IMPROVING YOUR COMPETITIVE POSITION:

Strategic and Financial Assessment of Pollution Prevention Investments

TRAINING MANUAL

3rd Edition
Revised and Updated

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The Northeast Waste Management Officials' Association

The Northeast Waste Management Officials' Association (NEWMOA) is a non-profit interstate governmental association whose membership is composed of the hazardous and solid waste program directors of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont. NEWMOA was established by the Governors of the northeast states as an official interstate regional organization and, in accordance with Section 1005 of the Resource Conservation and Recovery Act, has been formally recognized by the US Environmental Protection Agency. NEWMOA is a forum for increased communication and cooperation among the member states, a vehicle for the development of unified positions on various issues and programs, and a source of research and training on hazardous and solid waste management and pollution prevention. NEWMOA's well-established pollution prevention (P2) program is active in the following areas: (1) managing the Northeast States Pollution Prevention Roundtable - a regional roundtable of state and EPA pollution prevention staff; (2) coordinating several committees of the NE Roundtable; (3) training state and EPA officials and industry representatives in pollution prevention concepts and methods; (4) publishing a quarterly newsletter on state pollution prevention activities; and (5) managing a clearinghouse of pollution prevention technical information.

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DISCLAIMER

The views expressed in this report do not necessarily reflect those of the US EPA, NEWMOA, or the NEWMOA member states. Mention of any company, process or product name should not be considered an endorsement by NEWMOA, the NEWMOA member states or the US EPA.

Preface To The Third Edition

This training manual is the third edition of NEWMOA's curriculum on the financial analysis of pollution prevention (P2) investments. The original version - ***Costing and the Financial Analysis of P2 Projects: A Training Packet*** - was published in 1991 and was then revised and reissued in 1994 under the title - ***Improving Your Competitive Position: Strategic and Financial Assessment of P2 Projects***. The second edition comprised two volumes: a ***Training Manual*** and an ***Instructor's Guide***.

NEWMOA had three objectives in developing this third release:

- Reconfigure some of the material and examples to create greater consistency within and between chapters and case studies,
- Update material to reflect advances in the methodology of P2 financial analysis and its practical application over the past four years,
- Clarify and expand existing material and introduce additional topics, such as the calculation of the cost of capital, to provide a deeper and broader understanding of the issues and real world complexities involved in financial analysis.

The first two versions of the curriculum were designed to support introductory, one-day workshops on P2 financial analysis. The initial goal was to provide basic literacy in cost accounting and capital budgeting that would enable public sector assistance staff to "speak the language" of financial analysis and corporate decision making. The second edition of the manual was targeted more specifically at the private sector and had the objective of acquainting small and medium-companies with the benefits of pollution prevention and the tools to capture those benefits. In addition to "upgrading" the earlier editions, the third version was developed to support an advanced, two-day workshop. The longer, more in-depth training session is designed to elevate the level of knowledge and skill of assistance providers to the degree where they can lead and guide financial analysis efforts in clients' facilities.

Although this third edition contains information at a more detailed and comprehensive level than the previous versions, it will serve as the Training Manual for both advanced and introductory training. Workshops will focus on the appropriate material that is relevant to the particular objectives of the session. The existing ***Instructors' Guide*** will not be updated at this time and will continue to serve as a guidance tool for all levels of training.

For additional copies of these documents or for information about attending or holding a workshop, please call:

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Chapter 1 - INTRODUCTION AND OVERVIEW

PURPOSE OF THIS MANUAL

Pollution prevention (P2) has gained considerable stature over the past five years as the preferred approach to achieve environmental protection and performance. Although its incremental gains have frustrated some proponents who had envisioned a more rapid transition to a new industrial and regulatory paradigm, pollution prevention and its numerous semantic relatives (e.g., eco-efficiency, waste minimization, toxics use reduction) have become the accepted doctrine for many companies and environmental advocates. Yet, in spite of numerous success stories, obstacles continue to impede the adoption of aggressive P2 programs and to hinder investments in pollution prevention equipment and processes. Lack of proven technology or technical information, existing command-and-control regulations and infra-structure, insufficient financing, and underestimation of financial and less-tangible benefits all stand in the way of more rapid shift from pollution control to prevention.

POLLUTION PREVENTION
P2 Act of 1990

Any practice which reduces the amount of any hazardous substance, pollutant, or contaminant entering the waste stream or otherwise released to the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

Pollution prevention includes such techniques as: toxics use reduction, raw material substitution, process or equipment modification, product redesign, training, improved inventory control, production planning and

This manual explicitly addresses one of these obstacles - the tendency for companies to underestimate the financial gains and long-term qualitative benefits of investing in pollution prevention. Many P2 projects generate savings that may not be captured in financial analyses due to the way that costs are categorized and allocated by conventional management accounting systems. Compounding the problem of incomplete cost information is the common practice of estimating the financial impact of P2 investments through the use of profitability indicators that may be inappropriate and that may rule out projects that ought to merit approval. In addition to financial gains, pollution prevention projects often have beneficial impacts on a broad range of such strategic issues as market share and public image that may be difficult to quantify but that may have long-term competitive value. To provide a comprehensive and accurate assessment of the potential benefits of a pollution prevention project, it is crucial that all the costs and less tangible items be identified and evaluated in a project proposal.

The goal of this manual is to provide information and guidance to help improve the practice of pollution prevention financial analysis. More complete and accurate recognition of cost savings and less-tangible benefits can also lead companies to see how pollution prevention can advance a firm's strategic objectives and improve its competitive position. As a consequence, companies will be encouraged to devote greater resources to P2 investments.

By elevating the practice of financial analysis and demonstrating the link between P2 and ability to compete, this manual also helps to address a related issue - internal and external obstacles to financing pollution prevention. Companies that perform a comprehensive analysis of the benefits of P2 may be better able to convince internal corporate decision- makers and external lenders to provide the necessary funds.

This manual is designed to address a wide audience in both the private and public sectors, including environmental and engineering personnel, business and financial managers, technical assistance providers and regulators. It provides useful, hands-on guidance to corporate employees who will be involved in the planning and assessment of pollution prevention projects. Staff in state and federal assistance and regulatory programs, as well as private industry consultants, can also use the methodology to assist companies that are evaluating P2 investments. Although many individuals who are responsible for pollution prevention, both in business and government, may not have financial or accounting backgrounds and/or responsibilities in their organizations, an understanding of the basic concepts and the process discussed here can enhance their contribution to P2 planning. Plant personnel who design, supervise or work on operational processes and others who oversee environmental practices and compliance are often members of teams that are designated to identify pollution prevention options, specify equipment and evaluate a project's feasibility. Although these team members may have limited exposure to the financial and general business matters of a corporation, they are invaluable contributors to the assessment of a project's quantitative and qualitative impacts. Their involvement in plant operations provides familiarity with relevant costs and insights into less tangible issues that may be obscured from the perspective of upper management and financial controllers.

Overview of Manual

The financial analysis of pollution prevention projects requires the use of two basic business management tools: cost accounting and capital budgeting. While all companies employ these tools to help make business decisions, there is wide variance in the way they are practiced. The first chapter of this manual provides a general overview of these two topics in the context of P2 analysis and presents the process of performing a financial analysis: collecting cost information and applying measures of profitability. Chapter 2 defines the parameters of cost information and describes the sources of and procedures for gathering and developing this information. The third chapter details alternative methods for calculating profitability and explains the advantages and disadvantages of the different measures. The fourth chapter introduces the various qualitative or less-tangible issues to be considered in conjunction with a financial analysis in order to determine the impact of a proposed project. Often P2 projects produce significant benefits that are difficult to quantify but that can play a major role in justifying an investment.

COST ACCOUNTING

Financial analysis of a pollution prevention investment is dependent upon having accurate information about the costs of an existing manufacturing operation. Few companies, however, possess good, process-focused, cost information. Anecdotal reports, case studies and formal surveys[1] have all confirmed that many environmental and other "indirect" costs are not included in the calculation of savings generated by P2 initiatives. An understanding of the basics of cost accounting can help to explain how environmental costs are "hidden" in overhead, why the numbers generated by poor cost accounting systems should not be used in project analysis, and what approach is required in order to develop good cost information.

Cost accounting is a sub-set of ***management accounting***, which is the practice of collecting, organizing and using information about a firm's operations to facilitate internal decision making. Management accounting includes both non-financial information, such as through-put time, cycle time, and efficiency measures, and cost data related to labor and materials use. Managers rely on knowledge about a firm's costs to understand the profitability of products, to determine the allocation of resources for R&D and production and to perform capital budgeting. Unlike financial accounting, which reports on financial performance to external stakeholders according to strictly prescribed principles[2], management accounting provides managers with cost and operational data focused on products and processes. No external entities dictate what cost accounting practices a firm must employ, though several standard methods are used by most companies.

Conventional Cost Accounting

The most common method of cost accounting, still prevalent in US business in the late 1990's, is often referred to as *conventional cost accounting*. This method typically breaks out direct labor and direct materials and assigns these to specific products or processes based on measured average consumption of time and materials. Most other costs, however, are lumped together in large pools called overhead, which is allocated across many products, processes or departments through the use of a single proxy (cost driver), such as direct labor input or material dollars (Table 1.1).

Table 1.1 : Conventional Cost Accounting

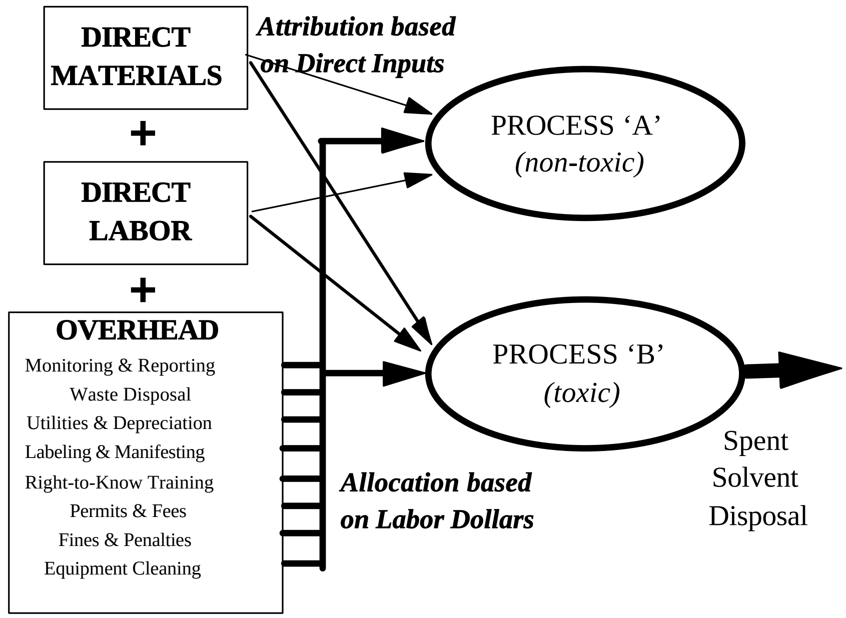
Cost Pools	Description
Direct Labor	Work performed directly in the production process
Direct Materials	Raw materials that become part of the finished product
Overhead	
Indirect labor	Work that supports production [e.g., equipment maintenance]
Indirect materials	Materials used in production that are not part of the finished product [e.g., cleaning solvent]
Facility costs	Lighting, heating, facility maintenance, rent
Corporate expenses	Administration, marketing, sales

1 *Environmental Cost Accounting for Capital Budgeting: A Benchmark Survey of Management Accountants*, EPA 1995, prepared by Tellus Institute

2 Financial accounting is subject to various rules and practices dictated by the Securities and Exchange Commission (SEC), the IRS, and the Financial Accounting Standards Board (FASB). Many of these are codified as Generally Accepted Accounting Principles (GAAP).

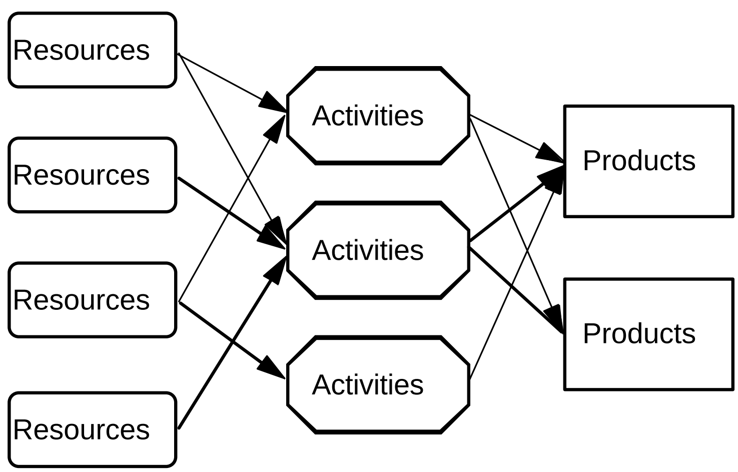
Figure 1.1 illustrates the concept of a conventional cost accounting system. In this simplified example, Process A uses no toxic substances and produces only non-hazardous solid waste. Process B, however, uses a solvent that requires disposal as a hazardous waste. Direct labor and materials are assigned on the basis of actual use, but all the environmental activities required for Process B are combined with other "indirect" costs in overhead. If the direct labor input is the same for both processes and is used as the cost driver, overhead would be allocated equally between A and B, even though more of the overhead costs are incurred by Process B. Thus B would appear to be less expensive to operate than it actually is, and a pollution prevention project assessment that relied on this cost accounting system as the sole source of information would probably **underestimate** the potential savings available from eliminating the solvent.

Figure 1.1
Conventional Cost Accounting System



Activity-Based Cost Accounting

Figure 1.2
Activity-Based Cost Accounting System



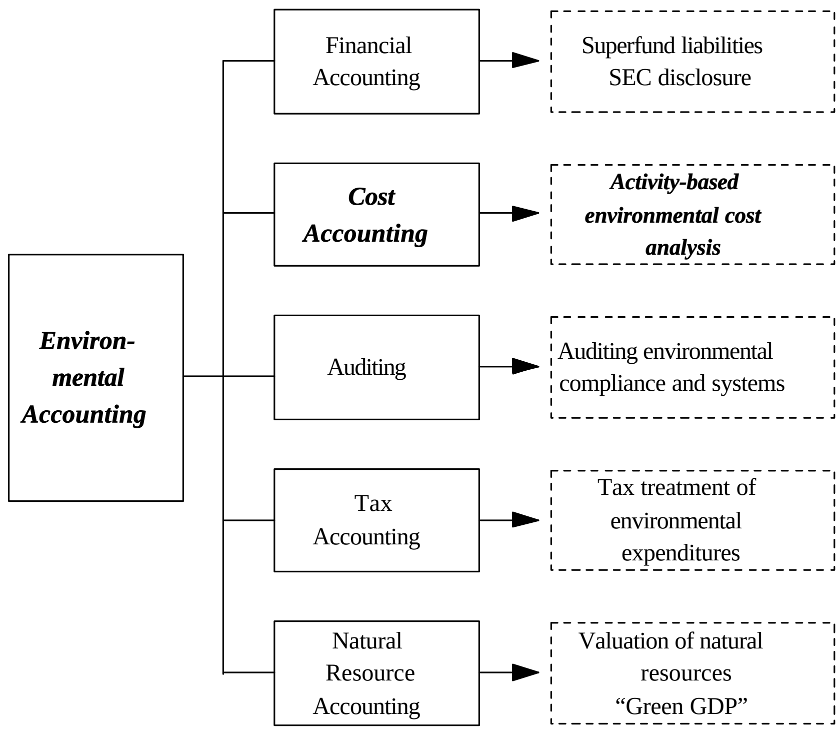
Years ago, when direct labor and material costs comprised the most significant portion of a manufactured product, conventional cost systems may have provided sufficiently accurate information to make informed business decisions. Over the past few decades, however, as overhead cost pools have grown to dwarf direct costs in many industries, the accuracy and utility of this type of accounting system has severely diminished. Recognition of the inherent limitations of conventional cost accounting has generated significant interest in the concept of activity-based costing, often referred to as ABC. ABC recognizes that making products require activities (e.g., inventory management, fabrication, finishing) and those activities require resources (e.g., labor, materials, utilities). By accurately defining, measuring and assigning resources to activities and activities to products, it is possible to develop a more accurate understanding of the true costs of producing a product (Figure 1.2).

Activity-based costing can be applied on a limited basis to understand the cost implications of a single parameter in a facility or on a corporate-wide basis to help run an entire business. Many companies have successfully used ABC to change their pricing or to better allocate their resources. The benefits of a well-structured ABC system extend beyond simply having a more accurate understanding of costs. Because ABC systems focus attention on the activities that are required to achieve business objectives, they encourage managers to improve the efficiency of activities and to reduce or eliminate activities that do not add value.

Environmental Cost Accounting

In recent years there has been considerable academic and corporate attention focused on the issue of environmental costs and how well (or poorly) companies identify, track and allocate those costs. Research has shown that due to the prevalence of conventional cost accounting systems and the mandatory nature of many environmental control and compliance costs, few companies have an awareness of either the extent or the sources of their environmental costs[3]. In one celebrated example, a major US oil company was found to have environmental costs equal to 20 percent of its operating costs, far in excess of the 2-3 percent initial estimate[4]. The interest in better understanding and controlling environmental costs has led to the development of a discipline called Environmental Cost Accounting (ECA), a sub-set both of Environmental Accounting and of Cost Accounting. Environmental Cost Accounting is the practice of defining costs that are related to environmental management and tracing those costs to the products or processes that generate them. ECA is the application of activity-based costing to a defined segment of costs (Figure 1.3).

Figure 1.3 Environmental Accounting



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[3] Ditz, Ranganathan and Bank, Green Ledgers, Case Studies in Corporate Environmental Accounting, 1995
[4] ibid.

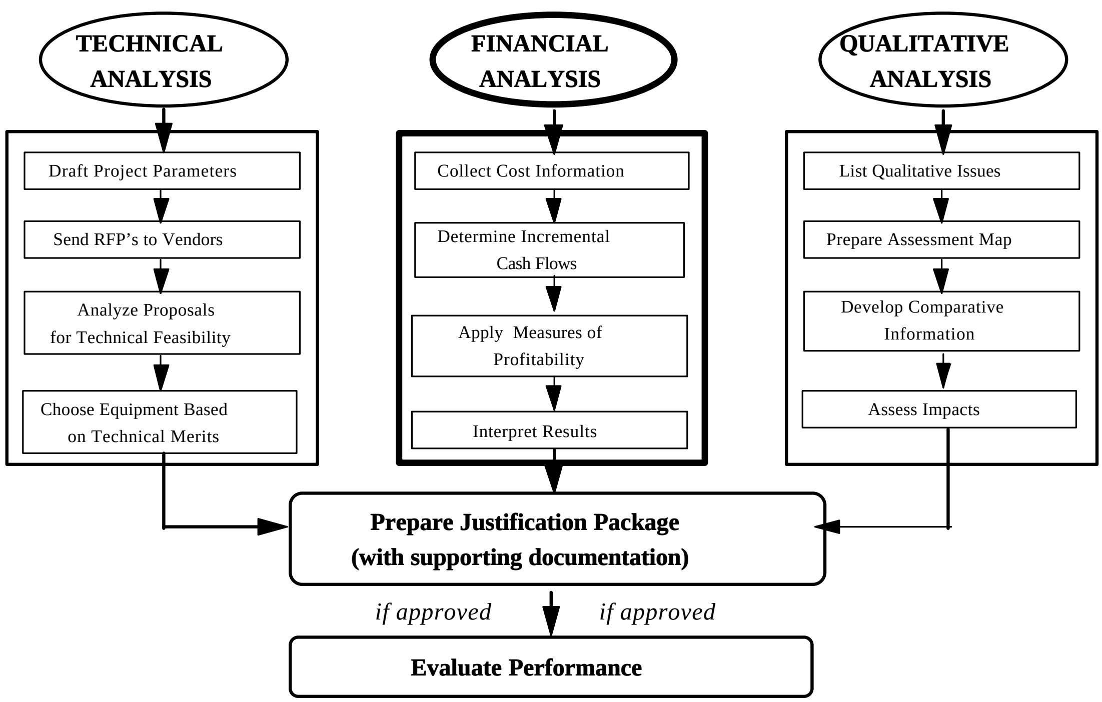
While environmental cost accounting can help managers make better decisions about a range of issues, in practice it is used principally in the financial analysis of pollution prevention initiatives. Nevertheless, several consulting firms have developed environmental cost accounting software, and a few companies have investigated the implementation of ECA systems on a broad scale. However, due to the resource-intensive nature of collecting environmental cost information, the practice usually makes sense on a project-specific basis.

CAPITAL BUDGETING FOR POLLUTION PREVENTION PROJECTS

Pollution prevention (P2) can take many forms, from simple, inexpensive "housekeeping" improvements, to costly equipment installations. Whether or not a P2 project requires large outlays for the purchase of equipment, it may involve significant engineering expense, create incremental costs or savings, or require extensive qualitative assessment related to such issues as product quality or employee health and safety. The analytic tools introduced in this curriculum are applicable to the assessment of the financial impacts and other issues for all pollution prevention initiatives.

Capital budgeting is the process of evaluating investments in long-lived (> one year) assets, such as new buildings, facility improvements and equipment. In its broadest sense, this process includes assessment of the technical and qualitative, as well as the financial impacts of a project, as illustrated in Figure 1.4. After a company has determined the appropriate technical solution to achieve project objectives, it must determine whether the investment will generate sufficient profitability or other benefits to merit the expenditure of financial and human resources.

Figure 1.4
Capital Budgeting Process



Although the three components are common to capital budgeting at most companies, the evaluation and approval process varies substantially, depending upon company size, culture, ownership, management philosophy and other variables. In a small, family-owned company, project assessment may be very informal: the environmental engineer might approach the president/owner with a request for pollution prevention equipment based only a "back-of-the envelope" calculation of its merits. Conversely, in larger companies, the capital budgeting process might include a standardized evaluation format and extensive justification package as well as a multi-level review and approval.

The financial analysis component of capital budgeting seeks to determine whether or not an investment will add economic value to a business, given a company's current situation, other investment options, and the availability and cost of financing. Multiple projects must usually compete for limited resources. Analysis requires a calculation of project profitability based on the amount of the initial investment and an estimation of the cash flow generated by the project over its useful life. The financial assessment of a pollution prevention project follows four steps:

- Collecting incremental cost information;
- Determining after-tax cash flows over the economic lifetime of the project;
- Calculating economic impact using profitability indicators (measures of profitability);
- Interpreting quantitative results.

Although this curriculum concentrates on the financial analysis aspects of the process, qualitative issues and other intangible factors also greatly influence the outcome of a P2 project proposal and may often outweigh the quantitative analysis. Central to the consideration of many projects are such issues as:

- relief from liability
- regulatory compliance
- worker health and safety
- pro-active environmental policy
- customer satisfaction
- green marketing
- public image
- technology upgrades
- community exposure reduction
- product or process quality

Gaining Support for a Project

Capital budgeting does not end with the conclusion of the analysis, especially in the case of a pollution prevention project that originated with a process engineer or an environmental manager. If the initiative requires a sizable outlay of cash, it is usually necessary to convince senior management, or possibly a lender, to provide financing. Thus the three analysis tracks shown in Figure 1.4 above all converge on the task of preparing a ***justification package***, a documented argument for gaining approval and resources. Constructing a strong justification package requires attention to the following considerations:

- **Presentation of financial and less-tangible benefits:** It is critical that both profitability and longer-term benefits are well presented and supported.
- **Link to competitive advantage and strategic goals**: Convincing management to invest in a P2 initiative may require more than simply showing that the project saves money and

meets profitability objectives. Ultimately a business must invest to further its strategic goals. Thus cost savings or qualitative benefits alone may not be sufficient to win approval for a project if it is competing for money with other initiatives that appear to be more directly aligned with forwarding the company's business mission. However, making a realistic connection between P2 gains and a firm's enhanced ability to compete may be possible. Examples include:

- ⇒ *Better cost structure*: lower costs enable a firm to price more aggressively and win market share.
- ⇒ *Supply chain positioning*: many original equipment manufacturers (OEM's) are requiring vendors to meet tougher environmental management and performance standards.
- ⇒ *Gains in through-put or cycle time*: enhanced production capabilities that may be a concomitant benefit of a P2 investment may enable market share gains.

- **Project origination and context**: The context of a P2 project within a company may influence how best to support its approval. Examples of contextual issues include the following:
  - ⇒ *Source*: a project directive issued by top management may be evaluated according to different criteria than an effort generated by the plant engineer.
  - ⇒ *Project objectives*: a P2 project driven by regulations, compliance or concern about a company's public image as a polluter may be judged by its qualitative benefits while the replacement of existing machinery may require a strong financial justification.

A pollution prevention team should consider the approvals it may need to implement a project, and the obstacles that it may encounter, as the team conducts its analysis. A justification package that is crafted as an integral part of the assessment process will be stronger than one developed as an afterthought and will have a better chance of winning crucial management support.

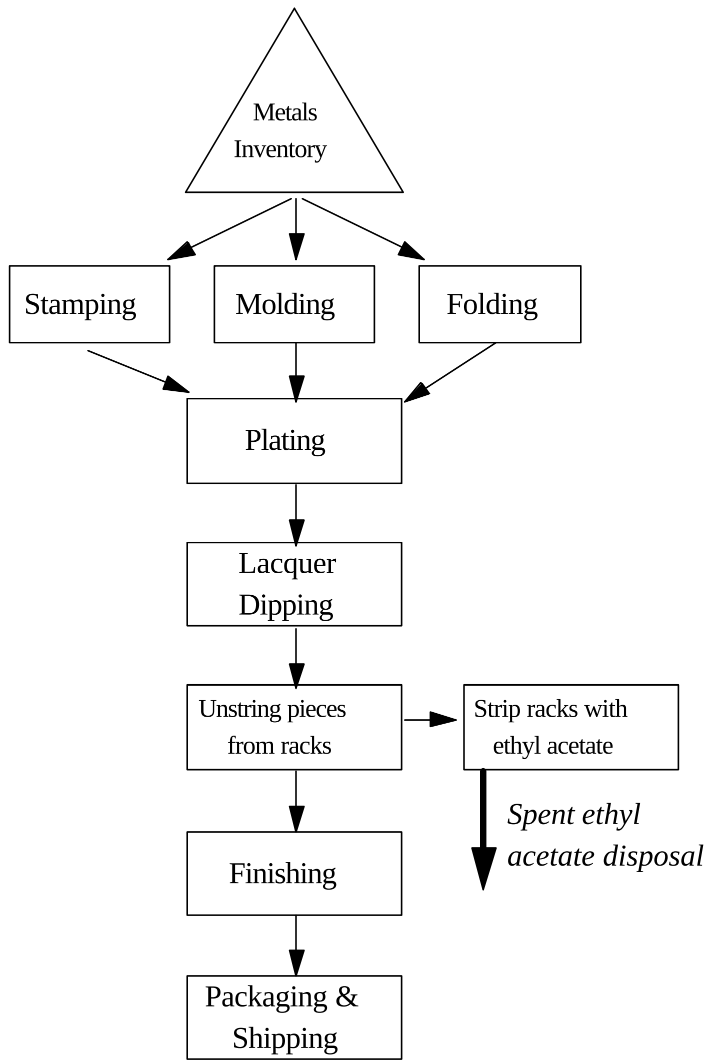
This chapter has presented an overview of the capital budgeting process and the objectives and key elements of financial analysis. The next chapter focuses on the process and tools for identifying and collecting cost information, the core of good financial analysis.
To provide a common theme for the presentation of material in the next three chapters, the Manual uses the data for many of its examples from an actual pollution prevention initiative undertaken at the Wrayburn Jewelry Company. (The name of the firm is fictitious but the facts and figures are real.) The brief synopsis that follows provides the background context of that data for a better understanding of its use in the examples. We strongly encourage all readers to review the full *Wrayburn Jewelry Company* case (Appendix B) to fully understand and tie together the information presented in the manual.

Synopsis of Wrayburn Jewelry Company Case Study

The Wrayburn Jewelry Company, a leading Massachusetts-based manufacturer of men's and women's costume jewelry, has traditionally exceeded environmental regulatory requirements in order to provide healthy working conditions for its employees, to alleviate potential community concerns and to improve its operating efficiency. The company is considering a pollution prevention project to reduce the high cost of purchasing and disposing of ethyl acetate as a hazardous waste. Jewelry pieces are dipped into a lacquer bath after silver plating to inhibit the tendency of silver to tarnish. Ethyl acetate is used as a solvent to strip the lacquer off of the plating racks. (*See* Process Flow Diagram).

Wrayburn is proposing to install a recovery still to recycle the ethyl acetate internally in the facility. The plant environmental manager, Peter Thorston, estimates that the still, which costs $14,000, will reduce ethyl acetate purchases to 25 percent of current volume. In addition to this raw material savings, the reduced ethyl acetate usage will save state regulatory fees and labor time for manifesting.

Wrayburn Jewelry Company
Process Flow Diagram



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Chapter 2 - COST INFORMATION

The most important part of performing the financial analysis of a pollution prevention initiative is the identification and collection of all costs that are relevant to current operations and proposed P2 alternatives. As mentioned in Chapter 1, research and anecdotal evidence have documented that companies often fail to include all costs in financial analyses, and therefore do not capture much of the potential savings from pollution prevention. Many companies do not have cost accounting systems that accurately track and allocate indirect costs by process or product and therefore such costs are not readily accessible and are often ignored. This chapter describes a process for identifying and collecting the cost information needed to gain an accurate assessment of the financial impacts of a P2 investment.

The first phase of the financial analysis of a pollution prevention project entails gathering complete and accurate cost data in the form of **relevant incremental costs** calculated on an **annualized basis**, as defined below.

Incremental costs: Incremental (or differential) costs, are the changes, or differences, between the costs of the current process and the projected costs of the proposed project. These costs include **initial** expenditures for equipment purchase and installation, and **operating** (also called 'period') expenses, such as raw materials, maintenance, waste disposal and utilities, which continue over the life of the project.

Relevant costs: Relevant costs are those incremental costs that have a material impact on the analysis and that are useful to those who evaluate the project proposal. The test for relevance depends on the circumstances of the particular case and must be considered within the context of a given project. For example, the elimination of 1 of 20 toxic chemicals may save only a few hours in employee safety training and manifesting, not enough to be relevant to the analysis. On the other hand, the discontinued use of the same amount of the **only** toxic chemical in a facility may enable the elimination of a range of activities with corresponding significant and relevant savings for the business.

NOTE: *A determination of relevance should be made only after the identification and initial review of all costs. Deciding a priori that a particular item is not relevant may lead to the exclusion of costs whose relevance only becomes apparent through its relationship to other issues or in projections of the 'out years' of a project.*

Annualized costs: All costs should be converted to total annual amounts in order to perform the financial analysis with common metrics. (See Table 2.1).

Table 2.1: Examples of Annualized Labor and Material Costs

Labor: Activity Hours x **Occurrences/Year** x **Wage Rate**

An engineer at Wrayburn spends 1.5 hours a month manifesting ethyl acetate for disposal at a total wage and benefit rate of $30/hr.

1.5 (hr.) X **12** (occurrences) X $**30** (wage) = **$540** (annual cost)

Materials: Volume Consumed per Week x **Weeks** x **Cost**

The rack stripping operation consumes 780 lbs. of ethyl acetate a week at cost of $.61 per lb., and the facility operates 52 weeks/yr.

780 (lbs.) X **52** (weeks) X **$ .61** (per lb.) = **$24,741** (annual cost)

PROCESS OF DEVELOPING COST INFORMATION

The **relevant incremental costs** incurred or saved by a pollution prevention project can be determined using six steps:

- Draft a process flow diagram of the existing process
- Identify cost generators
- Repeat above steps for the new process
- Identify incremental cost generators
- Attach dollar values
- Calculate incremental costs and savings

These steps are described in detail below.

FOR EXISTING PROCESS

(1) **Draft a process flow diagram**: Draft a process flow diagram of the existing production process that will be altered by changes in equipment, materials, process design or other pollution prevention techniques. The diagram should include not only the primary production process but also derivative process flows that are related to the main activity. For example, if the process generates wastes that are disposed of off-site, the diagram should show the waste stream, including its origin and disposal method, as shown for the spent ethyl acetate generated by Wrayburn Jewelry Company (see page 9).

(2) **Identify cost generators**: Use the process flow diagram to help identify all the **cost generators** - labor activities, materials, equipment and other operating expenses - that are involved in the production and secondary processes. Some of these costs, such as the raw materials, labor and the equipment used in the manufacturing operation, may be fairly easy to identify. Other items may be more difficult, either because the activities are not performed directly as part of production or because the activities or equipment cover a variety of processes. In a pollution prevention project the most important activities are those related to the tracking and disposal of "waste"[1], and those related to purchasing, handling and using hazardous chemicals. In this phase of the analysis, the P2 team should not attempt to attach actual dollar values to the items. Exhibit 2-1 (see page 13) provides a checklist of potential operating costs that should be considered.

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[1] The use of the term 'waste' here includes all by-products of a process that enter the air, water or land or are recycled internally or externally. The definition could be expanded to include any material or activity that does not add value to the products or services a company produces.

EXHIBIT 2-1

POTENTIAL OPERATING COSTS*

Materials	**Regulatory Compliance**
direct product materials	*monitoring*
catalysts and solvents	*manifesting*
wasted raw materials	*reporting*
transport	*notification*
storage	*recordkeeping*
	training (right-to-know, safety etc.)
Waste Management (Materials & Labor)	*training materials*
pre-treatment	*inspections*
on-site handling	*protective equipment*
storage	*labeling*
hauling	*penalties/fines*
insurance	*lab fees*
disposal	*insurance*
	R&D to comply with regulations
Utilities	*handling (raw materials and waste)*
electricity	closure & post-closure care
steam	
cooling & process water	**Revenues**
refrigeration	sale of product
fuel (gas or oil)	*marketable by-product*
plant air & inert gas	manufacturing through-put change
sewerage	*change in sales from:*
	increased market share
Direct Labor	*improved corporate image*
operating labor & supervision	
manufacturing clerical labor	**Future Liability**
inspection (QA & QC)	*fines & penalties*
worker productivity changes	*personal injury*
Indirect Labor	
maintenance (materials & labor)	
miscellaneous (housekeeping)	
medical surveillance	

* This list is adapted from material published by the Tellus Institute. The italicized items are those that many companies do not include in their financial analysis of a P2 project either because they are hidden in overhead or because their allocation is insufficiently specific.

Second and Third Order Costs

Although process mapping is a useful tool for identifying costs, its graphical focus is often limited to primary cost generators. Many primary costs have second and third order costs that are also important to capture. For example, the full cost of purchased items, such as protective equipment or special supplies, is more than simply the purchase price. An employee must evaluate the options, make a purchase decision, complete an order and process a payment. When the items arrive, they must be checked, handled and inventoried. Such activities may represent only a small part of the cost of an item, but they nevertheless represent time that could be better spent on more value-added activities and should be considered in a P2 assessment.

Table 2.2 lists common cost items often associated with pollution prevention projects (items in *italics* are those found in the Wrayburn Jewelry case.)

Table 2.2: Production And Environmental Costs

LABOR	MATERIALS	EQUIPMENT	OTHER
production work	raw materials	*production equipment*	*depreciation*
material handling	*solvents*	cleaning/degreasing	*waste disposal*
inspection	process water	material handling machinery	insurance
recordkeeping	cleaning water	waste treatment	*utilities*
manifesting	office supplies	wastewater treatment	*regulatory fees*
labeling	training materials	air pollution control	taxes
stocking	safety materials	painting equipment	maintenance
training	parts	protective equipment	lab fees
permitting		storage equipment	

FOR NEW or MODIFIED PROCESS

(3) **Repeat steps 1 and 2 for the new process**. Because the prevention project may reduce or eliminate many "indirect" costs that are not part of the production process, it is important to be especially attentive to changes in items listed above and included in Exhibit 2-1. Also, be sure to include all initial cost items related to the implementation phase of a new project (Table 2.3). Often, changes to a process require initial costs in a variety of areas that may not be immediately obvious or that may be difficult to anticipate. Exhibit 2-2 (see page 15) provides a comprehensive list of initial costs associated with new equipment installation or other major changes in a manufacturing process.

Table 2.3
Initial Costs

Equipment Purchase
Insurance
Start-up & Training
Delivery
Installation
Engineering

EXHIBIT 2-2
POTENTIAL INITIAL COSTS*

Purchased Equipment	**Materials**
equipment	piping
sales tax	electrical
price for initial spare parts	instruments
process equipment	structural
monitoring equipment	insulation
preparedness/protective equipment	building construction materials
safety equipment	painting materials
storage & materials handling equipment	ducting materials
laboratory/analytical equipment	
freight, insurance	
Utility Connections and New Systems	**Site preparation**
electricity	demolition, clearing etc.
steam	disposal of old equipment, rubbish
cooling & process water	walkways, roads, and fencing
refrigeration	grading, landscaping
fuel (gas or oil)	
plant air	**Engineering/Contractor (in-house & ext)**
inert gas	planning
general plumbing	engineering
sewerage	procurement
	consultants
Installation	design
vendor	drafting
contractor	accounting
in-house staff	supervision
construction/installation	
labor & supervision	**Contingency**
taxes & insurance	
equipment rental	**Permitting - Fees & In-House Staff**
Start-up & Training	**Initial Charge For Catalysts And Chemicals**
vendor/contractor	
in-house	**Working Capital** (funds for raw materials, inventory, materials/supplies)
trials/manufacturing variances	**Salvage Value** of replaced equipment

* This list is adapted from material published by the Tellus Institute. Many of these costs may or may not be capitalized, depending upon the judgment of a firm's financial staff.

FOR BOTH PROCESSES

(4) **Identify incremental cost generators**: Identify all the places where labor activities, materials, equipment and other operating costs are likely to change. Examples from the Wrayburn case include:

- purchase of ethyl acetate: reduced from 780 to 195 pounds per week
- manifesting: reduced from 12 to 4 times year
- disposal of still bottoms: replaces disposal of spent ethyl acetate
- TURA fees: decrease due to reduction in toxics use
- purchase of recovery still
- operational costs of recovery still

(5) **Attach dollar values**: Determine the dollar values for the cost generators in the current process and in the proposed project for those activities and items that will change because of the proposed project. Remember to translate all cost information to an annual basis. The following section - Types and Sources of Cost Information - describes how to collect the information needed to attach dollar values to the various activities.

(6) **Calculate Incremental Costs**: Calculate the differences between the current and proposed process costs (incremental costs). Start with the initial costs related to the purchase and installation of the new equipment. Next calculate the differences in the operating costs of the two processes, subtracting the 'new cost' from the 'old cost' to determine the difference as either a cost incurred by the project or a savings gained.

Table 2.4 shows the initial costs of the Wrayburn Jewelry project and the changes in operating costs and savings for one time period (i.e., one year).

Table 2.4: Wrayburn Jewelry - Incremental Costs

	Old Cost	**New Cost**	**Incremental (Cost) or Savings**
INITIAL COSTS (one time)			
Acquisition	n/a	14,000	(14,000)
Installation & Start-up	n/a	2,000	(2,000)
OPERATING COSTS (one year)			
Raw Materials: ethyl acetate - reduced from 20 tons/yr to 5 tons/yr	24,741	6,185	18,556
Labor: manifesting - reduced from 12 to 4 times/yr @ 1.5 hours X $30	540	180	360
Utilities: electricity for still	n/a	221	(221)
Waste Disposal: still bottoms instead of recyclable ethyl acetate	10,774	12,333	(1,559)
Fees: TURA - ethyl acetate use reduced to less than 10,000 lb./yr	1,100	0	1,100

TYPES AND SOURCES OF COST INFORMATION

The preceding section describes a method of determining the differential activities between old and new processes and calculating the incremental costs. To perform this procedure a project team must be able to attach accurate dollar amounts to each incremental cost item. Finding this cost information, however, is rarely straightforward and may require both ingenuity and persistence; for the process will involve more than simply extracting numbers from a company's financial and cost accounting systems. As mentioned earlier, many environmental and production costs are "hidden" in overhead accounts in a conventional cost accounting system and are therefore not readily accessible from that source. While a cost accounting system may provide some of the information about these costs, it will be necessary to go to ***primary sources*** and collect ***raw data*** to form a full cost picture. (See Exhibit 2-3 on page 18 for a comprehensive inventory of potentially hidden costs and Table 2.5 for a list of primary sources and types of raw data.)

Table 2.5: Sources of Cost Information

Primary Sources
Interviews with operational and environmental staff
Records from purchasing, payroll, inventory
Logs of activities or material usage
Receipts and **Invoices** from suppliers & vendors
Vendors of new equipment & industry price trends
Measurements of times, volumes, flow rates
Types of Raw Data
Time: Actual hours, percentages
Labor Costs: Total compensation rate (fully burdened)
Materials: Actual quantities, percentages
Fees: Per toxic substance, facility charge percentage
External Costs: Maintenance, waste disposal
General: Percentage of insurance, utilities

Uncovering Hidden Costs

A conventional cost system is often able to provide the information necessary for determining the direct labor and materials costs associated with a particular product or process. The cost information in the overhead accounts, however, is in a form that is usually neither accessible nor useful. A project team must turn to other primary sources to uncover cost information for these "overhead" items. Often the determination requires an estimate of the amount of time an employee spends on a particular activity (such as manifesting) or the amount of a resource that is consumed in the production process (such as the electricity used by a piece of equipment). Although such estimates often lack precision, if they are made by the people who actually perform the work or who are knowledgeable about a process, the information should be sufficiently accurate. Moreover, with planning it may be possible to conduct actual measurements of these activities to provide more accurate cost data. The following sections provide suggestions about where and how to locate information for the kinds of costs usually hidden in the overhead pools. (*See* Exhibit 2-4 on page 19 for an example of sources of cost information.)

EXHIBIT 2-3

Examples of Environmental Costs Incurred by Firms

Potentially Hidden Costs

Regulatory

- Notification
- Reporting
- Monitoring/testing
- Studies/modeling
- Remediation
- Recordkeeping
- Plans
- Training
- Inspections
- Manifesting
- Labeling
- Preparedness
- Protective equipment
- Medical surveillance
- Environmental insurance
- Financial assurance
- Pollution control equipment
- Maintenance
- Repair
- Spill response
- Stormwater management
- Waste management
- Taxes/fees

Upfront

- Site studies
- Site preparation
- Permitting
- R & D
- Engineering
- Procurement
- Installation

Conventional Costs

- Capital equipment
- Materials
- Labor
- Supplies
- Utilities
- Structures
- Salvage value

Back End

- Closure/decommissioning
- Disposal of inventory
- Post-closure care
- Site survey

Voluntary (Beyond Compliance)

- Community outreach
- Monitoring/testing
- Training
- Audits
- Qualifying suppliers
- Environmental reports
- Insurance
- Planning
- Feasibility studies
- Remediation
- Recycling
- Environmental studies
- R & D
- Habitat protection
- Landscaping
- Environmental projects
- Financial support of NGO's

Contingent Costs

Future compliance costs	Remediation	Legal expenses
Penalties/fines	Property damage	Natural resource damage
Response to future releases	Personal injury damage	Economic loss damages

Image / Relationship Costs

Corporate image	Relationship with prof. staff	Relationship with lenders
Relationship with customers	Relationship with workers	Relationship with communities
Relationship with investors	Relationship with suppliers	Relationship with regulators
Relationship with insurers		

This list is adapted from EPA's publication: ***An Introduction to Environmental Accounting As a Business Tool : Key Concepts and Terms***

EXHIBIT 2-4

EXAMPLES OF SOURCES OF COST INFORMATION

The following table provides examples of various environmental cost activities (**Activity**), the way those activities might be defined for determining frequency or volume (**Cost Driver**), the information needed to calculate the costs of the activities (**Measurement**), and the sources of information about the activities (**Source**).

ACTIVITY	COST DRIVER	MEASUREMENT	SOURCE
Spill/Leak Incident Reporting	Number of Spills Number of Incidents	Labor Hours $/week	Engineer Interview
Monitoring	Number of Toxics Number of Processes using Toxics	Labor Hours $/week	Engineer Interview
Manifesting	Number of Shipments	Labor Hours - $/week $/shipment or $/drum	Engineer Interview Manifesting Records
Right-to-Know Training (in-house)	Number of Sessions	Labor Hours $/week	Engineer Interview Engineering Records
Labeling	Number of Drums Shipped Off-Site	Labor Hours $/week $/drum	Engineer Interview
Permitting & Fees	Number of Toxics Number of Gallons or Lb. Discharged	Labor Hours $/week fees($/chemical or/gl)	Engineer Interview Accounting Records Regulatory Documnt
Maintenance & Repair (Old Equipment)	Number of Machines	Labor Hours $/week spare parts/equip $/item	Machine Manuftr Vendor Outside Repair Shop
Maintenance (new equipment)	Number of Machines	Labor Hours $/week spare parts / equip $/item	Machine Manuftr Vendor Engineer Interview
Solvent Disposal	Number of Drums	$/drum or /lb	Accounting Records Engineering Records
Permit Fees	Number of Reportable Chemicals	$/chemical/category	Permit Form Engineering Records
Training Supplies	Number of Employees Trained Number of Sessions	$/employee $/session	Engineering Records Accounting Records
Protective Equipment	Number of Employees Sq. ft protected	$/employee $/Sq. Ft.	Engineering Records Accounting Records

- **Manifesting, labeling and recordkeeping of wastes:** The environmental or manufacturing staff can provide an estimate of the number of hours per week, per shipment, or per ton.

- **Purchase, handling and recordkeeping of toxic materials**: Actual purchase orders are probably completed by the purchasing department, which could also estimate time spent on paperwork. Other incoming recordkeeping and handling may be performed by materials handlers, the stockroom and/or environmental staff.

- **Waste disposal, protective and safety equipment, miscellaneous supplies**: The accounting department can supply invoices for these items. Alternatively, vendors are often excellent sources for such information. Estimates of the use of a material in a particular process or its presence in a waste stream can be determined by observation and by operational staff.

- **Insurance**: May be either a cost or a savings, or may not be affected by a pollution prevention project. If a project dramatically changes a facility's waste disposal status, for example eliminating the use of all toxic and hazardous substances, environmental liability insurance may be reduced. An insurance agent should be able to provide an estimate of a project's potential impacts on insurance premiums.

- **Utilities and maintenance**: Plant engineers can usually provide estimates of utility consumption and maintenance costs.

- **General facility costs**: Rarely will general facility costs (e.g., heating and property taxes) change with a pollution prevention project unless the project is of such a scale as to require enlargement or reduction in the overall space used or a change in an operating environment, such as the construction of a temperature and moisture-controlled room.

Full Cost System

By identifying the sources of overhead costs and attributing those costs to processes based on actual consumption of time and materials, a project team breaks through the veil that traditional accounting systems impose on cost information. Figure 2.1 (see page 21) illustrates the contrast between this full cost approach and the conventional method of allocating overhead as described in Chapter 1 (Figure 1.1). Overhead costs are attributed directly to the processes based on the proportion of their actual consumption. For example, labeling/manifesting, right-to-know training, and permits and fees are caused by the use and disposal of the solvent and thus are attributed 100 percent to B, while the other costs are split between A and B on the basis of their consumption. With this kind of information, a project assessment that examines the elimination of this solvent can show much greater savings than one using the conventional cost system. The difference in the two systems is further illustrated by applying actual numbers to an example, as shown in Table 2.6.

Figure 2.1
Overhead Allocation Using
Full Cost System

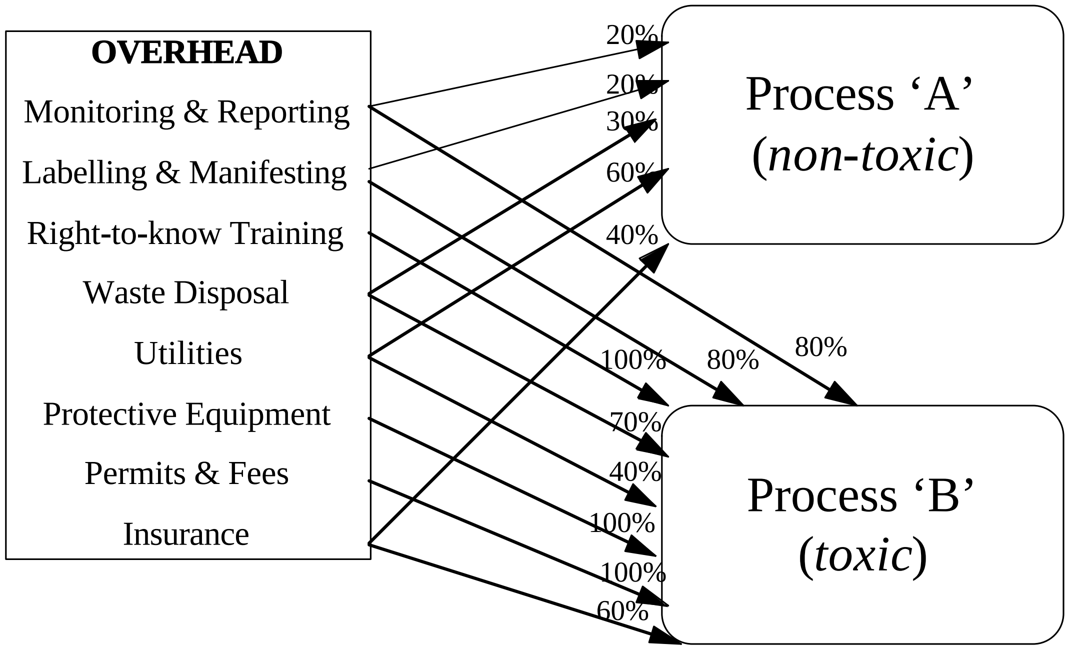


Table 2.6: Overhead Costs For Process B in Figure 2.1

	Annual Cost	Conventional System*	Actual Consumption	Full Cost System
Monitoring & Reporting	$1000	$500	80%	$800
Labeling & Manifesting	500	250	80%	400
Right-to-Know Training	500	300	100%	500
Waste Disposal	3000	1500	70%	2100
Utilities	1000	500	40%	400
Protective Equipment	800	400	100%	800
Permits & Fees	1200	600	100%	1200
Insurance	2000	1000	60%	1200
Total Overhead Costs	**$10,000**			
Overhead Costs of B		**$5000**		**$7400**

***** The total of all the costs included in overhead is multiplied by the cost driver, direct labor @ 50%, as illustrated in Figure 1.1 on page 4.

This manual was not designed to advocate that companies should change their entire cost accounting structure. The full cost system described above, however, does illustrate the use of activity-based cost analysis and is the recommended procedure for identifying and calculating the costs of those indirect activities that are changed by a particular project. The accurate inclusion of such costs can have a significant impact on the measurement of a project's economic value. Many of the costs listed above would be reduced if the toxic substance in Process B were eliminated.

CASH FLOW

After the initial and incremental costs have been identified, they must be translated into annual ***cash flow*** over a project's ***economic lifetime***. The definitions of these terms are provided below.

Cash Flow: Cash flow refers to the actual outflows and inflows of money - expenditures and savings - incurred and generated by a project. Cash flow differs from **accounting income,** which can include a variety of **non-cash** revenues and expenses, and it is considered the best way to analyze project profitability. There are three types of cash flows related to a P2 project, described below and illustrated in Table 2.7, (those in *italics* are found in the Wrayburn case.) Most of the "inflows" generated by a P2 project are avoided costs (savings) - cash that the company would not have if it did not make the investment. Some P2 projects can, however, generate incremental revenue by increasing capacity, improving quality, expanding "green" market and "green" supply chain opportunities or through the sale of a byproduct.

- Initial (one-time) cash flows: These include the cost of the equipment and all expenses required for installation and getting it up and running. Most of these one-time costs can be capitalized and included in the calculation of depreciation, discussed below. There may be one-time in-flows if an existing piece of equipment that is being replaced can be sold (salvage value).

- Operating cash flows: Operating (also called period) cash flows include all the incremental costs of operating new equipment or running the newly-configured process and all the savings (avoided costs) generated by the P2 project. Also included here would be incremental revenues specifically attributable to the project.

- Working capital: Working capital is additional cash required to finance incremental inventory and receivables. It is essentially the cost of the money that is tied up in inventory and receivables for the duration of project. Though working capital is usually required for a new plant, new product line or other business expansion, it may not be required for a P2 modification.

Table 2.7: Types of Cash Flow

	Outflows (Costs)	**Inflows (Savings)**
Initial or One-time	*Equipment* Engineering Decommissioning	Salvage of old equipment
Operating (Period)	Maintenance *Raw materials* Repairs Utilities	Raw materials, *Treatment & disposal* *Insurance* *Compliance*
Working Capital	Receivables Inventory	

Opportunity Costs: Incremental Savings versus Incremental Cash Flow

Recognizing the distinction between incremental savings and incremental cash flow is important. Some avoided costs, such as raw materials, waste disposal and utilities, translate directly into reduced cash outflow. Other incremental "savings", usually indirect labor costs associated with pollution control activities, such as manifesting, training, ordering or handling toxics, often do not reduce a firm's cash outflow. For example, if a company reduces its environmental compliance activities by three hours a week, it usually does not save cash by paying an employee for three fewer hours of work. This distinction can be referred to as "avoidable" versus "non-avoidable" costs.

Although some companies prefer not to include reductions in "non-avoidable" costs in their cash flow projections and financial analyses, P2 project proponents can make a strong argument for the inclusion of such savings. While non-avoidable cost savings do not have immediate *cash* value, they do have *economic* value, because they represent an opportunity cost to the firm that can be turned into tangible financial benefit if the saved time is redirected to more productive, value-adding activities. Additionally, there are cases where apparent non-avoidable cost savings do have immediate cash flow implications if reduction of work decreases overtime or if the saved hours enable a reduction in other spending - for instance, if an environmental engineer were freed-up to perform testing rather than having to hire an outside laboratory. Therefore, we recommend including all incremental savings in the cash flow figures.

Economic Lifetime: Cash flows must be estimated for the economic lifetime of a project, which is defined as the period of time over which a project is expected to add economic value to a business. The determination of a project's economic lifetime is a judgment based on many factors, including consideration of market and industry conditions, a company's business strategy and planning horizons, and an assessment of project risk and uncertainty. The economic lifetime of a project rarely corresponds to the physical lifetime of a piece of equipment purchased for the project. For example, the ethyl acetate still in the Wrayburn case might have an expected physical lifetime of 20 years. Its economic lifetime, however, might be considerably shorter due to technological innovation (i.e., development of a non-hazardous substitute for ethyl acetate), changing product line strategy, declining market demand or other issues that render it uneconomic to operate. Because economic lifetimes are project-specific and company-specific, there are no "rules-of-thumb" a company can use to plug in the right lifetime for a given investment. Historical data, however, does indicate that most companies use a period of three to ten years as a range for pollution prevention projects.

Inflation and Escalation: Forecasting Cash Flows Over Project Lifetimes

Over the past fifty years, the economy of the United States has been marked by varying degrees of moderate inflation - the purchasing power of the dollar has declined, causing the cost of goods and services to rise. In forecasting cash flows over a project lifetime, it is important to incorporate projected inflation, especially when P2 projects derive significant savings from avoided costs of purchased goods.

There is an important distinction, however, between inflation as a generalized figure that represents price trends for a entire economy, and price escalation that refers to changes in the price of specific items. The "rate of inflation" is usually represented by the Consumer Price Index (CPI), which averaged 2-3 percent through the mid-90s and which calculates the average price change for thousands of goods and services that consumers purchase. Such a generalized inflation rate may or may not have a close relationship to the expected price changes for the small number of items included in a pollution prevention financial analysis.

The preferred approach to incorporating inflationary trends is to estimate price changes for each of the individual incremental costs in the analysis. For example, a company may be using a solvent that is projected to increase in price significantly more than the general inflation rate. Such a price increase would translate into significantly higher savings over the life of the project if solvent use were significantly reduced or eliminated (Table 2.8). Similarly, labor contracts may dictate that labor costs will remain fairly steady over the course of a project's economic lifetime, and therefore those costs should be included at that lower escalation rate. When it is not possible to identify a particular item's expected price trend, then use of a projected general inflation rate is better than no price adjustment at all. Where possible, however, a P2 team should attempt to articulate and include price changes that may vary significantly from the general rate of inflation, if there is sufficient information to support them.

Table 2.8: Solvent Price Escalation Example: $5,000 Cost in Year 0

	@3%	@8%
Year 0	$5,000	$5,000
Year 1	5,150	5,400
Year 2	5,304	5,832
Year 3	5,464	6,298
Year 4	5,627	6,802

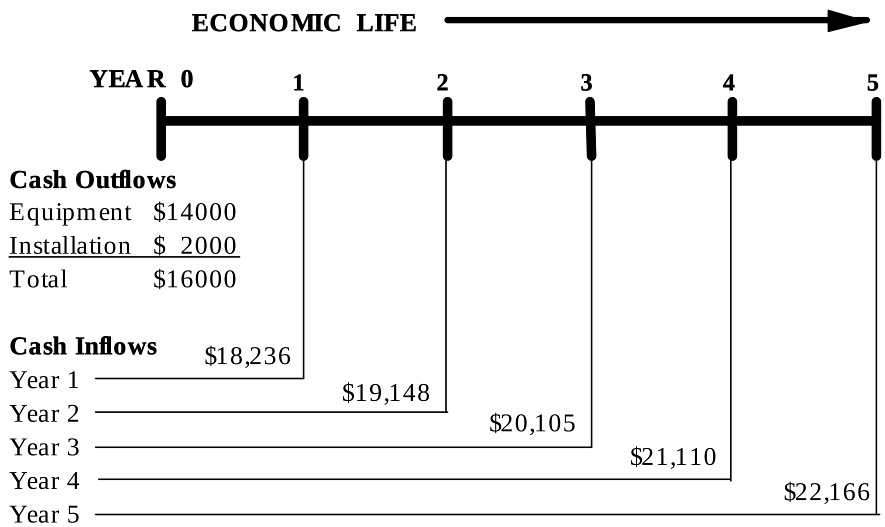
Extending the Wrayburn incremental cost figures from page 16 into a cash flow projection over the life of the project using a 5 percent inflation adjustment would result in the spreadsheet shown in Table 2.9. In this approach all the new costs are grouped and shown with parentheses to indicate that they represent outflows of cash (i.e., negative cash flow).

Table 2.9: Wrayburn Jewelry Company, Inc. - Incremental Cash Flow

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Additional Costs of New Process						
Purchase of ethyl acetate still	($14,000)					
Installation of still	(2,000)					
Still bottom disposal		(12,333)	(12,950)	(13,597)	(14,277)	(14,991)
Operation - utilities		(221)	(232)	(244)	(256)	(269)
Sub-total	**(16,000)**	**(12,554)**	**(13,182)**	**(13,841)**	**(14,533)**	**(15,259)**
Incremental Cost Reductions						
Ethyl acetate purchases		18,556	19,484	20,458	21,481	22,555
Spent ethyl acetate		10,774	11,313	11,878	12,472	13,096
Manifesting		360	378	397	417	438
TURA fees avoided		1,100	1,155	1,213	1,273	1,337
Sub-total		30,790	32,330	33,946	35,643	37,425
Net Annual Cash Flow		**18,236**	**19,148**	**20,105**	**21,110**	**22,166**
Total Initial Costs	**($16,000)**					

Cash Flow Timeline

Figure 2.2
Time Line / Economic Lifetime Cash Flows



A timeline is a useful tool to develop and understand cash flows over the lifetime of a project. The point at which the capital investment is made (i.e., when the company check is cut for the purchase, delivery and installation of the equipment) is Year Zero. The rest of the time line represents the years over which the equipment is expected to provide service to the business. For example, Figure 2.2 illustrates the Wrayburn pollution prevention project with a five year lifetime. The initial capital investment at Year 0 is $16,000 (i.e., $14,000 in purchase costs and $2,000 in installation costs). The equipment reduces the use of ethyl acetate and generates annual net savings (cash inflows) over the economic lifetime of the project. In this example, cash inflows increase each year due to projected inflation of avoided costs. A simple project that is not adjusted for inflation, however, would show the same inflows every year. Alternatively, a project might create mixed cash flows over its lifetime: savings for the first three years and losses due to costs for maintenance and parts for the fourth and fifth years.

As mentioned at the start of this chapter, determining the incremental costs (savings), translating them into cash flows, and adjusting them for price changes over the project lifetime is the most important part of financial analysis. Before using the cash flows to calculate project profitability, however, it is necessary to consider the impact of state and federal income taxes.

Tax Impacts on Cash Flow

Performing a financial analysis on an after-tax basis provides a more accurate picture of the economic impact of a project. Taxes affect financial analysis of many P2 investments in two ways.

Table 2.10: After-tax Cash Flow
(40% tax rate)

	Amount
Annual pre-tax cash flow	$6,000
Taxes @ 40%	2,400
After-tax cash flow	$3,600

- **Taxable Income**: Increased cash flow that is generated by reduced costs usually translates into increased income, which is subject to state and federal income taxes. Increased taxes reduce the cash flow savings from a project. After-tax cash flow is calculated by multiplying the annual pre-tax cash flow by the combined marginal tax rates to determine the amount of the tax and then subtracting the taxes from pre-tax cash flow, as illustrated in Table 2.10. Initial, one-time investment expenditures are not included in this calculation. They are lumped together and depreciated over the life of the project, providing a depreciation tax shield, as explained below.

- **Depreciation Tax Shield**: Depreciation of the initial capital investment reduces taxable income and thus increases after-tax cash flow. This is an important component of a financial analysis and is described in detail below.

Depreciation Defined

The accounting definition of depreciation is different than the colloquial use of the term. Although people often speak about how much their car "has depreciated" in value, depreciation in business accounting is not a valuation mechanism. Depreciation is also not intended to signify the accumulation of a fund to replace obsolete buildings or equipment. Rather, depreciation is an accounting convention that records the using up of a long-lived (> 1 year) asset over its useful life. When a company makes an investment in a new piece of equipment, it spends money to purchase the machine, conduct engineering studies, perform facility layout work, train employees and pay for other one-time expenses to make the equipment operational. These initial costs are "capitalized" - added together to form the depreciable base, a fraction of which is charged as an expense in each of the accounting periods that it provides service to the business. This gradual conversion of plant and equipment from "capital" into an expense is called **depreciation**, and the annual amount charged is the **depreciation expense**. Because the capitalized assets provide service (i.e. helps to generate profits) beyond the year in which the initial costs were incurred, depreciation helps to provide a more accurate reflection of a company's performance and financial condition.

Depreciation expense is a <u>non-cash expense</u> because there is no outflow of cash that corresponds with the annual depreciation charge. The cash outflow occurred at the time the initial costs were incurred. As a non-cash expense, depreciation is a <u>source</u> of cash because the depreciation charges **decrease** taxable income, and thus the **tax that is not paid** represents a **cash savings** that should be included in project analysis. Depreciation is known as a **tax shield** because the non-cash expense "shields" income from taxes.

Depreciation Calculation

Calculating annual depreciation expense requires a determination of three factors:

- **Depreciable base**: This is the total amount that is to be depreciated. It is calculated by adding all the qualifying initial costs and subtracting the expected salvage of the equipment after its useful life. Any one-time expenditure that is necessary in order to get a piece of equipment installed and ready for normal operations can be included in the depreciable base. Exhibit 2-2 (see page 15) presents a fairly comprehensive list of such costs, examples of which include engineering evaluation, facility preparation, purchase, installation, operator training and machine break-in. The salvage value is the best estimate of the actual market value of the equipment at the time it is projected to be retired.

- **Length of service (lifetime)**: The number of years used to calculate depreciation is usually set by the federal tax code, which specifies minimum depreciation schedules for various classes of capital investment (Table 2.11). In order to obtain the greatest advantage from the tax shield, companies usually select the shortest allowable schedule, regardless of the expected economic lifetime of the project. Thus there may be three "lifetimes" that apply to a piece of equipment: physical lifetime, economic lifetime, and depreciation schedule (i.e., service life).

Table 2.11: Depreciation Schedules
(from federal tax code**)**

Class	Years
Buildings	39
Equipment Class 1	10
Equipment Class 2	5

- **Depreciation method**: The third factor to be considered is the method of calculating depreciation given the depreciable base and number of years. There are three basic methods available to calculate depreciation, and these are defined below and illustrated using the data from the Wrayburn case:
  - ⇒ Example: total depreciable base is **$16,000** with a service life of **5 years**

Straight-line: In straight-line depreciation an equal fraction of the cost of the assets is expensed each year. The depreciable base is divided by the number of service years, giving the same depreciation expense for each service year (Table 2.12).

Table 2.12: Straight-Line

Annual depreciation expense
$16,000 / 5 = $3,200
Total depreciation
5 years x $3,200 = $16,000

Accelerated: Accelerated depreciation, as the name implies, speeds up the rate of depreciation, allowing a larger amount to be depreciated in the early years, which improves cash flow over those years. There are many variations of accelerated depreciation, of which the most common are sum-of-years digits and double-declining balance.

⇒ *Sum-of-years digits*: For each year the depreciable base is multiplied by a fraction that is determined by using the sum of the years of the project's life as the denominator and the number of years of life remaining as the numerator. The denominator in this example would be 15 or 5 + 4 + 3 + 2 + 1 (Table 2.13).

Table 2.13: Sum-of-Year's Digits

Annual depreciation expense				
Year 1:	$16,000	x 5/15	=	$5,333
Year 2:	$16,000	x 4/15	=	$4,267
Year 3:	$16,000	x 3/15	=	$3,200
Year 4:	$16,000	x 2/15	=	$2,133
Year 5:	$16,000	x 1/15	=	$1,067
Total depreciation			**=**	**$16,000**

⇒ *Double declining balance*: The straight line depreciation rate is doubled and applied to the undepreciated balance (i.e., the book value) of the asset remaining at the end of the previous year's depreciation calculation. For example, a five-year straight-line rate of 20 percent (1/5) would generate a 40 percent (2/5) double declining balance rate (Table 2.14).

Table 2.14: Double Declining Balance

Annual depreciation expense				
Year 1:	$16,000	x 40%	=	$6,400
Year 2:	$9,600	x 40%	=	$3,840
Year 3:	$5,760	x 40%	=	$2,304
Year 4:	$3,456	x 40%	=	$1,382
Year 5:	$2,074	x 40%	=	$ 829
Remaining Book Value			=	$1,245
Total depreciation			**=**	**$16,000**

Activity-based: Activity-based depreciation calculates the depreciation expense based on the amount of usage of the equipment rather than on a pre-set number of years. The depreciable base is multiplied by a fraction, whose denominator is the total number of hours of operation expected for a machine's useful life, and whose numerator is the number of hours of actual use during the accounting period (Table 2.15).

Table 2.15: Activity-based

Total hours of useful life: 20,000
Year 1 usage: 2,000
Year 1 depreciation rate: 1/10th (2,000/20,000)
Year 1 depreciation: 1/10th x 16,000 = $1,600

Depreciation, especially when it involves accelerated techniques, can become a complex issue. Many larger companies use multiple depreciation methods for different types of investments and are even permitted to use one method to calculate taxes and a different method to calculate shareholder reports. A pollution prevention team should ask company financial officers which initial costs can be capitalized and what depreciation method they should use to calculate the depreciation expense in a P2 project. In the absence of clear direction from management, the straight line method is the easiest to use and can provide an adequate illustration of the cash flow savings derived from the depreciation tax shield.

Depreciation Tax Shield Calculation: The value of the depreciation tax shield is determined by multiplying the depreciation expense by the tax rate. The resulting figure equals the amount of tax that is not paid and thus represents the cash savings to the firm. Table 2.16 shows the value of the tax shields for the depreciation expenses from the examples listed above.

Table 2.16: Value of Depreciation Tax Shield
(from example in Table 2.12 - Tax rate = 40%)

Method	**Year 1 Depreciation Expense**	**Tax Shield**
Straight-line	$3,200	$1,280
Sum-of-years-digits	$5,333	$2,133
Double-declining balance	$6,400	$2,560
Activity-based	$1,600	$ 640

After-Tax Cash Flow

By putting together the various issues covered in this section - incremental costs and savings, inflation, escalation, depreciation tax shields and after-tax calculations, the financial analyst can generate an accurate picture of the after-tax cash flow for a pollution prevention project. Table 2.17, uses the numbers in Table 2.9 to show the after cash flow for the Wrayburn case. In this example, the cash flows are broken out into two discrete components "operations" cash flow and "depreciation tax shield" cash flow. This format, which is used in this text and in the case studies that accompany this manual, was selected because it clearly shows these two aspects of cash flow analysis. Alternative formats are also commonly used in financial analysis. They provide the same answers.

Table 2.17: Wrayburn Jewelry Company, Inc. - After-Tax Cash Flow

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Additional Costs of New Process						
Purchase of ethyl acetate still	($14,000)					
Installation of still	(2,000)					
Still bottom disposal		(12,333)	(12,950)	(13,597)	(14,277)	(14,991)
Operation - utilities		(221)	(232)	(244)	(256)	(269)
Sub-total	**(16,000)**	**(12,554)**	**(13,182)**	**(13,841)**	**(14,533)**	**(15,259)**
Incremental Cost Reductions						
Ethyl Acetate Purchases		18,556	19,484	20,458	21,481	22,555
Spent ethyl acetate		10,774	11,313	11,878	12,472	13,096
Manifesting		360	378	397	417	438
TURA fees avoided		1,100	1,155	1,213	1,273	1,337
Sub-total		30,790	32,330	33,946	35,643	37,425
Total Initial Costs	**(16,000)**					
Net Annual Cash Flow		**18,236**	**19,148**	**20,105**	**21,110**	**22,166**
Taxes @40%	0	(7294)	(7659)	(8042)	(8444)	(8866)
Operations After-Tax Cash Flow	**(16,000)**	**10,942**	**11,489**	**12,063**	**12,666**	**13,300**
Depreciation (straight-line:16000/5)		3200	3200	3200	3200	3200
Depreciation Tax-Shield Cash Flow (Depreciation x tax rate)		**1280**	**1280**	**1280**	**1280**	**1280**
TOTAL CASH FLOW	**($16,000)**	**$12,222**	**$12,769**	**$13,343**	**$13,946**	**$14,580**

Total Cash Flow is the sum of *Operations After-Tax Cash Flow* and *Depreciation Tax-Shield Cash Flow*, which are calculated as follows:

- *Operations After-Tax Cash Flow:* Net Annual Cash Flow (same as final line in Table 2.9) is multiplied by the 40% tax rate to calculate the annual tax amount, which is then subtracted from the Net Annual Cash Flow.
- *Depreciation Tax-Shield Cash Flow:* the annual depreciation amount is multiplied by the 40% tax rate to calculate the value of the tax shield.

Chapter 2 described how to collect incremental cost information and translate it into after-tax cash flow projections for the life of a project. Chapter 3 describes how to apply profitability indicators to these cash flows to determine the economic impact of P2 investments.

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Chapter 3 - MEASURES OF PROFITABILITY

The financial analyst can calculate the financial impacts of a P2 project after identifying incremental costs and translating them into after tax cash flows through the use of profitability indicators, often called *measures of profitability*. There are four common measures, which can be grouped into two categories: **Simple** - Payback and Return on Investment (ROI) and **Discounted Cash Flow (DCF)**, which include Net Present Value (NPV) and Internal Rate of Return (IRR) (Table 3.1). Simple measures of profitability are generally easy to calculate but suffer from several serious drawbacks that render them less accurate.

Table 3.1
Measures of Profitability

Simple:
Payback
Return on Investment (ROI)
Discounted Cash Flow
Net Present Value (NPV)
Internal Rate of Return (IRR)

The following section describes the four most common profitability indicators, explains their calculation and the interpretation of their results and discusses their appropriate uses, advantages and limitations. Although discounted cash flow is a theoretically superior methodology, many companies continue to use Payback and Return on Investment as their principal financial analysis tools. Thus it is important that staff who are assisting companies in P2 financial analysis be familiar with all four measures. This section will demonstrate each method using the cash flow information from the Wrayburn Jewelry example shown in the previous chapters[1]. It is important to keep in mind that while financial analysis is an intrinsic aspect of the assessment of pollution prevention projects, the results must be considered in conjunction with potential positive *and* negative qualitative impacts, which are discussed in Chapter 4.

METHOD #1: PAYBACK PERIOD ANALYSIS: *Measures the amount of time needed for an investment to return the initial capital expenditure.*

Payback period analysis is the simplest of the four financial analysis methods. It evaluates how long a project will take to return its original investment, and it ranks projects according to the length of the period: the shorter the payback period, the more attractive the project. The payback period is calculated by adding together each year of a project's pre-tax cash flow (CF) in chronological order until the total savings equals the initial investment amount. If cash flow is projected to be the same for every year, the figure is divided into the investment (Table 3.2)

Table 3.2
Payback Period Calculation

$$\frac{\text{Initial Investment}}{(\text{Yr. 1 CF} + \text{Yr. 2 CF...Yr. N CF})}$$

or/ if the annual savings are the same:

$$\frac{\text{Initial Investment}}{\text{Annual Savings}}$$

[1] A synopsis of Wrayburn Jewelry can be found on page 3 of Chapter 1, and the full case with Exhibits is included as Appendix B.

Payback period analysis has three drawbacks: it does not consider the time value of money or the impact of taxes, and it ignores cash flows that occur after the initial investment has been recouped. A chart that tracks the percentage payback of all the cash flows over the life of the project offers one response to the latter objection. This refinement preserves the simplicity of the payback method yet increases its usefulness. Table 3.3 shows both the simple and the modified payback period methods. The simple payback method shows that the investment has an eleven month payback period, and the modified approach indicates the investment is expected to return 629 percent of the original investment over a five year period.

Table 3.3
Payback Analysis
(Wrayburn Jewelry)

Simple Payback (pre-tax)

$$\frac{16{,}000}{18{,}236} = \mathbf{0.88\ years}$$

Modified Payback (pre-tax)

Year	Cash Flow	% Recouped
1	18,236	114
2	19,148	234
3	20,105	359
4	21,110	491
5	22,166	629

Payback remains one of the most widely used measures of profitability, even among larger firms. Survey results show that the most common payback threshold is 1-2 years (Table 3.4), but anecdotal reports also indicate that some firms have multiple thresholds for projects of different size and strategic significance. (For example, a 1-year payback for small projects and a 3-year payback for major investments in new processing equipment.) A few firms have also indicated that they use a longer payback threshold for "environmental" projects in recognition that such projects often produce benefits that are not captured in a short-term financial analysis.

Table 3.4
Payback Thresholds

Payback	%*
< 1 year	10
1-2 years	50
2-3 years	32
> 4 years	8

Source: EPA/Tellus Report[2]
**% of respondents using payback*

Payback often provides a useful preliminary assessment of a project's attractiveness, and it may also, in spite of its deficiencies, be sufficient to give an accurate determination of a project's financial feasibility in some cases. The key is to distinguish between those cases when payback is sufficient and those when the use of discounted cash flow analysis is necessary in order to make the correct business decision.

If a company is looking at a single project with stable cash flows for which the payback period is quite short, for example six months or a year, payback analysis may be enough to justify an approval. Similarly, if a company is ranking two or three projects all of about the same investment level, and the same economic lifetime, and one project has a significantly shorter payback period (for examples 6 months compared to 3 and 5 years) then payback analysis would probably be a sufficient indicator of the project's financial superiority. There are several general situations, however, where payback is unlikely to be

[2] US EPA, *Environmental Cost Accounting for Capital Budgeting: A Benchmark Survey of Management Accountants*, 1995

sufficient, and where it is necessary to use a discounted cash flow analysis in order to gain an accurate picture of a project's profitability and to make the appropriate business decision.

- **Longer payback periods:** Projects that have a payback longer than the company threshold are often not approved on their financial merits, although they may be implemented for less-tangible reasons. Many projects, however, with three or four or even five year payback periods may appear economically viable when analyzed using a discounted cash flow method, depending upon the company's discount rate and the economic lifetime of the project. It is important, therefore, to perform a net present value or internal rate of return analysis (presented later in this section) for projects that may be excluded because they fall outside the payback period threshold range.

- **Variable cash flows**: Payback does a poor job assessing projects that have variable cash flows (i.e. not the same cash flows every year). This is especially true for P2 investments that eliminate the use of materials whose purchase and disposal is expected to increase significantly due to rising costs, fees, taxes or other regulatory or market-driven issues. Cash flows that increase in later years, from rising avoided costs or from such longer-term gains as green marketing sales, are often undervalued in a payback period analysis.

- **Ranking multiple projects:** If a company is evaluating multiple projects that have variable cash flows, or significantly different initial investment amounts or economic lifetimes, payback period analysis will generally not provide a sufficient method for ranking their financial attractiveness. As a simple example, payback would not distinguish between the two projects in Table 3.5, both of which have a three-year payback period. The cash flows of Project B, however, are clearly preferable, because a larger amount of cash is returned sooner ($40,000 after 2 years compared to $25,000).

Table 3.5: Ranking with Payback
Initial investment $50,000

	Project A	Project B
Year 1	10,000	25,000
Year 2	15,000	15,000
Year 3	25,000	10,000

Even in those cases where Payback may be sufficient to make the correct business decision, discounted cash flow will provide more accurate and more complete information about the financial impacts of a investment.

METHOD #2: RETURN ON INVESTMENT

Return on Investment is the least precise term among the four profitability indicators. While it is intended to measure the return (i.e., profitability) of a project as a percentage of the investment, numerous variations of the concept make interpretation difficult and comparisons potentially meaningless. Some variants use average net cash flow in the numerator while others employ net income. Similarly, the denominator may be the initial investment or a calculated average to account for depreciation of the assets (Table 3.6)[3]. As with Payback Period Analysis, Return on Investment fails to consider the Time Value of Money (TVM), the economic lifetime of a project and the effect of taxes. Although many companies continue to use variations of ROI, payback provides a better measure for a simple analysis because it has a standard definition and interpretation, while Internal Rate of Return (IRR) is highly superior if there is a need to have a measure that expresses profitability as a percentage. Simple ROI usually gives a highly inflated value that has little relationship to a true IRR.

Table 3.6
Return on Investment (ROI) Variations

Annual Cash Flow Savings ***or*** Net Income / Initial Cost ***or*** Depreciated Investment		
(Wrayburn Jewelry)		
13,000 / 16,000	or/	10,000 / 8,000
81% ROI		125% ROI

DISCOUNTED CASH FLOW - NPV and IRR

As discussed above, there are situations when payback may be sufficient to determine the acceptability of a project. There are times, however, when payback is not good enough, and it is necessary to use discounted cash flow to conduct a more accurate analysis. Discounted cash flow is the preferred method of calculating profitability because it incorporates the time value of money, using an interest (discount) rate that is tied to a company's financial structure (i.e., cost of capital). By providing a more accurate picture of the financial impact of an investment, Net Present Value (NPV) and Internal Rate of Return (IRR) can improve the decision-making process.

Time Value of Money: Future Value and Present Value

The **Time Value of Money (TVM)** recognizes that receiving \$100 today is not equivalent to receiving \$100 at some point in the future. The chance to invest the money and earn a return (known as ***opportunity cost***), the loss of purchasing power (i.e., ***inflation***) and uncertainty about the future (i.e., ***risk***) all make the value of that \$100 worth more today than one year from now. Most people have experience with TVM through the concept of

Table 3.7
TVM - Future Value Of An Investment

$$\mathbf{FV = PV \times (1 + r)^T}$$

$$FV = \$100 \times (1+.1)^2$$
$$FV = \$100 \times 1.21$$
$$FV = \$121$$

Where:
PV = Value of the money received today (PV = \$100).
FV = Value received in future when invested at r (FV = \$121).
r = Rate at which funds could be invested (r = 10%)
T = Number of periods in which interest is earned (T = 2)

[3] Return on Investment (ROI) <u>does</u> a have precise definition in the context of company ratio analysis, a well-established tool to evaluate corporate financial performance, where ROI is the net after-tax profit divided by total equity.

Future Value (FV). If the $100 is invested to earn a rate of return, its future value can be easily determined if one knows the interest rate and the period of time[4]. For example, if the interest rate or rate of return were 10 percent, after one year the $100 investment would be worth $110, and after two years $121 ($110 **x** 10% **+** $110). This $121 is equivalent to receiving $100 today and investing it at 10 percent for two years. The calculation can be performed for any number of years and any rate of interest using the Future Value formula shown in Table 3.8. Now assume a person is offered two alternatives: $100 today or $130 in two years. Because $100 today is only worth $121 in two years (assuming a 10 percent rate of return), the $130 alternative has the greatest value. The $121 and $130 represent values at a defined point in the future and are known as **Future Values (FV)**.

An alternate way of considering the TVM concept is **Present Value (PV)**. Rather than calculate what an amount will be worth at some point in the future, present value calculates what a future amount will be worth today. It is the inverse of future value, and can be calculated by reversing the equation to solve for PV, as shown in Table 3.8. Using the numbers from the previous example to make comparisons on the basis of present value, we need to ask: what amount invested now at 10 percent will equal $130 in two years? $130 discounted for two periods at 10 percent has a present value of $107.44, and thus receiving $130 in two years is equivalent to receiving $107.44 today and investing it for two years at 10 percent. These two investments can be compared on the basis of their present values ($100 vs. $107.44) or their future values ($121 vs. $130).

Table 3.8
Present Value

PV = FV / (1 + r)T
PV = $130/(1+.1)2 PV = $130/1.21 PV = $107.44

Capital budgeting can employ the concept of present value in financial analysis to eliminate the distortions of TVM. A company invests money in a project with the expectation that it will generate cash flows in the future. Translating those future cash flows into values of the same time period as the initial investment enables an evaluation of expenditures and cash inflows (i.e., savings) on an equal basis. The process of translating (or discounting) those future cash flows into their present values is the basis of discounted cash flow analysis.

Calculating Present Value

The present value formula shown above is useful for gaining an understanding of the components of TVM and the impact of compounding interest, but it is a cumbersome method for performing calculations. The simplest way to calculate present value is with a business calculator or PC spreadsheet software, both of which have TVM functions for NPV and IRR. These digital tools are the preferred method of performing financial assessment, but because their electronic calculations are not visible to users, they may not be the best way to learn and understand the process of performing discounted cash flow analysis. An alternative method that is less tedious than formulas but more demonstrative than computers is the use of **Present Value Tables (A and B)**, as shown on Exhibit 3-1 (page 44) and explained below.

- **Table A**: Each cell on Table A shows the present value (PV) of $1.00 received in a future

[4] The rate of return is expressed as an annual rate unless otherwise noted and the period of time is usually in years.

year at a given discount rate. The Table includes a range of rates between 5 percent and 20 percent for years 1 through 20. To calculate the present value of a future cash flow, multiply the amount by the **Present Value Factor** (PVF) located at the intersection of the appropriate year and rate.

- **Table B**: Each cell on Table B shows the present value (PV) of $1.00 received as an **annuity** - a stream of equal payments occurring at regular intervals - for a number of years at a given discount rate. To calculate the present value of an annuity, multiply the amount by the **PV Annuity Factor (PVAF)** located at the intersection of the appropriate number of years and rate.

Table 3.9 shows the calculation of the present value of $100 received each year for three years (Years 1,2 & 3). Because this is an annuity, the calculation can be performed using both Tables A and B. The present value of a stream of unequal cash flows can only be calculated with Table A.

Table 3.9: Present Value Calculations @10%

Years	**Yr 1**	**Yr 2**	**Yr 3**
Future Cash Flows	$100	$100	$100
Table A			
PV Factors (PVF)	.9091	.8264	.7513
Cash flows X PVF	$90.91	82.64	75.13
TOTAL PV		**$248.68**	
Table B			
PV Annuity Factor	3 years @ 10% = 2.4868		
Annuity X PVAF	100 X 2.4868 = $248.668		
TOTAL PV		**$248.668**	

The Cost of Capital and the Discount Rate

The interest rate that companies use to discount future cash flow is called the **discount rate**. This rate is based on a firm’s **cost of capital**, or the cost of the money (i.e., capital) it needs to operate. A firm’s discount rate is generally supplied by a company’s financial officer and is rarely calculated by a team assessing P2 investments. An understanding of the concept of the cost of capital, however, enhances one’s ability to interpret NPV and IRR calculations and to grasp why discounted cash flow is a superior method of analyzing profitability.

All companies, when they begin operations and at various points in their growth, require money to be in business. Companies obtain this capital from three sources: investors (called ***equity***), lenders (called ***debt***), and retained earnings (also considered ***equity***). Investors supply money with the expectation that they will receive a return, either in the form of dividends and/or through an increase in share value. All companies are funded in part, and some in full, through the equity investments of their shareholders. Most companies also obtain additional capital through borrowing from banks or other financial institutions and in the form of credit arrangements with vendors. Companies can also generate capital through profits as retained earnings, which is considered equity because it belongs to the shareholders. The types of debt and equity and their relative proportions are referred to as a company’s capital structure and together make up the Liability side of a company’s balance sheet. The Asset side of the balance sheet includes all the financial and tangible goods that the company holds. In brief, Assets are what the company owns, and Liabilities what it owes (to shareholders and lenders), and by definition the two sides must be equal (Table 3.10).

Table 3.10: Balance Sheet

BALANCE SHEET (summary)			
Assets		**Liabilities (debt + equity)**	
Cash	1000	Debt	10000
Inventory	5000		
P, P & E*	15000	Equity	10000
Total Assets	**20000**	**Total Liabilities**	**20000**

**PP&E: property, plant and equipment*

A company's cost of capital is the cost that the firm incurs to borrow money (debt) and the return that it must provide to shareholders, and it is calculated by multiplying the percentage of equity (original capital plus retained earnings) by the cost of equity and the percentage of debt by the cost of debt. These two costs are then added together. Table 3.11 offers a simplified example of the calculation of the cost of capital, using the balance sheet shown above. In this case Debt and Equity are equal amounts, and therefore each represents half the total capitalization of the firm.

Table 3.11: Calculation of the Cost of Capital

	Formula	Calculation
Cost of Debt share	Cost of Debt **x** (1 - tax rate) **x** % of total liabilities	**10% x 40% x 50% = 2%**
Cost of Equity share	Required return **x %** of total liabilities	**18% x 50% = 9.0%**
Total Cost of Capital	Cost of debt + cost of equity	**= 11%**

The majority of US companies have costs of capital ranging between 10 and 20 percent. Large, stable companies with low business and investment risk have low costs of capital and small, high risk firms are at the opposite end of the spectrum. (As examples: electric utilities, before the advent of deregulation, averaged cost of capital of around 8 - 10%, whereas start-ups need to offer the prospect of 30 to 40 percent returns to attract venture capital). To perform a discounted cash flow analysis, companies may use their cost of capital as the discount rate to translate future cash flows into their present value. Thus, the discount rate is intrinsically tied to a company's financial structure and required level of profitability for an investment. The discount rate does not, however, always need to be exactly the same as the cost of capital. If a project is considered to be significantly more risky than the firm's average business operations, the discount rate can be raised above the cost of capital to reflect the increase in risk. Similarly, the discount rate can be lowered to reflect a reduced risk for particular projects.

Discount rates are usually expressed in "**nominal**"[5] terms, incorporating projected inflation. As discussed in Chapter 2, an accurate financial analysis requires that all costs and savings should reflect expected inflation or price escalation (that is, be expressed in nominal terms). There may be occasions, however, when it is desirable to perform a discounted cash flow analysis using "**real**" cash flows that do not incorporate inflation. In such cases it is

[5] Nominal means "what we observe in the real world".

Table 3.12

Conversion From Nominal Rates To Real Rates
Real Rate = $\frac{(1 + \text{Nominal Rate})}{(1 + \text{Expected Inflation Rate})} - 1$
Conversion From Real Rates To Nominal Rates
Nominal Rate = (1+ Real Rate) x (1 + Expected Inflation Rate) -1

important to convert discount rates from nominal to real terms. Discounting real cash flows with nominal rates, and vice versa, can lead to large errors in the analysis. Table 3.12 shows the formulas for converting between nominal and real rates.

Just as some companies use a longer payback period threshold for environmental projects, other companies set a lower discount rate with which to analyze pollution prevention investments. From a theoretical standpoint this can be justified in two ways. First, many benefits of a project are difficult to quantify, and therefore are not included in projected cash flow. The lower discount rate is a means of "quantifying" those less-tangible gains. A second theoretical justification for the use of a lower discount rate for P2 investments may be that the risk or uncertainty associated with these cash flows may actually be lower than for typical business-related projects. If the company is investing in a well-established P2 technology, such as reverse osmosis, the savings generated from reductions in purchases of raw materials, disposal costs, insurance and other potentially hidden costs, may be articulated and quantified with a high degree of certainty, and therefore there may be little risk associated with the success of the project and its financial gains. Conversely, some P2 projects may be significantly more risky than average due to the use of experimental techniques, innovative but un-proven technology or new types of equipment.

An advantage of discounted cash flow is that it facilitates this risk-adjusted analysis of a project. Determining how much to modify the discount rate is, however, a difficult and often highly subjective judgment.

METHOD #3: NET PRESENT VALUE (NPV): *Measures the increase in shareholder wealth that an investment generates at a given discount rate.*

Table 3.13
Net Present Value Analysis

NPV = PV(Cash Inflows) - PV(Cash Outflows)
NPV = \$107.44 - \$100 NPV = \$7.44

Net present value analysis compares the present value of the future cash inflows to the initial cash expenditure. Using the figures from the example in Table 3.8, one could determine whether a projected return of \$130 in two years is worth an initial investment of \$100. To calculate the net present value, the initial investment amount (\$100) is subtracted from the present value of the cash expected to be received after two years (107.44), as shown in Table 3.13. This investment has a NPV of \$7.44, indicating that it increases shareholder wealth by \$7.44.

An understanding of the cost of capital and its relationship to discount rates facilitates an understanding of how to interpret the results of an NPV analysis (Table 3.14). When net present value equals zero a project has sufficient cash flow to meet three objectives:

Table 3.14: NPV Rule of Thumb

NPV > 0	Project accepted
NPV < 0	Project rejected
NPV = 0	Project equals required return

1) pay off the initial investment,
2) pay creditors who loaned money to the company, and
3) provide the required return to shareholders.

The first objective is incorporated into the calculation of NPV when the initial investment is subtracted from the present values of future cash flows (when all present values are "netted"). The second and third objectives are explicitly included in the calculation of a firm's cost of capital, the basis of the discount rate used in the analysis. If the discount rate is an accurate reflection of the cost of borrowing money and the return required by investors and if it incorporates the proper assessment of project risk, then a discounted cash flow analysis of a project using that rate will be acceptable when NPV equals 0. When NPV is greater than 0, the project generates cash flow sufficient to satisfy those three basic requirements plus it generates additional wealth to the shareholders. The NPV indicates how much *extra* return a project generates above the percent return that is required by a firm's owners or managers. In the example in Table 3.13 the investment generates $7.44 in excess of the 10 percent return that is required.

Table 3.15 presents the calculation of the **Net Present Value** of the recovery still in the Wrayburn example. Each cash flow is discounted using a 15 percent PV factor. The cash flow figures include the after-tax operating (period) cash flows and the tax shield savings created by the equipment depreciation.

Table 3.15
Net Present Value Analysis
Wrayburn Jewelry Case

Year	Cash Flow	15% PV Factor*	PV of Cash Flows
Year 0	-$16,000	1.0000	-$16,000
Year 1	12,222	.8696	10,628
Year 2	12,769	.7561	9,655
Year 3	13,343	.6575	8,773
Year 4	13,946	.5718	7,974
Year 5	14,580	.4972	7,249
NPV @ 15%:			**$28,279**

* PV Factor is obtained from Table A (page 44)

METHOD #4: INTERNAL RATE OF RETURN: *Calculates the rate of return that is generated by a project. IRR is the discount rate that would result in a zero NPV.*

The **Internal Rate of Return (IRR)** is the discount rate that will yield a net present value of zero for a given stream of cash flows. This method enables a comparison between the IRR of a project and a firm's discount rate. While calculators and spreadsheets have IRR functions, there is no simple formula to manually calculate the IRR of an investment, necessitating the use of a trial and error process that can be cumbersome for projects with long lifetimes and varying cash flows. Table 3.16 illustrates the trial and error method using the example of an investment of $100 that returns $115 in one year. If we analyze this investment using 10 percent, 15 percent, and 20 percent discount rates, we find the NPVs shown in Figure 3.16.

Table 3.16
NPV of $115 at 10, 15 and 20 Percent Discount Rates

10%	15%	20%
NPV = $115/1.1-$100	NPV = $115/1.15-$100	NPV = $115/1.2- $100
NPV = $104.55 - $100	NPV = $100 - $100	NPV = $95.83 - $100
NPV = $4.55	NPV = $0	NPV = ($4.17)

Discounting $115 at 10 percent results in a positive NPV, discounting at 20 percent leads to a negative NPV, therefore, the IRR must lie between 10 percent and 20 percent. When discounted at a rate of 15 percent the NPV of the investment is zero, therefore, the IRR of this investment is 15 percent.

Table 3.17: IRR Rule of Thumb

IRR > discount rate	Project accepted
IRR < discount rate	Project rejected
IRR = discount rate	Project equals required return

As with NPV, Internal Rate of Return provides an indication of project feasibility based on a company’s cost of capital. An IRR equal to a firm’s discount rate (often also called its hurdle rate) provides exactly the return that is required to satisfy shareholders and creditors and to cover the cost of the initial investment. An IRR greater than a hurdle rate indicates a project that has a higher rate of profitability than required to be accepted. The IRR for the Wrayburn Jewelry project is 75 percent, far above the company’s hurdle rate.

Comparison of NPV versus IRR

Both Net Present Value and Internal Rate of Return are based on the concept of discounted cash flow. They simply solve for different variables of the same equation. NPV sets the discount rate and solves for present value; IRR sets the present value (at zero) and solves for the discount rate. Each measure offers useful insights. NPV provides a dollar figure that represents the added shareholder wealth that a project will generate, while IRR provides a relative measure of profitability that gives management a sense of how much more or less profitable a project is than the company’s hurdle rate. In most cases, the two methods will provide the same accept/reject decision for single projects considered independently[6]. They may not, however, offer the same indications when a company is ranking multiple projects. Most significantly, IRR ignores the impact of the scale of a project. An investment of $100 that returns $125 in one year will have the same IRR as a project that requires a $200,000 investment and returns $250,000 in one year. NPV will always provide the theoretically correct answer, a distinction discussed in the next section.

Ranking Multiple Projects

When ranking multiple, mutually-exclusive projects, two situations require special consideration: projects of different **scale** (initial investments amounts) and different **duration** (economic lifetimes).

Projects With Different Initial Investments

Net present value will always provide the correct theoretical answer when used to evaluate or rank projects that have different initial investment amounts. Net present value calculates the increase in shareholder value that each project generates, and the highest NPV will therefore maximize shareholder value. Internal rate of return will show which project has the highest relative profitability but will not show which maximizes the creation of shareholder wealth. Assuming that a company has access to capital to invest in the projects under consideration, its objective should always be to maximize shareholder value, not necessarily to maximize the profitability of an individual set of projects. A simplified illustration of this concept is shown in Table 3.18

Table 3.18: Maximizing Total Return

Option A		Option B		Option C	
	Interest Earned		Interest Earned		Interest Earned
$1000 @ 5%	$50	$100 @ 100%	$100	$1000 @ 20%	$200
		$900 @ 5%	$45		
Return	**$50**		**$145**		**$200**

Option A: If you have $1000 in a bank account earning 5 percent, you would earn $50 in one year.
Option B: If someone offered you a guaranteed return of 100 percent on $100 investment and 5 percent on $900 you would earned a total return of $145 (option B).
Option C: If another person offered you a return of 20 percent on the entire $1000, your return would be $200.
Assuming that these are mutually exclusive investment opportunities and assuming you would leave any remaining funds in the bank and did not foresee other opportunities on the horizon, it would make the most economic sense to invest the entire $1000 at 20 percent to maximize the total return. The 100 percent investment would maximize profitability for the given amount but would not generate as much wealth. Because NPV measures total return and IRR measures relative profitability, NPV provides the correct answer when ranking these projects.

[6] Even in these cases, however, there are occasions when IRR can be misleading.

In practice, if a company is evaluating two pollution prevention options that have widely different investment requirements, the financial analysis will need to be understood in the context of many other factors to determine the best investment. The larger investment, which may have a small IRR but a larger NPV, might be theoretically preferable, but the investment amount might be larger than the capital budget would allow and therefore might require external financing that could impose extra costs on the firm. There also may be many less-tangible reasons that might argue for making the smaller investment with the higher IRR. NPV theory must be weighed against all the factors found within the context of that particular business decision.

Ranking Projects With Different Economic Lives

Comparing the net present values of projects with different economic lives - projects of five and ten years - on an even basis does not provide an accurate assessment of their relative financial worth. The projects must be artificially adjusted to enable comparison of projects with equal economic lives. This theoretical approach relies on what is called an “assumption of repeatability,” which states that a project can likely be repeated after the termination of its useful economic life. Therefore the correct method for analyzing projects with different economic lives is to repeat one or both of them until you reach a comparison between multiple projects of the same duration. For example, if the analyst is comparing projects of five and ten years, it is necessary to determine the appropriate cash flows, including new investments, as if the shorter project were repeated at the end of year five. Essentially the analysis then would be comparing two ten-year projects.

The viability of the assumption of repeatability receives different treatment in academic finance texts. In practice, the manner in which a company might handle such an analysis would again depend on all the factors involved in the decision making process, including:

- the relative difference in the economic lifetimes,
- the difference in the net present values calculated for the two projects,
- the difference in their initial investment amounts,
- differing levels of risk, and
- different less tangible benefits that might accrue from implementation of the projects.

Although financial analysis is always a critical piece of any project assessment, when comparing projects with significantly different economic lifetimes it becomes even more important to consider all the additional variables that might influence the investment decision.

This chapter has described the most common measures of profitability used to evaluate project cash flows, and Table 3.19 summarizes the key aspects of these measures. The full analysis of the Wrayburn Jewelry cash flows using Net Present Value is shown on the spread sheet on page 68. An alternative to creating a spreadsheet from scratch is to use software designed specifically to evaluate pollution prevention investments. Appendix C provides information about one such product, ***P2 Finance***, originally developed by the Tellus Institute in 1990. With funding from EPA, Tellus released version 3.0 of P2 Finance in 1996 and has also developed industry-specific versions with detailed cost inventories relevant to the target industry.

Table 3.19
Summary of Investment Performance Measures

	Ease of Use	Considers TVM	Measures Scale of Gain	When to Use	Key Advantage Disadvantage
Payback Method	Simple	No - but can adj. method to accommodate	No - looks only at time taken to earn investment back	Very small scale projects where major data gathering is not justified	Does not consider TVM or cash flows over the entire life of the project.
Return On Investment	Simple - Uses readily available information	No	No: Looks at impact on accounting earnings	Never	Does not look at project cash flows, only accounting earnings
Net Present Value	Need to estimate cash flows over life of project and estimate discount rate	Yes: Uses risk-adjusted discount rate - opportunity cost of capital	Yes - measures value added to firm in PV terms	Prioritize and/or evaluate: major investment or process decisions	Measures risk adjusted value added to business
Internal Rate of Return	Need to estimate cash flows over life of project	Yes - Measures time value of money with discount rate (IRR) implied by cash flows	No - Produces rate of return as measure	Use as initial screen and as further check on investment decisions	Can use to screen or prioritize w/o estimating discount rate

The following chapter discusses impacts and benefits of P2 investments that are difficult to quantify and to include in the financial analysis but that can have a major bearing on overall project evaluation.

EXHIBIT 3-1: Present Value Tables

TABLE A

Present Value of $1 Received at the End of n Periods

Yr.	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	18%	20%
1	.9524	.9434	.9346	.9259	.9174	.9091	.9009	.8929	.8850	.8772	.8696	.8621	.8475	.8333
2	.9070	.8900	.8734	.8573	.8417	.8264	.8116	.7972	.7831	.7695	.7561	.7432	.7182	.6944
3	.8638	.8396	.8163	.7938	.7722	.7513	.7312	.7118	.6931	.6750	.6575	.6407	.6086	.5787
4	.8227	.7921	.7629	.7350	.7084	.6830	.6587	.6355	.6133	.5921	.5718	.5523	.5158	.4823
5	.7835	.7473	.7130	.6806	.6499	.6209	.5935	.5674	.5428	.5194	.4972	.4761	.4371	.4019
6	.7462	.7050	.6663	.6302	.5963	.5645	.5346	.5066	.4803	.4556	.4323	.4104	.3704	.3349
7	.7107	.6651	.6227	.5835	.5470	.5132	.4817	.4523	.4251	.3996	.3759	.3538	.3139	.2791
8	.6768	.6274	.5820	.5403	.5019	.4665	.4339	.4039	.3762	.3506	.3269	.3050	.2660	.2326
9	.6446	.5919	.5439	.5002	.4604	.4241	.3909	.3606	.3329	.3075	.2843	.2630	.2255	.1938
10	.6139	.5584	.5083	.4632	.4224	.3855	.3522	.3220	.2946	.2697	.2472	.2267	.1911	.1615
11	.5847	.5268	.4751	.4289	.3875	.3505	.3173	.2875	.2607	.2366	.2149	.1954	.1619	.1346
12	.5568	.4970	.4440	.3971	.3555	.3186	.2858	.2567	.2307	.2076	.1869	.1685	.1372	.1122
13	.5303	.4688	.4150	.3677	.3262	.2897	.2575	.2292	.2042	.1821	.1625	.1452	.1163	.0935
14	.5051	.4423	.3878	.3405	.2992	.2633	.2320	.2046	.1807	.1597	.1413	.1252	.0985	.0779
15	.4810	.4173	.3624	.3152	.2745	.2394	.2090	.1827	.1599	.1401	.1229	.1079	.0835	.0649
16	.4581	.3936	.3387	.2919	.2519	.2176	.1883	.1631	.1415	.1229	.1069	.0930	.0708	.0541
17	.4363	.3714	.3166	.2703	.2311	.1978	.1696	.1456	.1252	.1078	.0929	.0802	.0600	.0451
18	.4155	.3503	.2959	.2502	.2120	.1799	.1528	.1300	.1108	.0946	.0808	.0691	.0508	.0376
19	.3957	.3305	.2765	.2317	.1945	.1635	.1377	.1161	.0981	.0829	.0703	.0596	.0431	.0313
20	.3769	.3118	.2584	.2145	.1784	.1486	.1240	.1037	.0868	.0728	.0611	.0514	.0365	.0261

TABLE B

Present Value of an Annuity of $1 per Period for n Periods

Yr.	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	18%	20%
1	0.9524	0.9434	0.9346	0.9259	0.9174	0.9091	0.9009	0.8929	0.8850	0.8772	0.8696	0.8621	0.8475	0.8333
2	1.8594	1.8334	1.8080	1.7833	1.7591	1.7355	1.7125	1.6901	1.6681	1.6467	1.6257	1.6052	1.5656	1.5278
3	2.7232	2.6730	2.6243	2.5771	2.5313	2.4869	2.4437	2.4018	2.3612	2.3216	2.2832	2.2459	2.1743	2.1065
4	3.5460	3.4651	3.3872	3.3121	3.2397	3.1699	3.1024	3.0373	2.9745	2.9137	2.8550	2.7982	2.6901	2.5887
5	4.3295	4.2124	4.1002	3.9927	3.8897	3.7908	3.6959	3.6048	3.5172	3.4331	3.3522	3.2743	3.1272	2.9906
6	5.0757	4.9173	4.7665	4.6229	4.4859	4.3553	4.2305	4.1114	3.9975	3.8887	3.7845	3.6847	3.4976	3.3255
7	5.7864	5.5824	5.3893	5.2064	5.0330	4.8684	4.7122	4.5638	4.4226	4.2883	4.1604	4.0386	3.8115	3.6046
8	6.4632	6.2098	5.9713	5.7466	5.5348	5.3349	5.1461	4.9676	4.7988	4.6389	4.4873	4.3436	4.0776	3.8372
9	7.1078	6.8017	6.5152	6.2469	5.9952	5.7590	5.5370	5.3282	5.1317	4.9464	4.7716	4.6065	4.3030	4.0310
10	7.7217	7.3601	7.0236	6.7101	6.4177	6.1446	5.8892	5.6502	5.4262	5.2161	5.0188	4.8332	4.4941	4.1925
11	8.3064	7.8869	7.4987	7.1390	6.8052	6.4951	6.2065	5.9377	5.6869	5.4527	5.2337	5.0286	4.6560	4.3271
12	8.8633	8.3838	7.9427	7.5361	7.1607	6.8137	6.4924	6.1944	5.9176	5.6603	5.4206	5.1971	4.7932	4.4392
13	9.3936	8.8527	8.3577	7.9038	7.4869	7.1034	6.7499	6.4235	6.1218	5.8424	5.5831	5.3423	4.9095	4.5327
14	9.8986	9.2950	8.7455	8.2442	7.7862	7.3667	6.9819	6.6282	6.3025	6.0021	5.7245	5.4675	5.0081	4.6106
15	10.3797	9.7122	9.1079	8.5595	8.0607	7.6061	7.1909	6.8109	6.4624	6.1422	5.8474	5.5755	5.0916	4.6755
16	10.8378	10.1059	9.4466	8.8514	8.3126	7.8237	7.3792	6.9740	6.6039	6.2651	5.9542	5.6685	5.1624	4.7296
17	11.2741	10.4773	9.7632	9.1216	8.5436	8.0216	7.5488	7.1196	6.7291	6.3729	6.0472	5.7487	5.2223	4.7746
18	11.6896	10.8276	10.0591	9.3719	8.7556	8.2014	7.7016	7.2497	6.8399	6.4674	6.1280	5.8178	5.2732	4.8122
19	12.0853	11.1581	10.3356	9.6036	8.9501	8.3649	7.8393	7.3658	6.9380	6.5504	6.1982	5.8775	5.3162	4.8435
20	12.4622	11.4699	10.5940	9.8181	9.1285	8.5136	7.9633	7.4694	7.0248	6.6231	6.2593	5.9288	5.3527	4.8696

Chapter 4 - QUALITATIVE ISSUES

As discussed in the overview to this manual, the financial (quantitative) analysis of a pollution prevention project should be augmented by the evaluation of other factors that are difficult to quantify but that may have strategic significance. A project's impact on market share, public image, financial liability or stakeholder relations can often dwarf strict economic criteria in the decision-making process. Although such factors are often referred to as "qualitative" or "intangible", such a strict either/or classification (i.e., quantitative/qualitative or tangible/intangible) is often misleading. Many issues fall between these end points and may be subject to some form of quantification or projection, especially given the ease of using a computer spreadsheet to perform sensitivity analysis. Moreover, a pitfall of defining issues too simplistically as "qualitative" or "intangible" is the tendency to pay less attention to those items that are not expressed in numerical terms. The emphasis on measurement (as some have said, "you are what you measure"), often leads to devaluation of issues that are outside the quantitative domain, even though their significance to the long-term success of an enterprise may be high.

It is important, therefore, to explore ways to quantify the issues discussed in this chapter before relying on a purely qualitative evaluation. Capturing a portion of the true cost or savings of a particular less-tangible item may often be possible. For example, negative publicity related to toxic pollution might take up a senior manager’s time (a highly measurable activity) and might also be suspected of having an impact on sales (perhaps more difficult to measure). If the toxic were eliminated and the negative publicity ceased, the saved management hours could be included in the quantitative analysis while the prospect of increased sales might be addressed qualitatively. Of course, every case is different and must be considered on its own merits. Few benefits are qualitative *a priori*; many have the potential to be quantified and should receive that attention.

While pollution prevention projects often generate significant less-tangible benefits, it is important to recognize that the impacts are not always advantageous. While some issues, such as improved public image, are presumed to be beneficial, other qualitative issues, such as product quality, may be either positive or a negative. Some may be both. A project that reduces workplace hazards may clearly improve employee health and safety but may be viewed skeptically by those same stakeholders if it also reduces the labor requirements and appears to threaten job security. After determining the nature of the impact, a P2 team must figure out how best to communicate fully the positive benefits of a project, or the group must consider ways to restructure the project to minimize undesirable consequences. The following section reviews the most common less-tangible issues, explains why they may be important and suggests ways that a project team can focus attention on them to emphasize their significance. As stated above, quantifying these issues and including them in the financial analysis wherever feasible can be beneficial.

Product quality: Customers are increasingly demanding environmentally-friendly products yet are rarely willing to surrender price or quality to achieve their demands. A pollution prevention project that is detrimental to product quality (e.g., through inferior material substitution or process changes that fail to meet design specifications) may result in lost sales or increased costs of rework and downtime. Alternatively, a pollution prevention initiative that improves quality may help to boost sales. Concerns about impacts on quality need to be addressed upfront by:

- conducting sufficient engineering review and testing before specifying equipment or changing a product or process;
- securing guarantees by the vendor, perhaps in the form of a performance bond;
- planning for incremental ramp-up of production using the new process or new material; and/or
- securing feedback to determine what impact changes may have on customer acceptance.

If there are concerns about impacts on quality, a project proposal should outline those concerns and describe in detail the measures that a team has taken to ensure that they have been addressed and resolved. Almost nothing can kill a project faster than the fear that it may harm product quality, and the project team should take steps to address those fears as much as possible. If, on the other hand, there is clear evidence that a P2 initiative will improve quality, that benefit should be communicated strongly, especially in those cases where quality plays a significant role in differentiating a company's products. Factors to consider in assessing the impact of higher quality include reductions in: scrap, rework, raw materials, product returns and warranty costs, and potentially increased sales.

Quality and Productivity Example

A manufacturer of forged lighting fixtures replaced a conventional solvent spray coating system with a powder coating one. In addition to significant savings in raw materials and labor, the new technology improved the quality of the coating, substantially reducing the amount of touch-up painting required. It also increased capacity by enabling coating in humid summer conditions that had previously halted production, and by allowing faster drying.

Productivity/Capacity: Process changes resulting from the implementation of a pollution prevention project could potentially increase or decrease the productivity and/or effective capacity of a plant. For example, switching from a solvent-based to an aqueous-based coating might require longer drying time, reducing capacity. Conversely, installing an ultra-violet coating system with a short drying cycle might substantially increase capacity. In both cases, of course, the impact on capacity would be a function of the entire system and the location of its bottlenecks, but the choice of coating technology could have a significant impact. As with product quality, engineering review of new process specifications is crucial to assessing a project's effect on production. Thorough review may enable the impact on productivity/capacity to be estimated with sufficient certainty to permit its inclusion in the financial analysis. If this is not possible, the potential impacts should be explored and described qualitatively, perhaps using sensitivity analysis to quantify their effect.

Public image: The importance of an environmentally-friendly image has greatly increased in the past decade, and many companies now tout their "green" credentials. While a good public image is important for its own intangible reasons, its value is increasing as the link between a company's public image and market acceptance of its products becomes stronger. Image can be especially important to a company that has suffered a poor environmental reputation. For example, Polaroid, which had received a lot of negative publicity for its toxic discharges, now promotes its pro-active strategies of pollution prevention and recycling. The company has received widespread recognition for many of its innovative environmental programs.

Although most real pollution prevention projects can bolster the environmental record of a business, one that directly addresses a publicly-recognized problem can be especially valuable. If a proposed P2 project eliminates a source of bad publicity, such as the discharge of effluent that discolors a waterway, the potential public relations benefits of the project should be strongly emphasized in the justification package. To demonstrate this impact, a team might include a brief description of a similar company that used its environmental activities to strengthen its image and improve its financial position. Public relations initiatives that are linked to an environmental effort must, however, be based on verifiable actions or progress or they could easily backfire.

"Green" market share: Numerous surveys have documented the trend of green consumerism, and companies have responded by emphasizing environmental attributes in new product development. The growing inclination of consumers to buy "green" refers to purchases of products or services that are environmentally-benign or that are offered by companies with good environmental records. A pollution prevention project that "creates" a green process or product may have a significant impact on sales, depending upon customer demand. A project justification proposal could promote the value of this factor by including survey data related to the particular industry or product type. Additionally the report could show how a specific product or company, in a similar situation or industry, either gained market share after emphasizing its green qualities or lost market share due to a poor environmental record. To further demonstrate the significance of this issue, developing computer-generated scenarios based on experiences of similar companies could be valuable in demonstrating how even small impacts on market share can generate large returns on the bottom line.

Green Market / Supply Chain Example

A Massachusetts manufacturer of surface preparation hand tools (e.g., paint scrapers, putty knives, and plaster blades) was selected by a national hardware/homeware chain based in part on the supplier's proven environmental track record, which included an aggressive adherence to pollution prevention and quality management. In 1997 the company was on the verge of achieving zero wastewater discharge, compared to 30,000 gallons a day in the early 1990's.

Supplier certification: Similar to the "green" consumer market is the "green" supply chain. Though perhaps later to emerge than its retail cousin, the green supply chain is rapidly gaining momentum as companies that have elevated their own environmental management systems and practices are looking for the same from their suppliers. This trend is likely to accelerate as more companies adopt ISO 14000[1]. Some wholesale customers make specific environmental demands on their suppliers, and pollution prevention initiatives that eliminate toxic or hazardous substances may directly enable the retention or acquisition of customers. In contrast to the green consumer market, where potential market share gains may be very difficult to estimate, in the wholesale or Original Equipment Manufacturer (OEM) supply chain segment it may be possible with

[1] ISO 14000 refers to the environmental management system that is being approved and promulgated by the International Standards Organization (ISO) and is similar to ISO 9000, a quality management system, which has become a de facto standard for doing business in Europe and is gaining global attention.

some certainty to relate a P2 investment to a quantifiable gain in sales and increase in cash flow.

Stakeholder relations: The term "stakeholders" can be broadly applied to almost any person, group or organization with which a business has contact or impacts, including: employees, stockholders, lending institutions, customers, suppliers, surrounding communities and others. Though small, privately-held firms may not be as susceptible to shareholder pressure as large corporations, they may be equally or more sensitive to the interests of such other stakeholders as the surrounding community and employees. For businesses in small towns, where they are one of the major employers, many of these interests overlap. The benefits of a pollution prevention project may affect relationships with these groups in different ways, as detailed in discussion of some of the other issues (i.e., public image, employee health and safety, and market share). Generally, most firms place importance on the value of being recognized as a good neighbor. If this is an important value to company management, it should be mentioned as part of the justification argument in a project proposal.

Employee health and safety: Improving working conditions can have both substantial short and long-term benefits, many of which may be quantifiable, including lower worker compensation rates due to safer conditions, lower health care payments, increased productivity, reduced absenteeism and reduced OSHA regulatory oversight. If a project enables immediate reductions in insurance or OSHA regulations, those projections can be incorporated into the financial analysis. Additionally, one can build support for a project by citing the gains other companies have realized by improving employee health and safety. Combining equipment/process specifications with occupational health and safety data can provide documentation of expected improvements in working conditions. Improved workplace health and safety often translates into improved employee morale, which in turn can generate enhanced productivity.

Pro-active environmental management / enhanced compliance capability: Environmental regulation shows a clear trend toward increasingly stringent limitations for contaminants in air emissions, wastewater, and hazardous waste. Companies that anticipate these tougher levels and incorporate them into their strategic planning will have advantages over those that are content to comply with current standards. P2 projects have the ability, inherent in their prevention philosophy, to position a company to meet or surpass projected future toxic use and discharge limits. A strong argument for a pollution prevention project is its capacity to alleviate such unknown factors as purchase price, disposal costs, or new health issues, that accompany the use of substances known to be environmentally damaging. A project team can mention these issues in a project justification packet and point to proposed new regulations or regulatory trends to support their arguments.

POTENTIAL LIABILITY

Financial liability: The financial liability from using and disposing of hazardous substances is potentially unlimited. One of the greatest benefits of a pollution prevention strategy is its capacity to reduced exposure to potential liability: Financial liability may be associated with:

- Disposal
- Storage
- Transportation
- Real property damage
- Civil actions
- Toxic tort suits
- Fines/penalties

Although reduction of liability can be one of the most significant advantages of a pollution prevention strategy, this benefit is often difficult to quantify and thus may be 'underweighted' in a project assessment. In addition to having difficulty developing realistic estimates of the monetary impact of potential liability, companies may be reluctant to disclose their estimates due to requirements by The Securities and Exchange Commission (SEC) and the Financial Accounting Standards Board (FASB). Those agencies may require companies to establish accounting reserves to cover liabilities expressed in monetary terms.

Companies, environmental consultants, the academic community and others have developed a variety of methods that attempt to quantify potential liability risk. These range from precise projections of financial exposure based on historical data of actual occurrences, such as a model developed by General Electric, to work at a university that attempts to use "fuzzy logic" to translate mangers' qualitative responses into quantitative assessments. In 1996 the US EPA's Environmental Accounting Project published a compendium of techniques for estimating the monetary impact of potential environmental liabilities.[2] As no method has gained wide acceptance and many are complex and require considerable time and expertise to employ, it is beyond the scope of this manual to describe their design or use in detail. However, even without a quantitative projection, it is possible for a pollution prevention project team to develop a picture of the nature and potential consequences of specific sources of liability.

Liability Risk Assessment

The following steps offer an approach to thinking about liability risk that balances the need for accurate information with the cost of conducting an analysis. As with the Assessment Map above, the process described here is more a conceptual framework than it is a rigid procedure that will be applicable to all projects and conditions. The use of ethyl acetate in the Wrayburn case provides an example for assessing liability.

(1) **Draft process flow diagram (PFD) for current process, marking potential liability sources:** The Wrayburn PFD on page 9 indicates the use of ethyl acetate, a toxic substance.

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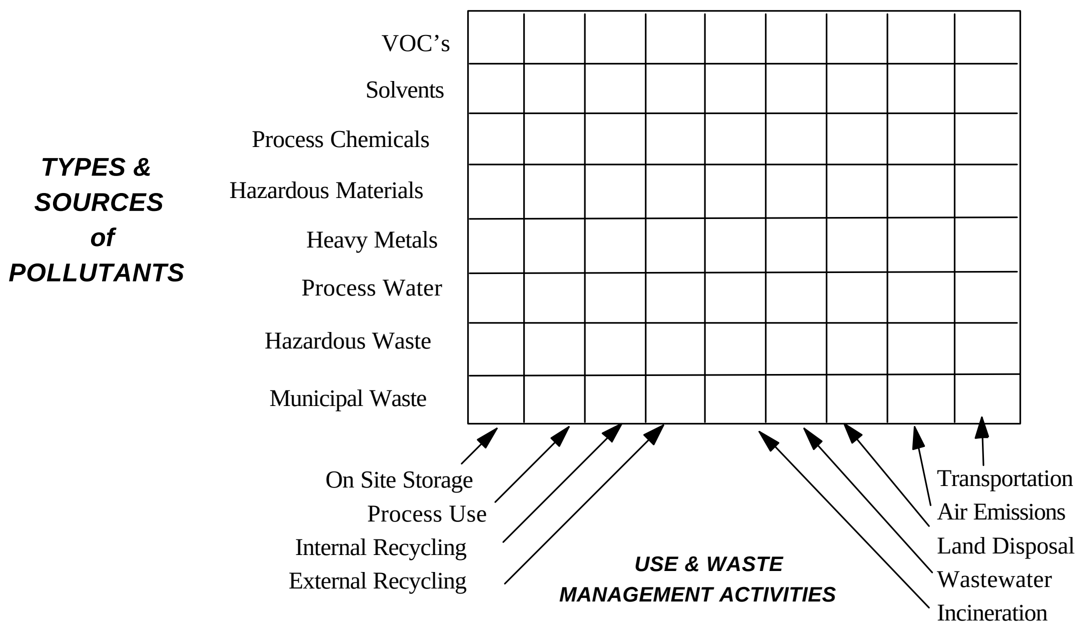
[2] US EPA, *Valuing Potential Environmental Liabilities for Managerial Decision-Making: A Review of Available Techniques, 1996*

(2) **Arrange liability sources into risk groups:** To assemble information about sources of risk and to define risk groups, we suggest using a table such as the one illustrated in Figure 4.3 (a full-scale version is included as Exhibit 4-2). The types and sources of pollution and waste are listed along the vertical axis and the activities associated with use and disposal along the horizontal axis. The categories listed here are **examples only**; every company and process would have its own types of liability. The intersection of these categories defines a risk group. For Wrayburn, ethyl acetate could fit under "solvents" or could comprise its own waste category. Activities related to the substance would probably include: on-site storage, process use, air emissions and external recycling or fuel burning (depending upon how the company disposed of the spent solvent). Each of these 'intersections' would be a separate 'risk group' with its own set of possible exposure events.

FIGURE 4.3
DEFINING RISK GROUPS



Steps 3 through 5 are then applied to each risk group. For our example, illustrated in Figure 4.4, we use the risk group defined by the intersection of ***solvent*** (ethyl acetate) and ***process use***.

Figure 4.4
Ethyl Acetate Process Use

Event	Probability (1-5)*	Severity (1-5)*
Minor spill or leak	3	1
Major spill or leak	1	3
Explosion	1	5
Employee exposure	2	3

*1 = lowest; 5 = highest

(3) List various exposure events for each risk group: Each risk group would have an associated group of events that could be potential sources of liability. The P2 project team can assemble this list from discussions with plant personnel, hazardous materials information sheets, vendors and internal brainstorming.

(4) **Assign probabilities for each event:** Any alphanumeric (e.g., 1-3, 1-5, A-E) or qualitative (e.g., low, medium, high) system can be used as long as there is consistency in the plant over time to ensure equal comparisons between projects.

(5) **Estimate severity of event:** As with the assignment of probabilities, any consistently-used system is acceptable to characterize the severity of the event in terms of its environmental and health impacts.

(6) **Use best professional judgment to assign high, medium, low degree of risk to overall liability:** The assignment of probability and severity is subjective and based on best professional judgment. The process of thinking through the possible consequences of each of the risk groups can help a team to develop and convey a general sense of the overall liability risk associated with the use of certain substances. As an additional benefit, even if a pollution prevention project does not completely eliminate the use of those substances, this process may assist management in devising ways to reduce risk by addressing those areas with the highest probability or severity of occurrence.

A project team could further characterize the possible consequences of specific liability risk groups by tracking recent judgments, fines, penalties and suits stemming from events similar to those that might occur at its facility. Including specific details in a proposal about the liability costs other firms have incurred can be a persuasive tools to sell a pollution prevention project that has the ability to reduce the risks of those costs.

Quantifying potential liability is less complicated when a company is considering a single type of event and has access to comparative cost data. As one example, a consulting firm quantified the potential liability costs of a long-term replacement strategy for electric transformers to eliminate PCB's. The analysis of potential leakage events projected a low, though probable, likelihood of an event with very high costs to address the contamination and remediation. Based on the assessment, the company decided to adopt an accelerated replacement schedule[3].

Criminal liability: The EPA and many states have markedly increased criminal prosecutions of environmental crimes, and recent court rulings have expanded the liability of owners and managers of businesses for environmental crimes committed unintentionally or by employees without their direct knowledge. Although most businesses operate within the law, managers should be aware of the increased exposure to criminal liability that these ruling have created when they manage facilities that use and dispose of toxic and hazardous substances. A project proposal could identify the reduction of this risk as one additional reason for implementing a project.

[3] Tellus Institute case study

PSYCHOLOGICAL BURDEN

The successful implementation of a pollution prevention strategy has the ability to reduce the psychological burden that often accompanies the management of an environmentally-regulated company. Anyone who has received a certified letter from the EPA Superfund division, been cited by a state environmental agency for non-compliance, or simply spent innumerable hours completing emissions reports knows how enervating such events or activities can be. When a business reduces or eliminates its pollutant-causing activities to the point where it is no longer under the jurisdiction of a regulatory body, the benefit to owners and employees is immeasurable. A pollution prevention project that starts or drives a company along the road to "zero regulatory oversight" has a large reward as its final destination.

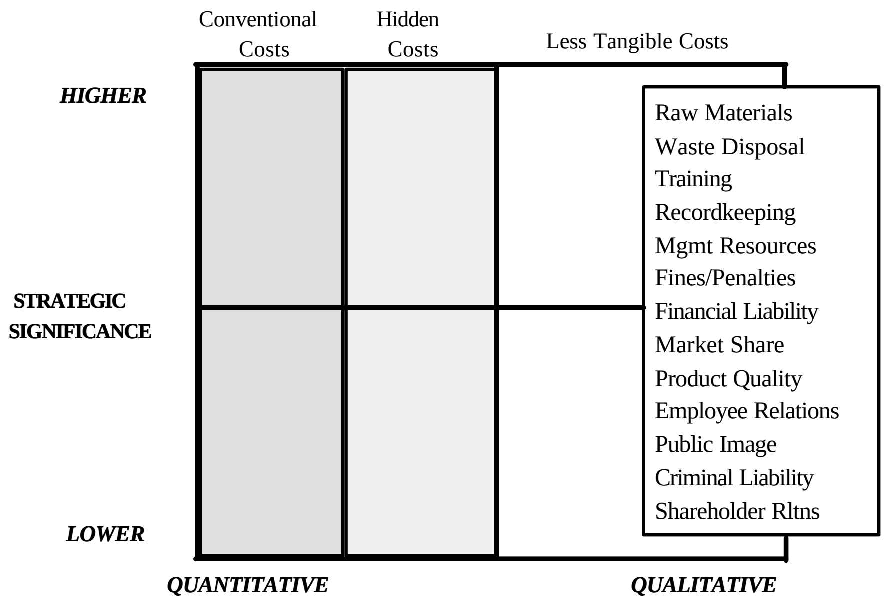
In some cases the initiation of a pollution prevention project can appear to add to managerial headaches, at least in the short-term. For a company that is currently in compliance with existing regulations and has developed and instituted a sound environmental program that manages wastes in an acceptable manner, the effort, time and cost of starting a P2 project that is not mandated by regulation may seem burdensome and excessive. Proponents of a P2 project may encounter the argument: "Why rock the boat? We're in compliance now." Issues described in this section - market share, public image, employee health and safety - can offer sound arguments to promote a particular P2 project in these cases.

Responding to advances in environmental and health knowledge and technical expertise, environmental officials continue to promulgate ever-more-stringent regulations. With increased knowledge about the dangers of pollutants and refinements to the sensitivity of analytical tools to measure them, regulatory agencies correspondingly ratchet-down the allowable limits on their discharge. While regulatory compliance pushes companies to meet tougher environmental targets, market forces are starting to pull them along that path with even greater speed. Green consumerism, manufacturers' demands on suppliers, and socially responsible investing all encourage more pro-active management of environmental issues. Thus, simply being satisfied with meeting today's compliance requirements and environmental standards will leave companies stranded in both the regulatory and competitive backwaters, while organizations with forward-looking strategies pass them by. A pollution prevention strategy can be a necessary basic ingredient both for meeting future regulatory limits and for improving a company's competitive position.

A FRAMEWORK FOR ANALYZING ISSUES

Figure 4.1 provides a mapping framework for charting the strategic and quantifiable dimensions of issues that a business should consider in assessing a pollution prevention project. (A full page version of the map is included as Exhibit 4-1). The framework is intended to be a flexible, conceptual tool that practitioners can use in a variety of ways to help guide project assessment and inform the development of a justification package. Initially a project team might use the map to identify those issues that are likely to be of the greatest significance in order to focus attention and limited resources in their analysis. Alternatively, the team might use it to think through which factors should be included in the financial analysis and which should be addressed qualitatively. Use of the framework may also prove valuable in a written proposal or oral presentation to illustrate the fact that many less tangible issues are often of high strategic significance. The map can thus help to highlight some of the benefits of pollution prevention projects that may tend to be ignored or undervalued.

Figure 4.1: ASSESSMENT MAP



We recommend that a team make a first pass effort to fill in the map prior to performing any detailed analysis and then revisit the process later in their work. The list on the right-hand side of Figure 4.1 provides examples of issues on which a pollution prevention project is likely to have an impact. Although these examples are common to many projects, the list is not intended to be comprehensive; conditions peculiar to specific projects can create a variety of other issues. The items can be plotted on the Y axis according to their relative strategic significance and on the X axis based on the feasibility of quantifying them.

The map groups items into three cost categories. The first vertical section indicates the realm of "conventional costs" that are usually included in a typical capital budgeting analysis, and the second section shows the expansion of the capital budgeting model to include the indirect "hidden costs" that are usually buried in overhead accounts. Chapter 2, Cost Information focuses on the identification and determination of these two costs areas. The right vertical half of the map includes less-tangible impacts whose costs are more difficult to project but may have quantifiable ramifications.

Figure 4.2 offers one example of how issues might be mapped for a particular project. The placement of these factors is not an absolute ranking of the importance of these issues for an organization; rather it is relative and project specific and thus will vary considerably even within the same company for different projects. We emphasize that this is a subjective process and that the example is presented to illustrate how the mapping framework can be used, **NOT** to establish a pattern of interpretation to be copied.

Figure 4.2: Assessment Map Example

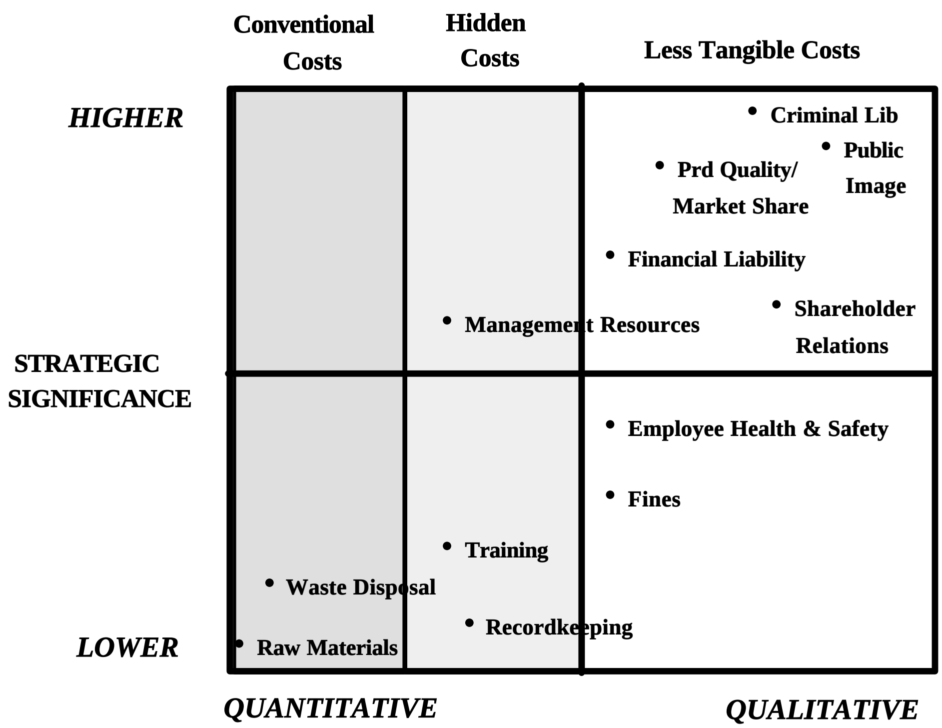


EXHIBIT 4-1

EXHIBIT 4-2

Appendix A - GLOSSARY & TERMINOLOGY

Financial and managerial accounting employ many specific terms in their practice. Although some are precisely defined, others acquire several different meanings as they come to be used in a variety of contexts. The advent of "environmental accounting" has exacerbated this trend, creating widely variant definitions of such terms as "full-cost", "life-cycle" and "cost-benefit". This ***Glossary & Terminology*** appendix presents definitions and explanations of some of the most common terms used in accounting and financial analysis.

GLOSSARY

Accounting Rate of Return - The rate of return of an investment, over its lifetime, based on the net income that the project generates. Average net income of the project divided by the initial investment.

Annuity - A level stream of equal dollar payments that exists for a fixed period of time.

Capital Budgeting - The process of planning and evaluating expenditures whose returns are expected to extend beyond one year.

Depreciation - A non-cash expense that is used to allocate the cost of a piece of equipment over its economic lifetime. The only impact of depreciation is to reduce the taxable income of the firm.

Depreciation Tax Shield - This represents the tax savings that are created each year, in a profitable firm, due to depreciation. The depreciation tax shield is calculated by multiplying the annual depreciation figure by the firm's tax rate.

Discount Rate - The interest rate used to discount future cash flows to their present values. This represents the rate of return that could be earned by investing in a project with risks comparable to the project being considered.

Future Value - Value of a sum of money at a future date when it is grown at a periodic interest rate.

Hurdle Rate - The minimum rate of return that a project must generate in order to be accepted by the firm. Projects that provide a rate of return below this rate will not be undertaken by the firm.

Incremental Cash Flows - The difference of a firm's cash flows with and without a project. Only cash flows that change with a particular project are relevant to the analysis.

Internal Rate of Return - The discount rate at which the net present value of an investment is zero. The IRR of a project can be compared to a firm's hurdle rate to determine economic attractiveness. The General IRR rule is:
If IRR ≥ hurdle rate then accept project.
If IRR < hurdle rate then reject project.

Net Present Value - The initial investment of a project subtracted from the present value of future cash flows, discounted at the opportunity cost of capital. NPV shows how much value will be created (destroyed) if a project is undertaken by the firm. The general NPV Rule is:
If NPV $\geq$ 0 then accept the project.
If NPV < 0 then reject the project.

Nominal Cash Flows - A cash flow is nominal if it represents the actual dollars, adjusted for projected inflation, that are expected to be received (paid out) in future periods.

Nominal Interest Rates - The nominal interest rate is the actual rate that an investment would earn. It can be viewed as the real interest rate plus the rate of inflation *(cf. real interest rates).*

Payback Period - The number of years required for a firm to recover a project's initial investment from the cash flows generated by that investment.

Present Value - The value of a future cash flow discounted at the appropriate interest rate.

Real Cash Flows - A cash flow is real if it is expressed in terms of current purchasing power.

Real Interest Rates - The real interest rate does not include the rate of inflation. The real rate represents how much the purchasing power of a sum of money has increased *(cf. nominal interest rate).*

TERMINOLOGY

A basic distinction is between financial and managerial accounting.

- **Financial Accounting** describes the information that a company prepares in order to report its financial performance and condition. If a company is privately-held, this information is only for the benefit of the owners and for a determination of state and federal tax liability. A publicly-owned company, however, must provide financial information to such external parties as shareholders, creditors, suppliers, bankers, government agencies and the general public. The form and substance of financial statements is set and revised periodically by the Financial Accounting Standards Board (FASB) and is codified as **GAAP** - generally accepted accounting principles. Financial accounting information is presented in three types of financial statements:

  > Income statement: to report sales, expenses and income for a set period of time (e.g., one quarter or one year).

  > Balance sheet: to report the financial condition of a company at one point in time (a snap-shot) - cash, receivables, inventory, debt, equity etc.

  > Cash flow statement: to report the actual flows of cash into and out of a business during a set period of time. This statement is important because the intricacies of accounting

rules often create a large disparity between the level of income shown on the income statement and the amount of actual cash that flows into a company.

- **Managerial Accounting:** In contrast to financial accounting, managerial accounting is intended solely for internal use and is not required by any governmental body or regulatory agency. The objective of managerial accounting is to provide information that enables managers to make decisions that further a company's pursuit of its strategic business mission. Because companies operate in vastly different ways and use different criteria to make decisions, the structure and content of managerial accounting reports vary greatly from company to company, even within the same industry. Although managerial accounting traditionally has involved only financial information presented in terms of costs, businesses are increasingly collecting, analyzing and using non-financial operating data in conjunction with cost information to assist in managerial decision-making. General examples of business issues for which managerial accounting information is used includes:

  ~ strategic planning
  ~ product profitability analysis
  ~ operational control
  ~ resource utilization
  ~ tracking of quality

  Cost information, with which we are concerned here, can be organized and presented in a variety of ways. Conventional managerial accounting seeks to allocate all costs incurred by an company to the products, product lines, or services produced. Costs, such as labor and materials, which are directly attributable to the production unit, are labeled **direct costs.** Many other costs, which are not easily attributable to particular products, are lumped together into cost pools labeled 'overhead' that are then allocated to products on the basis of a cost driver, such as labor hours or material dollars.

- **Activity-Based Costing:** The practice of allocating overhead cost pools on the basis of labor hours made sense in the early days of industrial activity when labor was the major input of a product's cost and overhead was relatively small. Today, however, in most manufacturing companies, the labor input is dwarfed by the overhead of expensive plant and equipment and large management, research and sales staff. Activity-based costing (ABC) seeks to reduce the distortions to product costing caused by using such measures as labor hours to allocate large overhead pools. The practice attempts to attribute 'overhead' costs to products on the basis of the activities that are actually performed in production. For example, costs related to inventory management might be attributed to products on the basis of the numbers of different parts in a product. The underlying concept of activity-based costing is central to the costing of pollution prevention projects: examining the costs of activities related to particular products or processes.

- **Full-Cost Accounting** is the term with perhaps the widest variations of use. As a strict accounting term defined by GAAP, full cost accounting refers to the requirement that a business include all costs (expenses) and revenues in its financial statements. In environmental accounting, the term denotes the practice of attributing all costs in a direct manner to products, production processes or services. The process is conceptually similar to **Total Cost Assessment** (TCA), a term and method developed by the Tellus Institute for analyzing P2 projects. In addition to including all costs, TCA also emphasizes a lengthening of the project lifetime in order not to omit savings that may be realized only after a project has been in place many years.

- **Life-Cycle Cost Analysis** is now commonly used in several related but different ways. As an environmental public policy tool, life-cycle costing refers to the effort to identify and quantify the costs of all the components and inputs of a product throughout its lifetime, from research and development to final dissolution. Although the state-of-the-art of life-cycle costing is still in its infancy, this type of analysis is gaining currency in environmental debates as a means to compare the impacts and costs of competing products or materials. For example, there have been several life-cycle assessments (LCA) of disposable versus cotton diapers and of polystyrene versus paper cups.

  (Modified) life-cycle costing is also a tool that companies are beginning to use to analyze the costs of a product or service over its extended economic life, including R&D and disposal. It is a more limited analysis than the public policy-driven LCA and is used for different reasons.

- **Cost Benefit Analysis** is a public policy tool that is used to evaluate the social costs and benefits of a proposed regulation or project. Analysts assess policies by monetizing the positive and negative impacts through the use of historically-derived formulae. Although the term "cost benefit analysis" is occasionally used to refer to the capital budgeting process, it is not in its strict sense applicable to business decision making.

Appendix B - WRAYBURN JEWELRY COMPANY

Company Background

Wrayburn Jewelry is a leading US manufacturer and distributor of men's and women's jewelry, personal leather goods, and personal accessory items[1]. Wrayburn's major manufacturing facility is located in Sutton, a small Massachusetts town. The Sutton facility employs 400 non-union workers on the shop floor, and 100 in management positions. This facility produces the firm's line of men's and women's high fashion costume jewelry pieces, as well as private label brands.

Wrayburn has traditionally been a maternal company where working conditions are constantly upgraded so as to improve worker satisfaction. This approach has lead to a steady, well motivated and loyal workforce. This maternal attitude has also extended to the surrounding community of Sutton. The facility has always been community oriented, and has been aware of the potential environmental concerns of the town of Sutton and its residents. Because of this, the facility has maintained a strategy of exceeding regulatory requirements. For example, the firm was 20 years ahead of regulatory requirements when it installed its waste treatment plant. The firm was also ahead of regulations when it installed *extra* exhaust hoods for the comfort of employees.

In terms of the capital budgeting process, William Sutherland, the Vice President of Quality and Environmental Affairs, drafts the capital budget for the upcoming fiscal year. He presents the budget directly to the board of directors. As such, the company does not have an extensive approval process, requiring only the sign-off of the board. During the year Sutherland has the discretion to approve expenditures up to $1,000; expenditures in excess of this must be approved by corporate headquarters.

Manufacturing Process

Despite the fact that Wrayburn's jewelry designs are constantly changing, the materials used remain the same. Metal sheets are simply molded, stamped, folded or plated according to the design schematics. The plant produces two types of finishes- white and yellow. The white finishes include silver plate, rhodium and tin-based finishes. For various artistic and production reasons Wrayburn has found silver to be the most desirable metal to use for white finishes. Because silver tarnishes, however, the silver plated pieces must be lacquer dipped prior to finishing. The silver jewelry pieces are strung onto plating racks and passed through a dip lacquering system. The silver pieces are then removed from the racks, and the plating racks are stripped of the lacquer using ethyl acetate. Currently the firm purchases the ethyl acetate, uses it to exhaustion, and then pays for its disposal as a hazardous waste. (See Exhibit 1 for the facility's process flow diagram.)

[1] We use fictitious names for the company, its employees and location in this case study to ensure confidentiality.

Pollution Prevention Project

In April 1991, Sutherland and the plant's new environmental manager, Peter Thorston, met with a representative of the Massachusetts Office of Technical Assistance (OTA). The three discussed changes to the dip lacquering system with its high costs of ethyl acetate purchase and disposal. They reasoned that a change was not necessary on regulatory grounds since the facility was in compliance with all applicable requirements. However, based on the trend set by Toxics Use Reduction Acts (TURA) nationally, the firm saw an opportunity to reduce the facilities costs while at the same time reducing its use of ethyl acetate. A solvent recovery still would drastically reduce the volume of ethyl acetate used by the firm. The firm queried several vendors on various still models, and settled on a $14,000 unit, which also required an additional $2,000 in installation costs.

Since the investment was not part of the capital budget submitted by Sutherland, approval for the purchase was needed from corporate headquarters. Sutherland and Thorston drafted a detailed proposal comparing the costs of the current and proposed systems (See Exhibit 2). The present method amounted to $683 per week in purchase and disposal costs, compared with $356.13 for the proposed method, a weekly savings of $326.87. Based upon these savings the still had a payback of eleven months. Despite this seemingly strong payback period the proposal had been "languishing" somewhere in corporate headquarters.

In the current process eight barrels of spent ethyl acetate are generated each month. Thorston spends approximately one and a half hours manifesting these barrels monthly. Instead of manifesting 12 times per year, the new process would require manifesting only 4 times per year, freeing up Thorston's time for other activities. Based on the premise that time is money, the labor reduction was treated as a cost savings, calculated at $30 per hour. The still will reduce the facility's TURA fees by $1,100 annually. The installation of the still will not impact the firm's right to know training, due to the other chemicals used at the firm. Likewise the still would have no impact on Thorston's normal daily monitoring activities. The time spent monitoring the still is roughly equal to the amount of time spent checking the dip lacquering system for malfunctions.

Since Sutherland received no response to the original proposal, he sought the help of the OTA representative in preparing a more formal financial analysis format. He hoped that this would help to demonstrate the financial attractiveness of the project. A discounted cash flow analysis was used (Exhibit 3) and assumed a five year useful life for the equipment[2], a 15 percent cost of capital, a 5 percent inflation rate, and a 40 percent corporate tax rate. This analysis incorporated all of the cost savings from the project, and yielded a favorable net present value of more than $26,000. While the payback of eleven months was convincing, the discounted cash flow took into account the time value of money, tax and inflation effects, and the less obvious savings associated with the project. The net present value of roughly $26,000 more than justified the proposed project.

[2] The actual case assumed a ten-year useful life. It has been shortened to 5 years in this example for simplicity.

EXHIBIT 1

WRAYBURN JEWELRY COMPANY

Process Flow Diagram

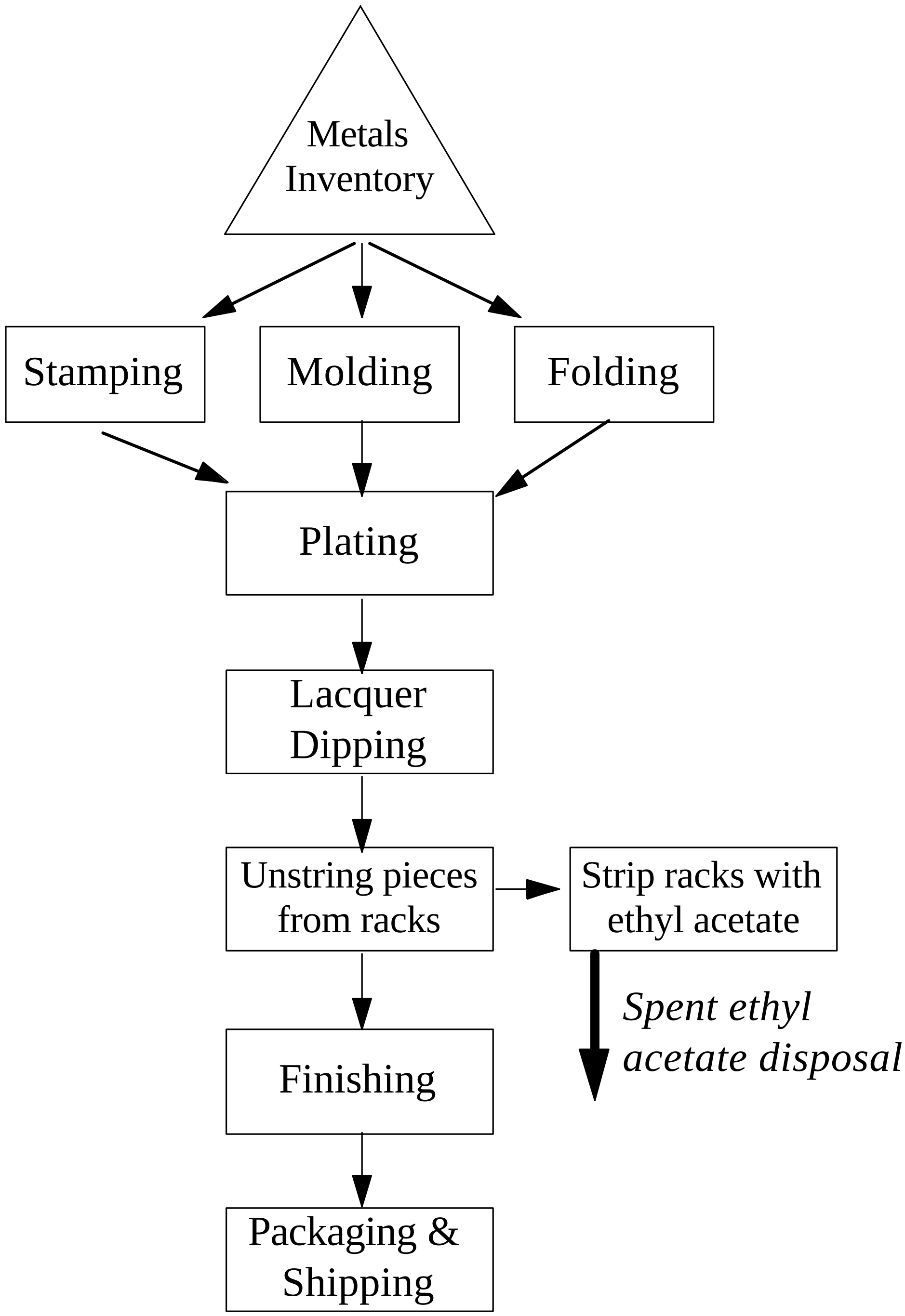


EXHIBIT 2

WRAYBURN JEWELRY COMPANY

Cost Savings for Ethyl Acetate Still

<u>CURRENT METHOD</u>: Purchase/Use/Disposal

<u>Purchase Costs:</u>

Current consumption of ethyl acetate stripping:
600 - 700 racks per day = **100 gals/wk**
Density = **7.8 lbs./gal.**
Weekly purchases in pounds = **780 lbs**.
Cost of new ethyl acetate = **$ 0.61 per lb.**
Weekly cost to purchase ethyl acetate = $ 0.61 x 780 = > > **$475.80**

<u>Disposal Costs:</u>

Evaporation/dragout losses = **5%**
Current weekly disposal volume = total purchased volume less 5% =
.95 x 780 = **740 lbs/week**
Disposal cost of spent ethyl acetate = **$ 0.28 per lb.**
Weekly cost to dispose of ethyl acetate = .28 x 740 lbs = > > **$207.20**

Total current weekly cost for ethyl acetate > > > > $683.00

<u>PROPOSED METHOD</u>: Purchase/Recover In-house/Make-up as required. Purchase of solvent still will permit recovery of approximately 75% ethyl acetate, disposal of balance as still bottoms.

<u>Purchase Costs:</u>

Purchase cost of ethyl acetate per week =
.25 x 780 lbs/week x $ 0.61
195 lbs. x $ 0.58 = > > > > > > **$118.95**

<u>Disposal Costs:</u>

Disposal volume of still bottoms = .25
x 740 lbs./wk = 185 lbs/wk

Disposal cost of still bottoms estimated @ $ 1.28 per lb. (Note: <u>unit</u> disposal cost of still bottoms is significantly higher because recyclable product has been removed.

Weekly disposal cost of still bottoms =
185 lbs. x $ 1.28/lb = >> > > > > **$237.18**

Total proposed weekly cost for ethyl acetate > > > > $356.13

EXHIBIT 2 (cont'd)

Cost Savings for Ethyl Acetate Still

Estimated Weekly Savings:

Weekly cost - current method	**$ 683.00**
Weekly cost - proposed still	**356.28**
Weekly savings	**$ 326.72**

Cost of Still

Still and peripheral equipment	**$ 14,000**
Installation cost (in-house labor and materials [not capitalized])	**2,000**
Total estimated cost	**$ 16,000**

Payback Analysis

$ 16,000 total cost/$327 savings per week = 49 week payback (11 months)

Notes

- Still can be operated at no additional labor cost

- Utility costs for operation are estimated at:
  > 15 gals recovered per 8 hours of operation
  > 100 gallons/15 gallons/8 hours x 53 hours per week
  > Power requirements = 4 kW
  > Weekly power consumption = 212 kW hours
  Operating cost = 212 kW hours per week x $ 0.02 kW hour = **$ 4.25**

EXHIBIT 3

WRAYBURN JEWELRY COMPANY
NOTE ON DISCOUNTED CASH FLOW ANALYSIS

ADDITIONAL COSTS INCURRED USING NEW PROCESS = The incremental costs that are associated with the implementation of the new system. These include the costs of purchasing and installing the new equipment and the costs associated with its operation. Only costs that are incurred as a result of the new system being installed should be considered. In this case a five percent inflation rate is assumed[3].

> *Purchase Ethyl Acetate Still* = The cost of the equipment used in the ethyl acetate recovery system, $14,000. Since this is a capital purchase it needs to be depreciated over the economic life of the project.
>
> *Installation of Still* = Those costs associated with the installation of the ethyl acetate still, $2,000. Since this is a capital purchase it needs to be depreciated over the economic life of the project.
>
> *Operation - Utilities* = The yearly cost associated with the additional power used to run the still, $221 annually.
>
> *Still Bottoms Disposal* = The yearly cost associated with the disposal of the still bottoms generated in the new process. 185 lbs. will be generated per week with a disposal cost of $1.28 per lb., resulting in disposal costs of $237.18 weekly or $12,333 yearly.

INCREMENTAL COST REDUCTIONS FROM DISCONTINUED PROCESS = Those incremental costs that will be saved by discontinuing the current process. Only those costs that will change with the discontinuation of the present system should be considered. In this case a five percent inflation rate is assumed.

- *Ethyl Acetate Purchases* = The cost savings associated with the reduction of the firm's need to purchase ethyl acetate. The firm expects to reduce its purchases of ethyl acetate by 75 percent, or $18,556 annually.

- *Spent Ethyl Acetate Disposal* = Disposal costs for ethyl acetate after it is used to exhaustion. 740 lbs is currently generated weekly, at a disposal cost of $.28 per lb., $207.20 weekly or $10,774 annually.

- *Manifesting* = The still will reduce the necessary manifesting activities associated with the handling of ethyl acetate. The still will reduce the manifesting activities from 12 times per year to four, with an average of one and a half hours for each event. Using a wage rate of $30 per hour the annual savings is $360 (8 x 1.5 hrs x $30/hr = $360).
- *TURA Fees Not Incurred* = The still will reduce the facility's MA TURA fees by $1,100 annually.

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[3] Although the 5 percent inflation actually starts to occur during Year 1, for this example the spreadsheet incorporates inflation only in Years 2-5 in order to permit easier understanding of the relationship between the calculations described in these Notes and their location on the spreadsheet.

Total Incremental Savings - PreTax = The total incremental cost reductions from discontinued process less the total additional costs incurred using new process. This represents the cash flow impact that the project will have on the firm each year (excluding depreciation) on a before tax basis.

> *Taxes* - The increased taxes that result from the lower costs of the new system. The installation of the system resulted in lower costs for the firm, therefore, taxable income would be higher. This line represents the additional taxes that the firm will have to pay.

Total Incremental Savings-After Tax = The actual benefits, on an after-tax basis, that the firm will realize from placing the new system into operation, excluding depreciation. *Total incremental savings = (Pre tax savings* less *taxes).*

Operating CF NPV @ 15 percent = The net present value of the after tax operating cash flows, excluding depreciation, discounted at the firm's discount rate. This figure represents the value that is created from the operation of the new equipment.

DEPRECIATION = The value of a piece of equipment that is considered to be "used up" each year. This is calculated for tax purposes and is based on set schedules depending on the type of asset purchased. The amount "used up" each year is taken as a tax deduction in that year. Depreciation represents a nominal cash flow, hence the discount rate should also be expressed in nominal terms.

> *Straight Line Method* = Total capital purchases of the system divided by the useful life of the equipment. In this case it is the cost of the still and its installation allocated over the five year life of the project. [($14,000 + $2,000) / 5 = $3,200]

> *Tax Shield* = This is the tax savings that the depreciation will produce each year, calculated by multiplying the depreciation amount by the tax rate [$3,200 X 40% = $1280.] In this case the firm's taxes will be reduced by $1280 each year due to the depreciation of the equipment. If the firm were in a non-tax paying situation, then there would be no value to this tax shield.

Depreciation NPV @ 15 percent = The net present value of the depreciation tax shield discounted at 15 percent. This figure represents the value that is created from the depreciation tax shield.

Base NPV = This is the net present value associated with the operating cash flows and the depreciation. This is the value that is created from the firm undertaking the proposed project.

Appendix C - P2 FINANCE

P2/FINANCE is a spreadsheet software package designed for data collection and analysis of pollution prevention projects. It is is a flexible tool designed to complement a company's existing project evaluation practices while ensuring that prevention investments receive balanced and unbiased treatment during the capital budgeting process.

P2/FINANCE uses a Total Cost Assessment (TCA) approach, which differs from conventional practices in four key ways:

- a broader inventory of cost and savings,
- allocation of all costs and savings to specific process and product lines rather than to overhead accounts,
- expanded time horizons for the capture of long-term benefits, and
- the use of profitability indicators that incorporate the time value of money.

The accompanying pages provide information about how to obtain copies of the software and User's Guide.

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