and disposal. The environmental impact of a product, largely, determined during its design phase. By taking environmental considerations into account during product planning, design, and development, your company can minimize the negative impact of your products on the environment.

Design changes made to prevent pollution should be implemented in such a manner that the quality or function of the product is not affected adversely. Design for the environment can be achieved by the people directly involved, within the framework of company policy and with the support from company management, whether or not in response to incentives external to the company.

The process of looking at all aspects of product design from the preparation of its input materials to the end of its use is life cycle assessment. A life cycle assessment of the product design evaluates the types and quantities of product inputs, such as energy, raw materials, and water, and of product outputs, such as atmospheric emissions, solid & waterborne wastes, and the end product.

The three stages of life-cycle assessment include:

1. The identification and quantification of energy and resource use and waste emissions (inventory analysis).

2. The assessment of the consequences those wastes have on the environment (impact analysis).

3. The evaluation and implementation of opportunities to effect environmental improvements (improvement analysis).

The life-cycle assessment is not necessarily a linear or stepwise process. Rather information from any of the components can complement information from the other two. Environmental benefits can be realized from each component of the assessment process. For example, the *inventory* alone may be used to identify opportunities for reducing emissions, energy consumption, or material use. *Impact analysis* typically identifies the activities with greater and lesser environmental effects, while the *improvement analysis* helps ensure that any potential reduction strategies are optimized and that improvement programs do not produce additional, unanticipated adverse impacts to human health and the environment.

GOALS OF PRODUCT DESIGN OR REDESIGN

When beginning to look at product design or redesign to make it environmentally compatible, the first step is to define the goals. When redesigning an existing product, goals may involve modifying those aspects of its performance that are judged environmentally unacceptable and that can be improved. Aspects that should be examined include whether it uses scarce input material, contains hazardous substances, uses too much energy, or is not readily reused or recycled. These

environmental criteria can be added to the initial program of requirements for the product, such as quality, customer acceptance, production cost.

The goals of new product design can be reformulation and a rearrangement of the products' requirements to incorporate environmental considerations. For example, the new product can be made out of renewable resources, have an energy efficient manufacturing process, have a long life, be non-toxic, and be easy to reuse or recycle. In the design of the new product, these environmental considerations can become an integral part of the program requirements.

In both design of new products and redesign of existing products, the methods applied and the procedure followed will be affected by additional environmental requirements. These new environmental criteria will be added to the list of traditional criteria. The box lists some environmental criteria for product design.

Environmental criteria to consider in designing products:

- Use renewable natural resource materials.
- Use recycled material.
- Use fewer toxic solvents or replace solvents with alternative material (e.g. use bead blasting instead of solvents for paint removal).
- Reuse scrap and excess material.
- Use water-based inks instead of solvent-based ones.
- Produce combined or condensed products that reduce packaging requirements.
- Produce fewer integrated units (e.g., more replaceable component parts).
- Minimize product filler and packaging,
- Produce products that are more durable.
- Produce goods and packaging reusable by the consumer.
- Manufacture recyclable final products

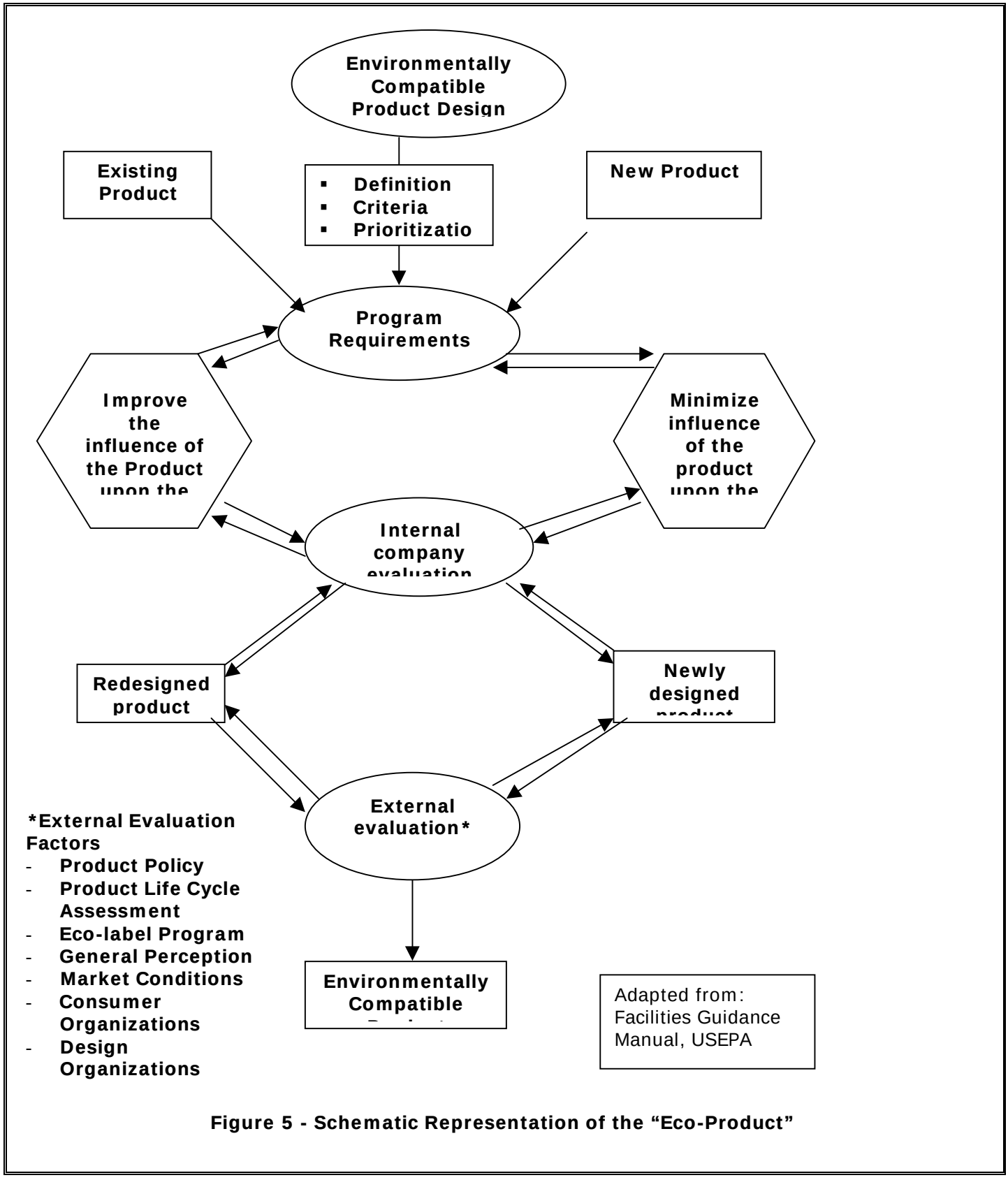


Figure 5 - Schematic Representation of the "Eco-Product"

CHAPTER 5

ENERGY CONSERVATION AND POLLUTION PREVENTION

Energy conservation and pollution prevention are complimentary activities. That is, actions that conserve energy reduce the quantity of wastes produced by energy-generating processes, and actions that reduce production process wastes lower the expenditure of energy use for waste handling and treatment.

PREVENTING POLLUTION BY CONSERVING ENERGY

Processes that consume materials and create wastes that pollute the environment if released directly generate nearly all energy used in Canada and the United States. These wastes require treatment or the even less satisfactory measure of long-term containment.

Ways to Conserve Electrical and Thermal Energy

Production facilities consume enormous amount of energy in both their production processes and the operation of their facilities. Aside from environmental considerations, the rapid increase in the cost of electricity provides a strong motivation to conserve its use.

Your company can conserve energy by:

- Implementing housekeeping measures such as turning off equipment and lights when not in use.
- Placing cool air intakes and air-conditioning units in cool, shaded locations
- Using more efficient heating and air-conditioning units.
- Using motors that are more efficient.
- Eliminating leaks in compressed air supply lines.
- Improving lubricating practices for motor driven equipment.
- Using energy-efficient power transfer belts.
- Using fluorescent lights and/or lower wattage lamps or ballast.
- Installing timers and/or thermostats to better control heating and cooling.

You can reduce loss with thermal energy conservation by:

- Adjusting burners for optimum air/fuel ratio.
- Improving or increasing insulation on heating and cooling lines.
- Instituting regular maintenance to reduce leakage and stop steam trap bypass.
- Improving the thermodynamic efficiency of the process by options such as:

- Using condensers or regenerative heat exchangers to recapture heat.
- Using heat pumps or similar equipment to recover heat in distillation columns.
- Using heat exchangers that are more efficient.
- Using congregation of electricity and steam.

CONSERVING ENERGY THROUGH POLLUTION PREVENTION

Energy consumption is reduced when waste generation is controlled. Treating and transporting pollutants represents an enormous drain on the energy reserves.

Pollution prevention activities result in improved efficiency of resource use, consequently reducing the amount of energy required to process input materials. For example, reuse of metals such as copper and aluminum requires considerably less energy than is expended in extracting and processing the ores. Reducing the amount of metal used in the production process, thereby saving energy required to recover the metal, can save additional energy.

APPENDIX A
CHECKLISTS

This appendix tabulates information that may be helpful to you if you decide to customize the worksheets in Appendix A. General pollution prevention ideas and approaches are listed in Table 1. Table 2 is a checklist for all industries covering raw material, product storage, laboratories, maintenance, etc. Checklists for specific sectors will be provided to related industries.

Table 1. Pollution Prevention Through Good Operating Practices

Good Operating Practice	Program Ingredients
Waste Segregation	• Prevent mixing of hazardous waste with non-hazardous wastes • Store materials in compatible groups • Segregate different solvents • Isolate liquid and solid wastes
Preventive Maintenance Programs	• Maintain equipment history cards on equipment location, characteristics, and maintenance • Maintain a master preventive maintenance schedule • Keep vendor maintenance manual handy • Maintain a manual or computerized repair history file
Training/Awareness Building Programs	Provide training for: • Operation of the equipment to minimize energy use and material waste • Proper material handling to reduce waste and spills • Emphasize importance of pollution prevention by explaining the economic and environmental ramifications of hazardous waste generation and disposal • Detecting and minimizing material loss to air, land, or water • Emergency procedures to minimize loss of material during accidents
Effective Supervision	• Closer supervision may improve production efficiency and reduce inadvertent waste generation • Centralize waste management. • Appoint a safety/waste management officer for each department. • Educate staff on the benefits of pollution prevention. • Establish pollution prevention goals. • Perform pollution prevention assessments
Employee Participation	• Seek employee participation through group discussions, brainstorming, etc. • Solicit and reward employee suggestions for waste reduction ideas.
Production Scheduling/Planning	• Maximize batch size to reduce clean out waste • Dedicate equipment to a single product • Alter batch sequencing to minimize cleaning frequency (light- to - dark batch sequence, for example)
Cost accounting/ Allocation	• Charge direct and indirect costs of all air, land, and water discharges to specific processes or products • Allocate waste treatment and disposal costs to operations that generate the waste Allocate utility costs to specific processes or products

Table 2. Checklist for All Industries

Waste Origin/Type	Pollution Prevention and Recycling Methods
Material Receiving: Packaging materials, off-spec materials, damaged container, inadvertent spills, transfer hose residual	• Use "Just-in-Time" ordering system. • Establish a centralized purchasing program. • Select quantity and packaging type to minimize packing waste. • Order reagent chemicals in exact amounts. • Encourage chemical suppliers to become responsible partners (e.g., accept outdated supplies) • Establish an inventory control program to trace chemical from cradle to grave. • Rotate chemical stock. • Develop a running inventory of unused chemicals for other department use • Inspect material before accepting a shipment. • Review material procurement specifications. • Validate shelf –life expiration dates • Test effectiveness of the outdated material • Eliminate shelf-life requirements for stable compounds. • Conduct frequent inventory checks. • Use computer-assisted plant inventory system. • Properly label all containers. • Buy pure feeds. • Find use for off-spec material, which would otherwise be disposed. • Change to reusable shipping containers. • Switch to less hazardous raw material. • Use rinsable/recyclable drums.
Raw Material and Product Storage: Tank bottoms; off-spec and excess materials; spill residues; leaking pumps, valves; tanks, and pipes; damaged containers; empty containers.	• Establish Spill Prevention, Control, and Countermeasures plans. • Use properly designed tanks and vessels only for their intended purposes. • Install overflow alarms for tanks and vessels. • Maintain physical integrity of all tanks and vessels. • Set up written procedures for all loading. Unloading, and transfer operations. • Install secondary containment for storage tanks and processing areas. • Isolate idle/redundant lines or leaky process lines. • Use sealless pumps. • Use bellows-seal valves. • Document all spillage • Perform overall materials balances and estimate the quantity and dollar value of all losses.

Table 2. (Continued)

Waste Origin / Type	Pollution Prevention and Recycling Methods
Raw Material and Product Storage: (Continued)	• Use floating-roof tanks for VOC control. • Use conservation vents on fixed roof tanks. • Use vapour recovery systems. • Store containers in a way that allows visual inspection for corrosion and leaks. • Stack containers in a way to minimize the chance of tipping, puncturing, or breaking. • Maintain Material Safety Data Sheets to ensure correct handling of spills. • Provide adequate lighting in the storage area. • Maintain a clean, even surface in transportation areas. • Keep aisles clear of obstruction. • Maintain distance between incompatible chemicals. • Avoid stacking containers against process equipment. • Follow manufacturers' suggestions on the storage and handling of all raw materials. • Use large containers for bulk storage whenever possible. • Empty drums and containers completely before cleaning or disposal. • Reuse scrap paper for notepads, recycle paper.
Laboratories: Reagents, off-spec chemicals, samples, empty sample & chemical containers.	• Use micro or semi-micro analytical techniques. • Increase use of instrumentation. • Reduce or eliminate the use of highly toxic chemicals in the laboratory experiments. • Reuse/recycle spent solvents. • Recover metal from catalyst. • Treat or destroy hazardous waste products as the last step in experiments. • Keep incompatible waste streams separate. Segregate hazardous waste from non-hazardous waste. Segregate recyclable waste from non-recyclable waste. • Clearly mark the identity of all chemicals and wastes on their containers. • Investigate mercury recovery and recycling.
Operation and Process Changes: Solvents, cleaning agents, degreasing sludge, sandblasting waste, caustic, scrap metal, oils, and greases from equipment cleaning.	• Maximize dedication of process equipment • Recover residual product/ process chemical prior to rinsing. • Use closed storage and transfer systems. • Use cleaning systems that avoid minimize solvent use and clean only when needed. • Sufficient drain time for liquids. • Use counter-current rinsing. • Reuse cleanup solvent. • Reprocess cleanup solvent into useful products. • Segregate wastes by solvent type. • Reclaim solvent by distillation. • Schedule production to lower cleaning frequency. • Use mechanical wipers on mixing tanks.
Sludge and spent acid from heat exchanger cleaning	• Use bypass control or pumped recycle to maintain turbulence during turndown. • Use smooth heat exchanger surfaces. • Use on-stream cleaning techniques. • Use high-pressure water cleaning to replace chemical cleaning where possible. • Use low-pressure steam.

APPENDIX B
OPTION RATING: WEIGHTED SUM METHOD

The Weighted Sum Method is a quantitative method for screening and ranking pollution prevention options. This method provides a means of quantifying the important criteria that affect waste management in a particular facility. This method involves three steps.

1. Determine what the important criteria are in terms of the program goals and constraints and the overall corporate goals and constraints. Example criteria are:

- Reduction in waste quantity
- Reduction in waste hazard (e.g. toxicity, flammability, reactivity)
- Reduction in waste treatment/disposal costs
- Reduction in raw material costs
- Reduction in liability and insurance costs
- Previous successful use within the company
- Not detrimental to product quality
- Previous successful use in the industry
- Low capital cost
- Low operating and maintenance cost
- Short implementation period with minimal disruption of plant operations

The weightings (on a scale of 0 to 10, for example) are determined for each of the criteria in relation to their importance. For example, if the reduction in waste treatment and disposal costs are very important, while previous successful use within the company is of minor importance, then the reduction in waste costs is given a weight of 10 and the previous use within the company is given a weight of 1 or 2. Criteria that are not important are not included or given a weight of 0.

2. Each option is then rated on each criterion. Again a scale of 0 to 10 can be used (o for low and 10 for high).

3. Finally, the rating of each option for a particular criterion is multiplied by the weight of the criterion. An option's overall rating is the sum of the products of rating times the weight of the criterion.

The options with the best overall ratings are then selected for the technical and economic feasibility analysis. Table D-1 presents an example using the Weighted Sum Method for screening and ranking options.

Table D-1. Sample Calculation using the Weighted Sum Method

ABC Corporation has determined that reduction in waste treatment costs is the most important criterion, with a weight factor of 10. Other significant criteria include reduction in safety hazard (weight of 8), reduction in liability (weight of 7), and ease of implementation (weight of 5). Options X, Y, and Z are then each assigned effectiveness factors. For example, option X is expected to reduce waste by nearly 80%, and is given a rating of 8. It is given a rating of 6 for reducing safety hazards, 4 for reducing liability, and because it is somewhat difficult to

implement 2 for ease of implementation. The table below shows how the options are rated overall, with effectiveness factors estimated for options Y and Z.

	Ratings for each option			
Rating Criteria	**Weight**	**X**	**Y**	**Z**
Reduce treatment cost	10	8	6	3
Reduce safety hazard	8	6	3	8
Reduce liability	7	4	4	5
Ease of implementation	5	2	2	8
Sum of weight times ratings		166	122	169

From this screening, option Z rates the highest with a score of 169. Both options X and Z should be selected for further evaluation, as their scores are high and close to each other.

APPENDIX C

Example of Management Environmental Protection Policy

The Piston and Crankshaft Electro-Plating Company is committed to making the protection of the environment a high priority. We will achieve pollution prevention by examining substitution to less hazardous substances, production process modification, product reformulation, improvements in operations and maintenance, and in-process recycling of production materials. Our ultimate objective is to have a zero discharge of hazardous wastes to the environment. We are also committed to minimizing our use of water and energy. It is our belief that pollution prevention at the source and conserving resources makes environmental sense and business sense. In addition to protecting the environment and helping to create a sustainable society for now and the future, pollution prevention and conservation of resources can achieve significant cost savings, improve efficiencies in operation, improve product quality, enhance customer satisfaction, enhance the company's public image, improve profitability, reduce or eliminate environmental liabilities, and achieve the highest standard of employee health and safety.

The Piston and Crankshaft Electro-plating Company will use the following guidelines to achieve excellence in pollution prevention:

1) Concern for the environment is a concern for every employee of the corporation.
2) All employees will be given training regarding pollution prevention and environmental management.
3) Employees are encouraged to recommend ways that the company can prevent pollution at the source and minimize water and energy usage.
4) The company will establish an environmental taskforce to develop a pollution prevention program. The taskforce will advise the company how to develop and implement a pollution prevention plan. It will find ways to encourage the company to strive for continuous improvements in minimizing and eliminating the generation of hazardous wastes. It will also recommend ways that the company can reduce water and energy usage. The General Manager of the company will be the team leader and will be responsible for overseeing the pollution prevention program.
5) The company is committed to finding ways of minimizing and eliminating the generation of wastes by orienting its research, process design, and plant operations to identify ways of substituting with less toxic chemicals, finding suitable process modifications, examining possible product re-formulations, finding improvements in operations and maintenance, and finding means to do in-process recycling of chemicals.
6) For those hazardous chemicals that the company finds it still has to use, the company will develop an environmental preparedness plan to prevent and to recover from environmental emergencies.
7) The company will adhere to all environmental acts, regulations and by-laws.

APPENDIX D
POLLUTION PREVENTION SUCCESS STORIES

Transcontinental Printing

Process Modifications / Printing and Graphics

Transcontinental Printing, in Vancouver, became the first plant in North America to recycle and make reusable all wastes in the printing plant, by adopting MARATEK's clean technology. This Annacis Island plant is one of British Columbia's largest printing facilities. It covers 120,000 square feet and prints a wide range of material including advertising inserts, specialized periodicals, newspapers and corporate brochures.

The new plant was opened in 1994; it is an expansion of an existing business in Langley, British Columbia. The new facility was subject to strict environmental guidelines when built, especially with regard to sewer discharge limits and because of its close proximity to the Fraser River.

Description of Project

The plant uses many chemicals in its processes, which cannot be discharged to the sewer. These include: solvents, photo chemicals (fixer and developer), inks, plate developer and fountain solution. The plant recycles most of these wastes on site. In fact, there are no drains in the entire production area of the plant. Ninety percent of liquid waste streams are diverted from waste hauling. The remaining 10% is waste hauled for professional waste treatment at a licensed facility. The result is that the plant is 'green,' and can claim to have "Zero Discharge." of industrial effluent.

In order to maximize the opportunities for recycling, each waste stream is segregated and dealt with appropriately. Blanket wash and pressroom sink waste is treated through a two-stage membrane system. Water is separated and reused for toilets, etc. The concentrate is waste hauled with a volume of 5% of the original waste stream.

Fixer was replaced with a recycled fixer product, which provides no waste. Used fixer is collected in a central tote, and removed for treatment. Impurities (such as silver) are removed, and the product is remanufactured to a detailed quality control specification. Remanufactured fixer is then supplied back to Transcontinental. Used fountain solution is pumped through a Fountain Solution. Recycling System and recovered (70%) for reuse. Developer is still hauled off site for final disposal

Benefits

Environmental: a cleaner environment; 90% diversion of liquid waste streams from waste hauling.

Economic: estimated savings of $80,000/year in waste hauling fees; and $20,000/year in new chemistry purchases; excellent pay-back of less than 2 years for all technologies and guaranteed compliance

Recognition

In May 1995, the ultra-modern plant won the Canadian Direct Marketing Association's prestigious Environmental Respect Prize; in December 1996, Transcontinental Printing became the first web printer in North America to secure the EcoLogo certification as a mark of environmental excellence; and, in March 1997, they received a Certificate of Environmental Citizenship supported by????????

Contact

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APPENDIX E

REFERENCES

Canadian Environmental Protection Act (CEPA) guidelines for Pollution Prevention

Facility Pollution Prevention Guide by USEPA, May 1992, EPA/600/R-92/088

Pollution Prevention: A Guide to Program Implementation – Illinois Hazardous Waste Research and Information Centre, February 1993, TR-009

In-Plant Environmental Assessment Sourcebook: A guide to Pollution Prevention Planning – prepared by Chemonics International Inc. for U.S. Agency for International Development.

APPENDIX F
OTHER RESOURCES

This appendix lists reference material that may be helpful to you as you develop your pollution prevention program.

- **Environment Canada**

  Visit the site and explore various links that give information on Pollution Prevention, Sustainable Development, Canadian Environmental Protection Act, Pollution Prevention Guides, Success Stories and many more.
  http://www.ec.gc.ca/envhome.html

- **Ontario Ministry of the Environment**

  http://www.ene.gov.on.ca

- **Canadian Center for Pollution Prevention**

  A recognized leader in pollution prevention, the Canadian Center for Pollution Prevention (C2P2) encourages that would avoid or minimize creation of pollutants and waste, to foster a healthier environment and a sustainable society.

  An excellent source to get information on-line or through their toll free number 1-800-667-9790.
  http://www.c2Pollution Preventiononline.com

- **USEPA Region 2 Pollution Prevention Resources**

  http://www.epa.gov/r02earth/Pollution Prevention/Pollution Preventionres.htm

- **Industrial Assessments for Pollution Prevention and Energy Efficiency**

  http://www.epa.gov/ttbnrmrl/625/R-99/003.htm

- Pollution Prevention Resources

  Office of Pollution Prevention and Toxics Pollution Prevention Resource Exchange (P2Rx) provides information that is easily accessible and easy to search, collect, synthesize and update technical information, and it identifies experts and/or other sources

  The Pollution Prevention Resource Exchange (P2Rx) is a network of nine regional pollution prevention centers that offer a variety of resources, including information for specific industry sectors, training, libraries, referrals and research. Through Pollution PreventionRx, the nine centers are laying the groundwork for a seamless national network of easily accessible, high-quality Pollution Prevention information.

  http://www.p2rx.org

- **Printed Wiring Board Resources Center.**

  One of the national Compliance Assistance Centers, the PWBRC (www.pwbrc.org) serves as a "first-stop" source of information on federal regulations and pollution prevention practices for printed wiring board manufacturers. The Center's Web site will include a "walk through a plant" feature in which users can click on parts of the manufacturing process and find out applicable regulatory requirements, and pollution prevention and control means for compliance.

- **National Metal Finishing Resource Center (NMFRC)**

  The National Metal Finishing Resource Center (NMFRC) is designed to be the most substantial, comprehensive environmental compliance, technical assistance and pollution prevention information source available to the metal finishing industry.
  URL: http://www.nmfrc.org

- **Sector-based Information**

  The EPA's Office of Compliance has developed a series of profiles or notebooks containing information on selected major industries. These notebooks, which focus on key indicators that holistically present air, water, and land pollutant release data, have been thoroughly reviewed by experts from both inside and outside the EPA.
  URL: http://es.epa.gov/oeca/sector/index.html

- **Green Chemistry Expert System**

  The Green Chemistry Expert System (GCES) allows users to build a green chemical process, design a green chemical, or survey the field of green chemistry. The system is equally useful for new and existing chemicals and their synthetic processes. It includes extensive documentation. Click here for instructions and to download the Green Chemistry Expert System.

- **Cleaner Technologies Substitutes Assessment (CTSA): A Methodology and Resource Guide (EPA744-R-95-002)**
  http://www.epa.gov/opptintr/dfe/screenprinting/ctsa/index.html

- **Toxic Use Reduction Institute (TURI)**

  The Massachusetts Toxics Use Reduction Institute (TURI) was created to promote reduction in the use of toxic chemicals and the generation of toxic by-products in industry and commerce in the State of Massachusetts. The Toxics Use Reduction Institute encourages you to reproduce and distribute the information on this web site. No copyright restrictions apply to the material contained on this site.

  http://www.turi.org/

- **Pollution Prevention GEMS**

  Pollution Prevention GEMS is an internet search tool for facility planners, engineers, and managers who are looking for technical, process, and materials management information on the web.

  URL: http://www.Pollution Preventiongems.org