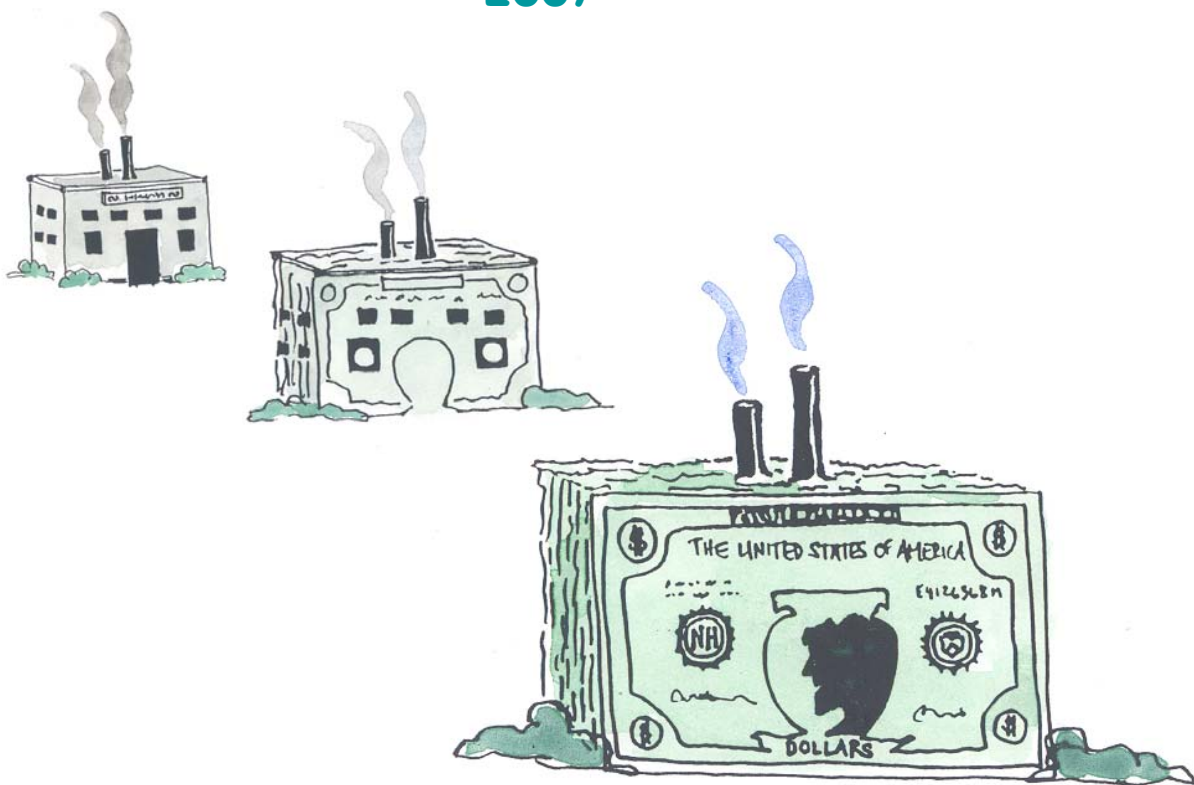

Planning for Profits ...

A Guide to Pollution Prevention
for New Hampshire Businesses
2007



N.H. Department of Environmental Services

Planning for Profits...

A Guide to Pollution Prevention for New Hampshire Businesses

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Introduction

Planning for Profits

“All waste is lost profit.”
-Adolph Coors

How can this guide help me?

\$avings. If you knew there were \$100 bills hidden in your facility, would you take a good look around? Of course! By taking a critical **L**ook at your facility’s operations, you can find ways to save money and improve efficiency.

How? By reducing **WASTE**. Waste means any material, energy, or other resources not incorporated into a product. These resources may be lost in the form of **air** emissions, **water** discharges, **solid** and **hazardous** waste, or **heat**.



When your company generates waste, it means you’re not using resources efficiently. You’re losing money through sewer pipes, air vents, and waste shipments. So, the trick is

to find the cash hidden in your facility before it has a chance to escape.

This guide can help your company reduce waste generation at its source -- **BEFORE** it becomes a pollutant or “lost” resource. That is what **pollution prevention** is all about.

Pollution prevention may be as simple as improving preventive maintenance and fixing leaks. It may also involve upgrading to an energy-saving technology, substituting non-toxic for toxic materials, or making a fundamental change in product composition.

If you want to **increase** profits and reduce your company’s impact on the environment, this guide is for you.

How do I use this guide?

This guide takes you step-by-step through the process of pollution prevention planning.

First, use the manual as a framework for analyzing operations to understand where and why your company generates waste. In doing so, you’ll be able to define hidden costs these wastes impose on your company. Next, try some of the ideas presented in the guide. Finally, consider making pollution prevention planning a part of your overall business strategy.

Many of the tools presented allow you to create charts, diagrams, or other graphics that can serve as effective visuals to discuss environmental issues with employees or management. Because this guide is a generalized overview of pollution prevention planning, you will want to adapt the approaches for your facility’s needs.

Throughout this guide, shaded boxes will refer you to **Appendices** containing worksheets and other helpful information.

Introducing Lincoln Products

To better illustrate pollution prevention planning in action, this guide follows a fictitious company, Lincoln Products, as it goes through the planning process. For the most part, Lincoln Products is based on a real New Hampshire company. A small job shop with about 50 employees, the company manufactures custom-made ball bearing seals and other molded rubber/metal bonded parts.

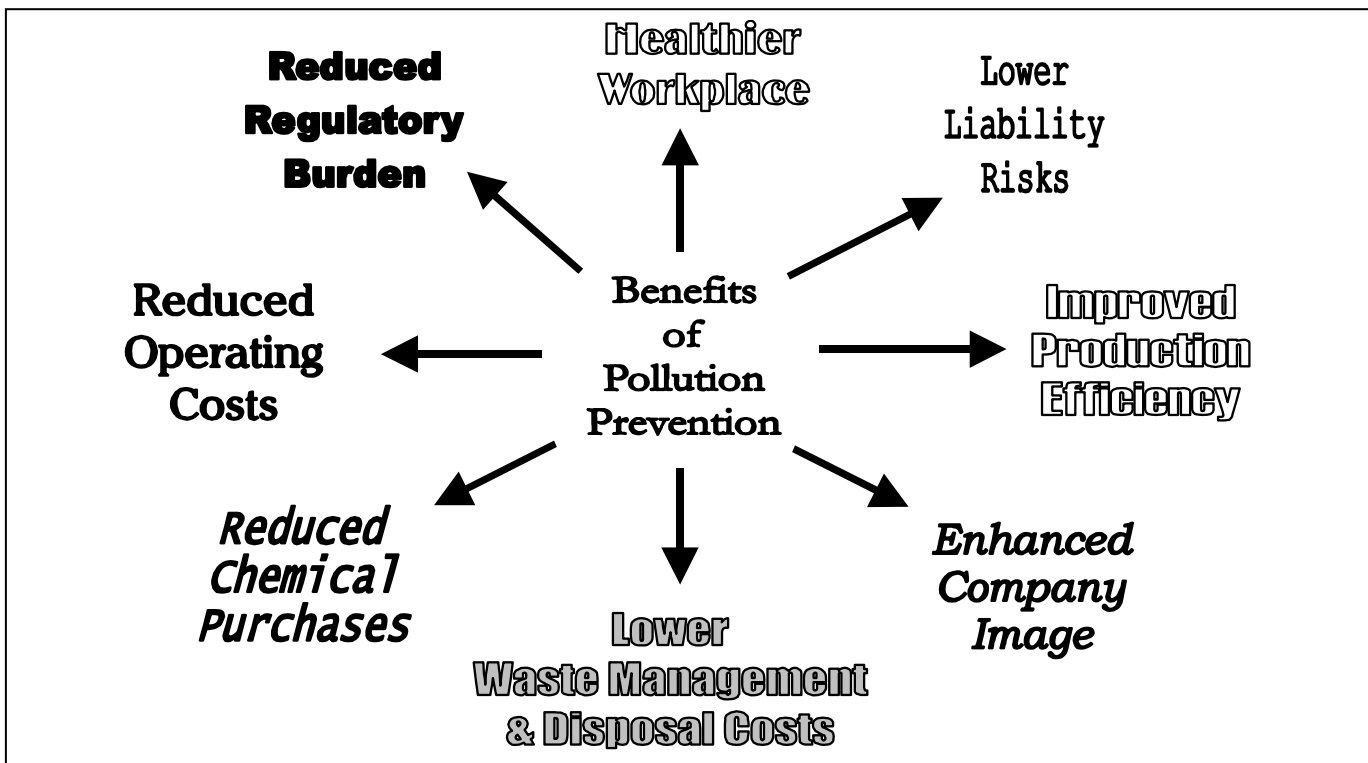


Lincoln Products has always prided itself on its quality manufacturing process, but the company recently received a couple of minor compliance violations, and waste disposal costs seemed to be increasing out of control. Although the company has enjoyed steady growth since it was formed 15 years ago, the management team felt that continuing this trend was going to be possible only if they approached these environmental challenges in a more **systematic** way. Lincoln Products needed a way to anticipate potential problems, instead of simply reacting to them as they arose.

section to see the planning process in action.



The quality assurance manager, who was given the lead on this project, didn't quite know how to get started. To get some ideas, he called the New Hampshire Pollution Prevention Program (NHPPP). NHPPP helps industries in New Hampshire work through the same pollution prevention planning steps you'll find in this guide. Just look for this Lincoln Products logo in each



Six Steps to Savings



**Pollution Prevention
Planning:
An Overview**

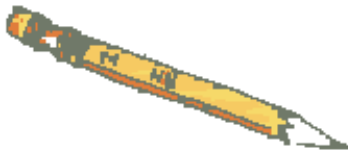
Steps

Six

Step 3

Step 1

Get Organized



Make sure **MANAGEMENT** supports the effort to investigate pollution prevention opportunities and make changes.

Form a **Planning Team**. Individuals from different departments of the plant can play roles in each step of the planning process.

Let everybody know what's going on. **SEEK INPUT** from personnel at all levels. They are your most valuable asset.

Step 2

Analyze Processes



Take a critical *look* at each step of your production process, from purchasing raw materials to shipping finished product.

Pinpoint where materials are used and where wastes are generated.

Figure out **TRUE COSTS** of waste generation, including disposal and regulatory costs.

These costs, along with other factors, will help you **prioritize** losses and **TARGET** your pollution prevention efforts.

Identify Alternatives



The first step to finding effective ways to reduce material losses is to get at the **ROOT CAUSE** of the problem. What factors are responsible for creating the waste? Poor equipment maintenance? Type of raw materials used? Scheduling?

Once you've figured this out, it's time to **be creative**. List as many alternatives as possible for reducing loss.

Use group brainstorming, employee incentives, or outside assistance to generate **ideas**.

\$avings

to

Step 4

Evaluate Alternatives



You may be able to implement the easy, inexpensive projects right away without further study.

For more complex alternatives, determine which are **feasible** based on three major criteria:

- 1. Effectiveness**
- 2. Implementability**
- 3. Cost**

SELECT alternatives for implementation using one or more decision-making tools.

Step 5

Implement Projects



Schedule projects keeping in mind resources, time, and financial constraints.

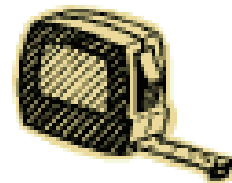
Assign responsibilities for who is going to do what and when.

TALK to the workers who will be affected by the changes you'll make. Include them in the implementation phase.

Stay in touch after implementation, get employee **feedback**, and work out the bugs.

Step 6

Measure Progress



TRACK waste generation, material usage, and cost savings as a result of the changes you've made.

Use a method of measuring pollution prevention that takes into account **variations** in production level.

Document results.

Publicize and **CELEBRATE** your success!

Now **go back to Step 2**. Keep the momentum going. There's **more work** to do.

1 Get Organized

“If you don’t know where you’re going, you’ll end up somewhere else.”
-- Yogi Berra

Get the boss on board.

Management can demonstrate a **commitment** to pollution prevention by launching a program with slogans, logos, and T-shirts or by distributing a simple memo. Either way, it’s the meaningful support of management that is crucial to successful pollution prevention.

The people in charge can show they are serious about examining and, if appropriate, modifying products or operations by:

- Establishing a pollution prevention **policy**.
- Allocating **time** and **money** to pollution prevention planning and implementation.
- Assigning **responsibilities** for tracking progress.
- Incorporating pollution prevention awareness into existing **training** programs for quality, compliance, or health and safety.
- Recognizing achievements through **awards** or bonuses.

Make it a team effort.

Pollution prevention planning requires a variety of skills and access to different types of information. All employees have a role to play at some point in the process -- gathering information, suggesting improvements, evaluating alternatives, or implementing projects. Get a team together to organize these planning activities. By going through the planning process, employees will gain a better understanding of the business and see the true consequences of “business as usual.”

Who should be on the planning team?

The team should be made up of supervisors and workers from different parts of the company to provide a mix of insights, perspectives and expertise.



Employees who are familiar with some of the following issues will be helpful.

- Purchasing/finance/accounting
- Facility and production processes
- Waste management operations
- Quality control requirements
- Environmental regulations

How big should the team be?

It depends on the size of your company. In smaller companies, employees often have multiple responsibilities, and owners are also “workers.” So, the team may consist of only two or three people. In larger companies, the team might include representatives from each department.



Lincoln Products quality assurance manager, John LaBranch, took on the role of pollution prevention planning team leader. He needed to

organize a team, so he announced the pollution prevention planning project at the monthly safety meeting. Since John also had responsibilities for regulatory compliance and

waste management, he needed people with expertise in other areas of the company for the planning team. First, he asked the purchasing manager to participate. Then, after posting a request for participation on the planning team, a couple of interested employees from the production line volunteered. John was now ready to assign responsibilities for reviewing company processes.

Worksheet: Forming a Planning Team

Use this worksheet to jot down ideas about potential planning team members, when the team could meet, and what the team could do to get employees interested and involved in the effort.

1. Our team should be made up of these employees who have ...

- ✓ Familiarity with facility and production processes _____
- ✓ Familiarity with waste management operations _____
- ✓ Understanding of product quality control requirements _____
- ✓ Understanding of environmental regulations _____
- ✓ Good rapport with manager/owner _____
- ✓ Ability to communicate & interact well with other people _____
- ✓ Other qualities that would be helpful _____

2. Our team could meet regularly ...

(e.g., over coffee in the morning? Before or after other meetings you attend together?)

3. Our team could get employees interested in pollution prevention by ...

(e.g., devising a contest for best pollution prevention ideas? Including pollution prevention in training programs?)

2 Analyze Your Processes

"The root of all pollution prevention lies in understanding the process."

author unknown

Understanding *where* and *why* wastes are generated and *how much* they really cost your business is a critical step to finding ways to improve efficiency and save money.

This second step in the planning process involves a systematic assessment of your current operations to see where you should direct your efforts. To analyze your operations ...

1 MAP out the steps in each process.

2 Determine the **AMOUNTS** of raw materials used and waste generated.

3 Determine the **FULL COSTS** of raw materials used and waste generated.

4 TOUR your facility and ask questions.

5 TARGET processes for pollution prevention.

After Step 5, you'll be ready to identify alternatives for reducing wastes in the targeted processes.

1 Map out the steps in each process.

Draw a "picture" showing the **inputs** and **outputs** of each step in the production process, from purchasing raw materials to shipping finished product. Inputs include raw materials, water, and energy. Outputs are products and wastes.

Wastes are any losses, including spills, leaks, evaporative losses, cooling water, cleaning rags, unusable raw materials, sludge, spent chemicals, heat loss, and defective products -- anything not going into a useful product or by-product.

This type of picture, called a **process map**, is a useful tool because it:

- Offers a visual image that shows the relationship between different parts of the process.
- Provides the planning team with a common understanding of day to day operations.
- Pinpoints where your business generates waste.

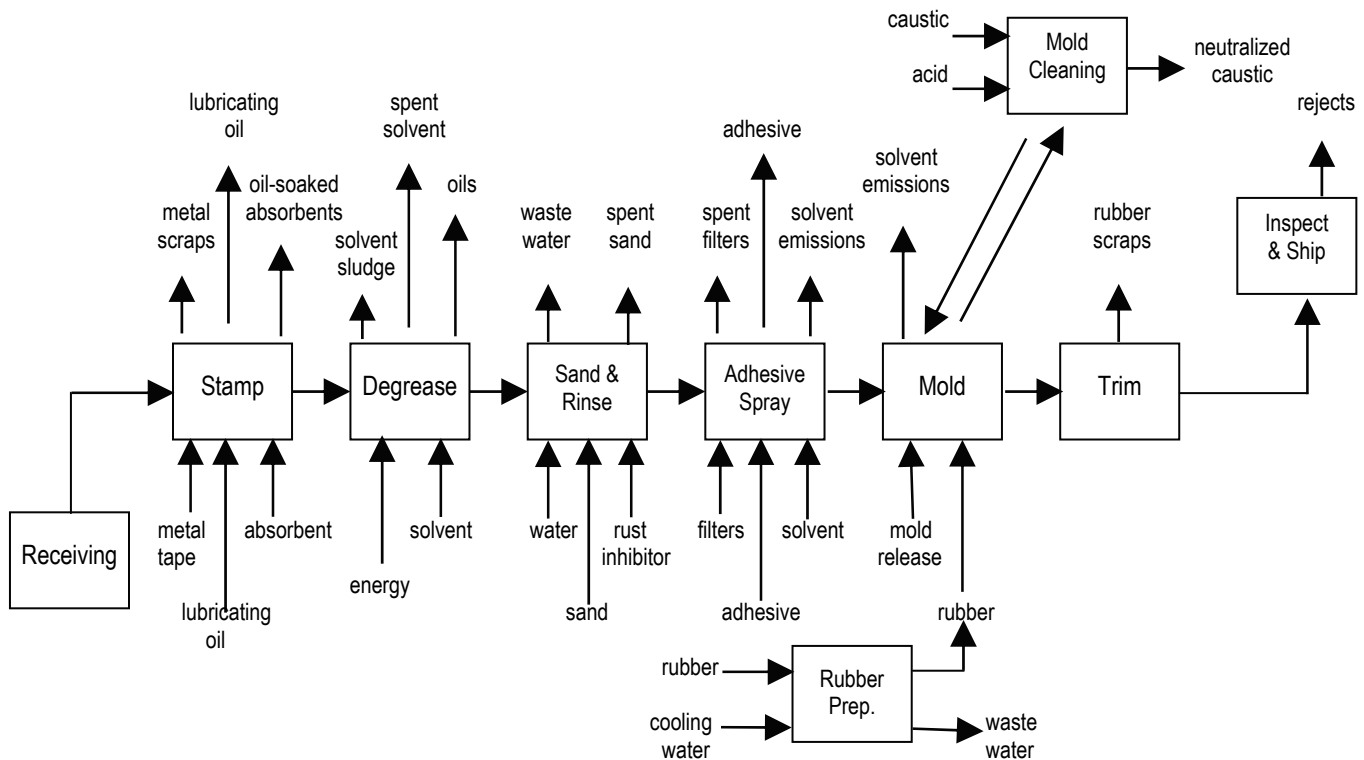
Remember to show steps in your operation that are not directly part of the production process. These activities include **intermittent operations** (e.g., cleaning tank dumps, oil/fluid changes) and **support functions** (e.g., chemical storage, labs, wastewater treatment, boilers). Many cost-saving pollution prevention opportunities can be discovered here.



The next page shows a simplified process map for making ball bearing seals at Lincoln Products.



Process Map for Making Ball Bearing Seals



Process Description

The Lincoln Products manufacturing process starts with the creation of metal washers. These are produced by feeding cold rolled steel ribbon into a **stamping** machine. Lubrication oil is applied by hand using a squeeze bottle. Waste oil is absorbed by clay absorbent and discarded as hazardous waste.

Following stamping, the washers are cleaned in a vapor **degreaser**, which uses trichloroethylene as the cleaning agent. After cleaning, the parts undergo a **surface preparation** step to allow a uniform coating of adhesive to be applied to the metal.

Adhesive is then applied using a standard spray gun. To do this, the parts are placed in a small wire mesh drum in a spray booth. As parts tumble in the drum, an operator sprays on the adhesive.

Overspray from the coating operation is captured by filters, which are changed every few weeks.

After being sprayed with adhesive, the parts are coated with rubber in heated presses. **Rubber is prepared** by heating and extrusion. The hot extruded rubber is cooled with municipal water.

Prior to **molding**, the dies are sprayed with a silicone-based mold release agent. The rubber and metal parts are then molded together. Because the mold release agent tends to build up on the dies, the dies must be routinely cleaned. A hot caustic bath is used. The caustic undergoes pH adjustment before being discharged to the sewer.

Following removal from the mold press, the parts are **inspected, packaged, and shipped**.

2 Determine the AMOUNTS of raw materials used & wastes generated.

For each process, determine the annual amount of raw materials used and wastes generated. The reason for this step is to develop baseline data on your current operations. This information together with cost calculations will help you:

- * **Prioritize** areas that need the most immediate attention.
- * **Evaluate** proposed pollution prevention alternatives.
- * **Measure** success after you have implemented a project.

Where to look for process information

Most of the necessary information may already be in the facility. Your purchasing or accounting department will probably have the information you need on annual purchase amounts. Look for waste information on manifests, permits, and environmental reports.

See Appendix B for more hints on where to look for process information.

3 Determine the FULL COSTS of raw materials used and wastes generation.

First, figure out how much the raw materials cost for each process on an annual basis. Second, calculate what it costs to treat and dispose of each waste in the process. Third, identify the “HIDDEN COSTS” associated with compliance activities.

What are the “HIDDEN COSTS”?

The FULL COST of waste generation includes more than just treatment and disposal costs. You spend a lot of money complying with regulations for wastes your business generates. These environmental expenses are often referred to as hidden costs because they are usually assigned to overhead and not to processes responsible for them. Some of these costs are tough to track down, so using estimates is okay. Costs typically hidden in overhead include activities such as:

Reporting	Monitoring
Recordkeeping	Labeling
Permits & fees	Insurance
Pre-treatment equipment	Waste storage
Safety training	Manifesting
Protective equipment	Inspections

Waste disposal costs are often just a fraction of the full cost of generating the waste. Many pollution prevention projects will not appear to be justified if a company considers only a fraction of the likely savings.

Hidden Costs at Lincoln Products



As business increased, so did the use of regulated materials and generation of waste. Lincoln Products was on the verge of going from a NH Small Quantity Generator to a NH Full Quantity Generator, greater than 220 pounds/month of hazardous waste. The facility was also about to exceed air permitting and reporting thresholds. These are just some of the “hidden costs” it would incur if it continued business as usual:

- \$ Increased hazardous waste inspections, personnel training and reporting requirements.
- \$ Increased preparedness, prevention and emergency posting requirements.
- \$ Hazardous waste disposal fees.
- \$ Air permitting preparation, reporting and maintenance.

THESE REQUIREMENTS COULD ADD UP TO THOUSANDS OF DOLLARS!

4 Tour your facility and ask questions.

Walk through the facility to complete and verify your process maps. **Talk to employees** along the way to fill any gaps in information on material usage or waste generation. Doing so may be especially helpful for learning about intermittent and unplanned activities such as spills, clean-ups, and rinses. Staff responsible for monitoring, manifesting and other compliance activities will be able to help estimate hidden costs.

There are no dumb questions.

Let employees know why the team is conducting the facility assessment and ask for their input. **Ask questions** about why things are done the way they are even if the questions seem **dumb**. You may be surprised by the answer.

Here are a **few key questions** to get the team started:

1. Why is the process or chemical used?
2. What are the consequences of using this chemical or process:
 - ❖ On costs?
 - ❖ On worker health and safety?
 - ❖ On the environment?
 - ❖ On compliance requirements?
3. How can we make the process better?
 - ❖ What if we simply didn't use this chemical?
 - ❖ How can we use it more efficiently?
 - ❖ Can we substitute a safer chemical?

Make the Tour Efficient & Effective.

- See Appendix C to find ...
- Tips for Touring the Facility
 - 10 Questions to Think About During the Walk-Through

5 Target processes for reductions.



Your team has found a number of areas that could use some help. Where do you start? Start by prioritizing pollution prevention opportunities. Consider issues important to your company, such as:

- ☞ Regulatory compliance
- ☞ Cost of raw materials and energy
- ☞ Cost of waste management
- ☞ Worker health and safety
- ☞ Availability of cost-effective alternatives

Start with small projects if you have to, but just get started. Small improvements over the long-term yield **BIG** results in the end.

A picture says it all.

Small companies often need to prioritize opportunities based on cost. A good way to get management's attention is to illustrate the full cost of each waste stream on a pareto chart. You may have heard of the 80/20 rule – about 80 percent of your full costs are caused by 20 percent of your waste streams or activities. This chart makes the most costly waste streams readily apparent.



Targeting waste streams a and b would be a good starting point.

3 Identify Pollution Prevention Alternatives

"Nothing is more dangerous than an idea when it is the only one you have."
- Emile Chartier, Philosopher

Are there any detectives or artists in the crowd?

At this point, your team has zeroed in on a problem you want to fix. The next step in your planning effort is to generate as complete a list as possible of pollution prevention **alternatives** to reduce those losses.

This section offers some methods to help generate pollution prevention ideas. First, get at the root cause of the problem. This may take a little detective work. Secondly, conduct a group brainstorming session to conjure up some *creative* possibilities. Seek employee input to come up with potential solutions too. Finally, consider looking to outside resources if you need help.

Get to the root of the problem.

Businesses generate wastes for a variety of reasons. Unnecessary purchases, outmoded processes, poor employee training and inadequate preventive maintenance often result in lost resources. Your task is to figure out what factors are responsible for creating waste.

Ask Why.

One way to identify the cause of a problem is to ask "why?" several times. Lincoln Products received a compliance violation for exceeding discharge limits on copper.

Therefore, reducing this waste was a **TOP**

PRIORITY. They were considering purchasing ion exchange equipment to remove the copper before discharge. Fortunately, they first decided to ask **WHY** they had so much copper in their wastewater in the first place.



It's a good example of how a company can avoid compliance problems through pollution prevention.

THE CASE OF THE MYSTERIOUS COPPER CONTAMINATION

Why do we have copper in our wastewater?

The mold cleaning bath has high levels of copper in it.

Why does the bath have high levels of copper in it?

Copper from the brass brush used to clean the molds is getting into the hot caustic cleaning bath.

Why does copper from the brush get into the bath?

Brushes remain in the bath between cleanings.

Why are the brushes left in the bath?

Line operators leave them there or drop them in and are unable to retrieve them.

Molds are used to press the rubber and metal pieces of the ball bearing seal together. Molds are cleaned periodically using a brass brush in a hot caustic bath to remove mold release spray and rubber **residue**. Once the team realized that the copper was coming from the brushes, they tested alternative brushes. After having no success, the company created a separate brushing and rinsing station to avoid brushing over the caustic tank.

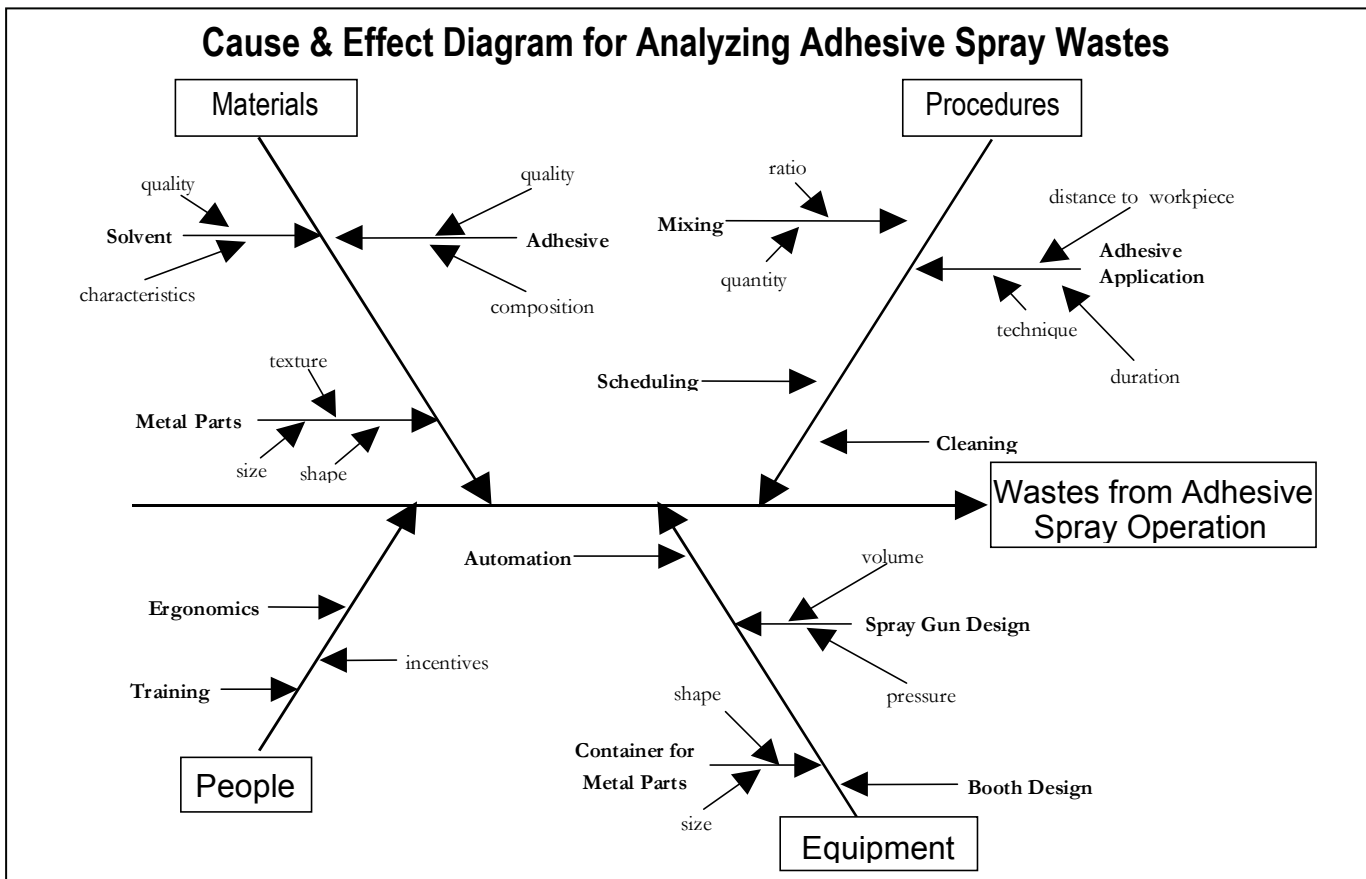
Lincoln Products made a simple change, but it was not simply a "band-aid" solution. This simple change helped the company return to compliance without spending thousands of dollars on ion exchange equipment that still would have produced a hazardous waste.

Create a Cause and Effect Diagram.

A cause and effect diagram is another tool that can help your team understand why a problem occurs or why a waste is generated. It provides a picture that shows everyone what factors affect a process and outlines possible causes of waste to explore in more detail. This type of diagram encourages people to look to many possible causes of a problem instead of simply acting on the first one they identify.



The planning team at Lincoln Products put together the cause and effect diagram shown below to analyze losses from the adhesive spray operation. They targeted the adhesive spray process because solvent use and waste generation (and associated costs) were soaring. Furthermore, the level of solvent use was nearing a threshold that would have triggered the need for an air permit. And that would mean more paperwork and expenses.



The planning team went back to the adhesive spray process to examine the potential causes they had identified. The team found that the conventional spray equipment, application techniques and mixing procedures appeared to have the most significant effect on waste generation. With these major cause categories in mind, it was time for the team to do some **BRAINSTORMING** to come up with possible alternatives to the current process.

Hold a BRAINSTORMING session.

Once your detective work has led you to the most likely cause(s) of a particular problem or loss, hold a brainstorming session. Group brainstorming is an effective technique for generating ideas for solving the problem. It encourages spontaneous free flowing thought—the evaluation comes later.

Think a Cause & Effect Diagram might help your company?
 Appendix D shows how to create one.

The only way to have a good idea is to have many ideas.



BRAINSTORMING TIPS

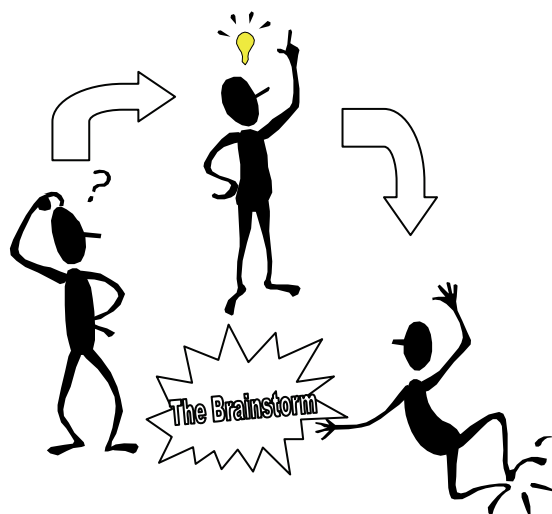
- **Get a diverse group together.** People who aren't directly involved with the targeted process can oftentimes ask the best questions, like why are we doing this in the first place?
- **State the problem clearly** before you begin brainstorming so everyone is looking for an answer to the same question.
- **Visit the work area** and make sure workers involved with the targeted process are in the brainstorming group.
- **Display the process map.** This will help group members visualize changes and explain ideas to others. Look at the processes that occur before and after the step under consideration.

A few rules for the brainstorming exercise will keep creativity flowing and prevent negative thinking from influencing the team members.

Brainstorming Rules

- List every idea.
- No criticism of discussion.
- List even the outrageous alternatives.
- Stress quantity of alternatives, not quality.
- Build on alternatives posed by others.
- Have fun!

Of course, it is not always necessary to go through a formal process such as brainstorming to know what needs to be changed. If you already know what needs to be done, move on to the implementation phase. However, a typical mistake is to settle for an inadequately small list of alternatives to solve a problem. Keep in mind, the more alternatives you consider, the more likely you are to select the one that is best for your plant.



Consider a range of pollution prevention techniques.

Pollution prevention techniques fall along a continuum from fundamental change in products and processes to increased efficiency in what already exists. During your brainstorming session, consider the following six categories of **pollution prevention techniques**:

1 Product Reformulation

Can you reformulate your products to reduce the amount of toxicity of substance in it? For example, paint and ink manufacturers have reformulated products to eliminate heavy metals.

2 Input Substitution

Could any raw materials be replaced with less toxic substitutes? Many metal working firms have replaced chlorinated solvents with aqueous cleaners.

3 Process Redesign

Are there alternative ways of making your product that would cut raw material use or waste generation? Some printed wiring board manufacturers have switched to a direct metallization process for making through-holes conductive. This change eliminates use of formaldehyde and may reduce water and energy usage as well.

4 Process Modernization

Are there ways to modify or replace existing equipment that would cut raw material use or waste generation? Using an automated high volume, low pressure (HVLP) paint spray gun instead of a manual spray gun can reduce overspray.

5 Improved Operations & Maintenance

How can you reduce the needless waste of the materials you store, transport, handle and use? Examples include: computerizing inventory control, repairing leaks, installing overflow alarms and segregating wastes.

Appendix E contains a list of "Good Operating Practices" applicable to all industries.

6 Reuse and Recycling

Can any of your waste be recycled and/or reused, preferably without leaving the production process? One recycling technique involves installing a hard-piped solvent distillation unit capable of reclaiming spent solvents for reuse.



Brainstorming Results. Lincoln Products planning team got together with two adhesive spray operators to list possible ways to reduce losses from the adhesive spray process. This box shows their ideas.

Brainstorming Session

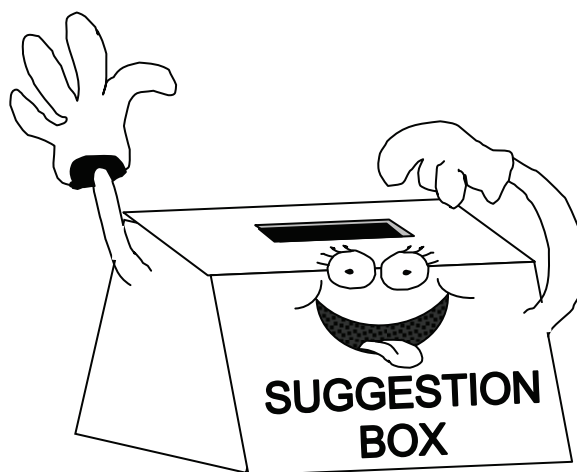
GOAL: Reduce adhesive spray wastes.

- *Use washable filters, reuse solvent.*
- *Use solvent still to recover/reuse solvent.*
- *Use electrostatic charge to apply adhesive.*
- *Reuse gun cleaning solvent to thin adhesive.*
- *Switch to more efficient spray gun.*
- *Spray for shorter duration.*
- *Clean guns less frequently.*
- *Install spray gun washer unit.*
- *Dip parts rather than spray.*
- *Improve training for mixing and spraying.*

Once your team has a list of alternatives, the next step is to evaluate which project(s) to implement.

Encourage employee participation.

In many cases, the people working on the shop floor already have ideas for reducing waste, but have never had the opportunity to express them. Develop an easy way for employees to make suggestions. Offer a bonus or other incentive for workers who come up with ideas that are used. Or, publicize your pollution prevention efforts with an event, like a facility-wide pollution prevention contest.



Seek outside help.

To supplement your lists of ideas, consider turning to external sources of pollution prevention information. Talk to vendors. Get in touch with your trade association or industry peers. Look in industry-specific journals and books. Attend workshops and industry trade shows.

Call one of the many technical assistance resources available to New Hampshire companies. These resources will provide your team with assurance that it has not overlooked simple proven techniques already used by other companies.

See **Appendix A** for a list of technical assistance resources.

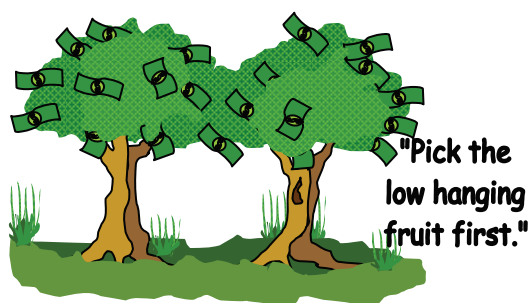
4 Evaluate Alternatives

**“Treating Pollution is an expense.
Preventing it is an investment.”
-author unknown**

Sounds good; is it right for us?

Your team has generated a long list of pollution prevention alternatives for each targeted process. The next step is to determine which projects are feasible and **prioritize** them for implementation.

First, eliminate alternatives that are clearly unacceptable. Screen out any ideas that merely **shift** pollutants from one waste stream to another, or that treat or recycle waste after they have already left the process.



Alternatively, you might find that some ideas are so straightforward, inexpensive, and effective that no further assessment is needed in order to implement them. Make these cost-effective, low-tech pollution prevention changes first. These types of projects typically involve training and awareness, procedural changes, waste stream segregation, improved maintenance, and inventory control. Payback is often immediate. Move on to more capital-intensive alternatives as time and money permit.

Determine what's feasible.

Judge the advantage and disadvantages of the more complex alternatives based on three key criteria -- effectiveness, implementability, and cost.

1. Effectiveness

What is the alternative's potential for reducing losses from the process under consideration?

For example, the proposed project may eliminate or reduce use of a hazardous material, or allow your company to recover valuable by-products.

2. Implementability

Will the alternative work for us? Your team will want to know how easy or difficult it will be to implement the project in terms of:

- System requirements and equipment reliability.
- Production and product quality issues.
- Worker acceptance and staffing needs.

Appendix F is a checklist your team can use to assess environmental, technical and personnel issues for proposed projects.

3. Cost

What will the alternative cost? Will it be profitable? Realistically, the selection of a pollution prevention alternative will be heavily based on how it affects the bottom line. Every company has its own approach to the economic evaluation of capital investments, and each uses different criteria to justify these investments. Make sure your economic evaluation fits in with your company's approach.

Once again, be sure to consider how the proposed project affects environmental costs. Perhaps your project will reduce regulatory requirements or lower liability concerns. Standard cost analyses often overlook these sources of potential savings.

For more details on conducting an economic evaluation of pollution prevention projects, see **Appendix G**.

Keep a permanent record of the alternatives considered and your reasons for rejecting those you do not implement. This may help you avoid repeating this effort in future years.



For those alternatives you do want to implement, documenting the evaluation results will come in handy when it comes time to sell the project to management.

Select alternatives for implementation.

“Bubble up/Bubble down” is a neat trick for deciding among a large number of pollution prevention alternatives. First, the team lists the alternatives for a given process on a flip chart. Then, the group discusses the first two alternatives on the list to decide which of the two is “BETTER” in terms of effectiveness, implementability and cost. The better one “bubbles up” to the top of the list.

Next, the team looks to the next unique pair. If item ② bubbled up on the last round, the next unique pair would be ① and ③. If not, the next unique pair is ② and ③. As alternatives are added to the list, they become part of new pairs to be evaluated. For example, if the team decides that ⑥ is better than ⑤, it then asks whether it is also better than ④. If so, is it better than ③, and so on. When the alternative stalls, the team goes back down the list to find the next unique pair and the process continues. Feasible alternatives readily bubble up, while the not so good ones quickly bubble down.

Criteria Matrix

Another way to decide among pollution prevention alternatives is to use a criteria matrix. The first step is to list the alternatives down one side of a table. The team selects criteria to be considered and writes them across the top of the matrix. The matrix below uses effectiveness (E), implementability (I) and cost (C) as the criteria. Your team may choose to consider more specific criteria such as those used for targeting processes in the first place, e.g., compliance, health and safety, waste reduction, reduced costs, energy use.

Next, the team must agree on a scoring system, such as rating on a scale of 1 to 10 or 1 to 5. Some teams use a scale of +, -, 0. Finally, rate the alternatives and total the scores.



After eliminating alternatives that were clearly infeasible, the Lincoln Products team used a criteria matrix to select alternatives for minimizing adhesive spray wastes. They used a five-point scale. Two alternatives received a score of 15 -- switching to automated HVLP spray guns and reusing spray gun cleaning solvent to thin the next batch of adhesive. They also decided that training operators to mix the amount of adhesive appropriate for a given job more accurately (score of 13) was also worth a try—a no-cost way to reduce waste.

Lincoln Products Criteria Matrix

Alternatives to reduce adhesive spray wastes

Alternative	E	I	C	Total
1 use washable filters	2	3	4	9
2 install solvent still	3	4	3	10
3 reuse gun cleaning solvent	5	5	5	15
4 use HVLP spray guns	5	5	5	15
5 paint gun washer unit	3	4	3	10
6 improve training	4	4	5	13
7 clean guns less frequently	2	5	5	12
8 spray for shorter duration	2	5	5	12

E=Effectiveness; I=Implementability; C=Cost

5 Implement Projects

"Try? There is no try. There is only do or not do."
Yoda, in *The Empire Strikes Back*

Schedule projects and set goals.

Your team may find a pollution prevention alternative that would benefit your company for each of the targeted processes. The projects selected are both technically possible and profitable. However, few companies are able to invest immediately in every project that appears promising. Resource, time and capital *constraints* often make it necessary to set *priorities* and implement changes over time. So, schedule projects for implementation with these constraints in mind.

Implementation Schedule

Project	Start Date	Target Date	Goal	Leader
1				
2				
3				
4				
5				

Establish a **timeline** for each project and assign responsibilities for who is going to do what and when. Schedule *simple investments* first because they provide **quick**, money-saving results. Achieving obvious successes early on helps keep the momentum going.

Once your team knows what changes will be made, set goals for each pollution prevention project. Goals should be easily understood, easily measured, supported by the people they affect, and realistically achievable. A goal might be "25 percent reduction in rubber scrap per part produced," or a goal may be to eliminate a cleaning operation all together.

Step 6: Measure Progress discusses how to evaluate performance.

Questions about Financing your Project?
The NH Small Business Development Center can help. Refer to **Appendix A**.

Tips for successful implementation

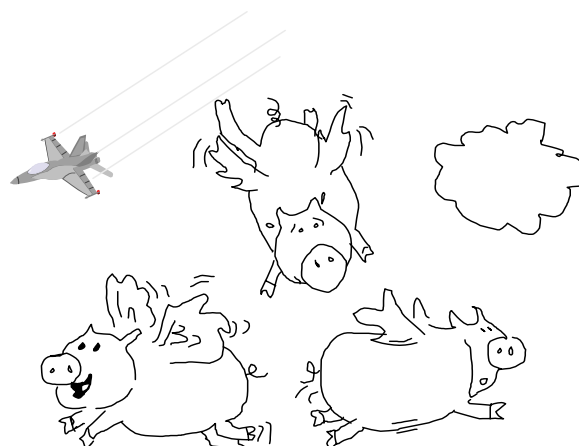
To ensure success, your company will need to get the active cooperation of all employees. Lincoln Products offers these **3 Tips** to help make implementation go smoothly.



Tip #1: Involve Employees. Make sure the people who are affected are involved with implementing the change from the very start.

Tip #2: Provide Training. Provide the necessary training for workers to operate the new equipment and to use new procedures. Explain the environmental and financial advantages of the new way of doing things.

Tip #3: Stay In Touch. Implementation doesn't end with the installation of new equipment and/or new work practices. Encourage comments from all affected workers. Be prepared for fine tuning.



"...and they said it couldn't be done."

6 Measure Progress

"Not everything that can be counted, counts.
Not everything that counts, can be counted."
Albert Einstein

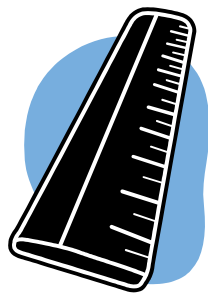
Is it Working?

Tracking the progress of each project is critical to show that your investment was worth it and that material losses are being reduced. Documenting successes also sets the stage for additional pollution prevention. The best way to measure progress of your pollution prevention project is to:

- 1 **Calculate cost savings.** Is the project meeting expected economic benefits, e.g., net operating cost savings, payback? Compare actual savings to those projected in your economic evaluation in **Step 4** of the planning process.
- 2 **Calculate changes in waste generation of material use** as a result of the pollution prevention project. Use the materials accounting and waste generation information your team collected as part of **Step 2** in the planning process as the basis for comparison.

Account for production variations.

If quantities of waste or chemical use decrease after your company introduces a pollution prevention technique, the improvement might be attributed to the pollution prevention effort ... or it might have happened because production decreased during that period. To get an **accurate measure** of losses prevented as a result of a pollution prevention project, correct for changes in production rate. One way to do this is by measuring material use or waste generation per **unit-of-product**.



Selecting a unit-of-product

A unit-of-product is a measure that reflects the level of production or activity associated with the use of a material or generation of a waste. For some firms this will be as easy as keeping track of the amount of product produced annually, e.g., a chair manufacturer could use the number of chairs. For other facilities, this might not be a simple issue. Other measures of production levels should be used, such as pounds, square feet, or gallons of product manufactured.

Examples of Unit-of-Product Used by Different Industries	
Industry	Unit-of-Product
metal finishing	ft ² of substrate plated or coated
paper recycling	tons of paper produced
electronics	# of passes substrate makes through process
pharmaceutical	kilogram of product produced

Lincoln Products had several choices for its unit-of-product, including:



- ◆ Number of finished products made.
- ◆ Mass of metal produced.
- ◆ Surface area of metal processed.

Number of products was rejected because it fails to account for the wide range of sizes and shapes of the products, which affects the amount of chemicals used. **Mass of metal produced** was eliminated because it was not directly related to the amount of material used or waste generated in the adhesive spray process.

Surface area of metal processes was chosen as the unit-of-product because it is directly related to material use and waste generation in the adhesive spray operation.



The Lincoln Products team measured the success of their new automated HVLP system for applying adhesive. To measure the percent reduction in solvent use while adjusting for increased production, they used this formula:

$$\% \text{ Reduction} = \frac{(A - B) \times 100}{A}$$

A = annual solvent use BEFORE project unit-of-product

B = annual solvent use AFTER project unit-of-product

The company used 1,800 gallons of solvent during a year when they processed 325,000 square feet of metal. After the new system was implemented, they used only 660 gallons of solvent while INCREASING the annual production rate to 500,000 square feet metal processed.

$$\% \text{ Reduction} = \frac{(1800 \text{ gal./}325,000 \text{ ft}^2) - (660 \text{ gal./}500,000 \text{ ft}^2) \times 100}{1800 \text{ gal./}325,000 \text{ ft}^2}$$

= 76% Reduction!

By implementing this pollution prevention project, Lincoln Products achieved:

- ☞ **A 76% reduction in solvent use per square feet** of metal processed compared to what they would have used with their previous spray system.
- ☞ **Annual savings of \$24,000** as a result of decreased costs in:

Waste disposal	\$6,000
Solvent purchases	\$18,000
- ☞ **Avoided regulatory costs** (potentially thousands of dollars) they would have incurred had they continued to use solvent and generate waste at their previous rate.


Does your company submit an Annual Hazardous Waste Report to the New Hampshire Department of Environmental Services? Measuring progress using the method shown here will put you in a good position to answer questions about your company's waste reduction efforts.

Publicize success stories

Early successes can help build enthusiasm for pollution prevention among workers and management--perhaps making it easier to gain approval and funding for future pollution prevention changes. So, document the results of your projects and let everyone know how these changes are working out.

Appendix H contains a sample form for documenting pollution prevention progress.

Here are some other ways to highlight achievements ...

- Recognize the efforts of individuals who provided suggestions that were implemented. Cash awards wouldn't be a bad idea.
- Use a newsletter, memo, or bulletin board to highlight project savings, waste reductions, energy savings and product quality improvements resulting from pollution prevention projects.
- Grab some positive media attention by putting together a news release for local newspapers. Emphasize benefits for the company and for the surrounding community.
- Apply for the Annual Governor's Award for Pollution Prevention and get the recognition you deserve. 

See Appendix J for more information about the Pollution Prevention awards.

Next Steps...

Planning for the Future

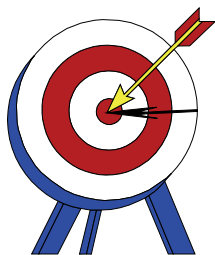
"The trouble with our times is that the future is not what it used to be."

Paul Valery

Repeat the planning process.

If pollution prevention is to take root and prove genuinely successful in your facility, make sure your pollution prevention team doesn't wither after it has made a few improvements. Repeat the steps outlined in this guide to search for new pollution prevention opportunities.

Update process maps and **revisit** your list of opportunities on a scheduled basis. Develop more accurate data on material use and waste generation. Select **new targets** for pollution prevention efforts.



Remember that pollution prevention alternatives take shape against the backdrop of pending regulations, shifting costs of raw materials and disposal, and changing public concerns and customer demands. Being aware of these changes can help you identify new pollution prevention opportunities or make a case for changes that might previously have been unattractive.

Integrate pollution prevention into business practices.

Each successful pollution prevention experience provides incentive for management to support and diversify pollution prevention within your company. With time, pollution prevention can become a natural part of the company's infrastructure and operating practices. For example, as your company develops new processes or products, you may consider how to design them with pollution prevention in mind.

The Quality Connection

If your company has embraced the principles of TOTAL QUALITY MANAGEMENT (TQM), you will recognize that pollution prevention and **TQM** share central beliefs. Like **TQM**, pollution prevention requires the active and sustained commitment of a wide range of personnel: from top management, to purchasers, to research and development personnel, to production line workers. Both programs also call for continuous incremental improvements, each of which moves your firm closer to the ultimate goal of best possible quality or of least possible losses. Use your quality management system to integrate and sustain pollution prevention efforts.

Environmental Management Systems

Is your company ready to take environmental management a step further? Pollution prevention planning provides a foundation for developing an **environmental management system (EMS)**. An EMS is a more formal and comprehensive way to review and improve operations for better environmental performance. An **EMS** can cover pollution prevention, energy use, natural resource issues, regulatory compliance, emergency planning, communication with interested parties and other environmentally-related issues. With an **EMS**, environmental issues can become integrated into all facility operations.

Every company can benefit from an EMS, regardless of whether the facility chooses to pursue ISO 14000 certification. (ISO 14000 is the international standard for environmental management, much like ISO 9000 is the standard for quality management.) An EMS can help your company meet business and environmental goals.

NOTES

APPENDICES

Appendix A

Technical Assistance Resources

New Hampshire Pollution Prevention Program (NHPPP)

The NHPPP is a free, confidential, non-enforcement, compliance and pollution prevention assistance program for businesses, municipalities and institutions in New Hampshire. NHPPP offers:

- On-site compliance and pollution prevention assistance
- Confidential regulatory research
- Multi-media pollution prevention technical research
- Conferences, workshops and presentations
- Annual Governor's P2 Award program
- *Wastelines* newsletter

Contact: Sara Johnson
 NH Department of Environmental Services
 P.O. Box 95
 Concord, NH 03302-0095

Phone: (603) 271-6460
 Toll-free in NH: (800) 273-9469

e-mail: nhppp@des.nh.gov
 NHPPP web: www.des.nh.gov/nhppp/

Small Business Technical Assistance Program (SBTAP)

The SBTAP is a free, confidential non-enforcement technical and compliance assistance program for small business. SBTAP offers:

- Small Business Ombudsman
- Regulatory and permitting assistance with a focus on Clean Air Act requirements
- Workshops and conferences
- Technical assistance for pollution control and pollution prevention technologies

Contact: Rudy Cartier
 NH Department of Environmental Services
 P.O. Box 95
 Concord, NH 03302-0095

Phone: (603) 271-5629
 1-800-837-0656
 FAX (603) 271-1381

E-mail: sbtap@des.nh.gov
 SBTAP web: www.des.nh.gov/sbtap/

Technical Assistance Resources *(continued)*

Occupational Safety & Health Consultation Program

The OSHA Consultation Program is a free, on-site assistance program to help businesses identify, evaluate and correct workplace hazards. OSHA Consultation Program offers:

- On-site OSHA assistance for any size business
- Health and Safety plan development
- Identification industrial hygiene issues
- Regulatory research
- Workshops and presentations

Contact: Stephen Beyer
NH Department of Environmental Services
P.O. Box 95
Concord, NH 03302-0095

Phone: (603) 271-2024
Toll-free in NH (800) 852-3345 ext 4676

OSHA Consultation Web:
www.des.nh.gov/ARD/EHP/index.html

Small Business Development Center (SBDC)

The SBDC Compliance Assistance Program provides free, confidential business counseling service to any small NH business. SBDC offers:

- Business/financial planning and counseling
- Management seminars
- Environmental compliance counseling
- Assistance with loan applications

Contact: Andrea O'Brien
Small Business Development Center
Rivier College - Sylvia Trotter Hall
400 Main Street
Nashua, NH 03060

Phone: (603) 897-8484
E-mail: aobrien@rivier.edu
SBDC web: www.nhsbdc.org/eap.htm

Pollution Prevention Intern Program

The University of New Hampshire Pollution Prevention Intern Program teams chemical engineering students with companies interested in implementing pollution prevention projects. Students are trained in pollution prevention strategies and companies define and supervise student work.

Contact: Dr. Ihab Farag
UNH Chemical Engineering Department
255 Kingsbury Hall
Durham, NH 03284

Phone: (603) 862-2313
UNH P2 web: www.unh.edu/chemical-engineering/pp2.html

Technical Assistance Resources *(continued)*

Internet P2 Resources List

Regional P2 Resources:

Pollution Prevention Resource Exchange	www.p2rx.org/
Northeast Waste Management Officials Association	http://newmoa.org/prevention/
Toxics Use Reduction Institute	www.turi.org/

National Resources:

US Environmental Protection Agency Pollution Prevention Program	www.epa.gov/ebtpages/pollutionprevention.html
National Pollution Prevention Roundtable	www.p2.org/

Commercial P2 Websites:

Cleaner Production	www.cleanerproduction.com
Toxic Use Reduction Institute Solvents Alternatives	www.cleansolutions.org/
Solvents Alternatives Guide	http://clean.rti.org/
Coatings Alternatives Guide	http://cage.rti.org/

Appendix B

Where to Look for Process Information

1. ENVIRONMENTAL RECORDS

- SARA 313 Form R
- Hazardous waste manifests and annual reports
- POTW or NPDES Permits
- State air source registration records
- Laboratory waste analyses and flow measurements
- Previous environmental reports

2. PROCESS SCHEMATICS

- Facility blueprints
- Schematics of storage, processing and shipping areas
- Piping diagrams
- Process maps or other process descriptions
- Equipment lists

3. TECHNICAL DATA ON SUBSTANCES AND PROCESSES

- Material Safety Data Sheets (MSDS)
- Maintenance procedures and records
- Production line scheduling records
- Production line job sheets, batch make-up records and mix tickets
- Equipment operating manuals

4. TECHNICAL DATA ON PRODUCTS

- Customer specification
- Quality control records
- Product data sheets

5. OTHER BUSINESS OPERATIONS RECORDS

- Chemical inventory records
- Chemical purchasing data
- Product sales records
- Waste transporter invoices
- Scrap sales and recycling records

6. FINANCIAL RECORDS

- Department cost accounting reports
- Treatment and disposal cost records
- Chemical purchasing cost records

Appendix C

Tips for Touring the Facility

- Schedule the tour and publicize it in advance.
- Let workers know why you are doing this; ask for suggestions for improvement.
- Examine intermittent operations such as maintenance procedures.
- Cover all areas where materials are used or processed.
- Follow the path the materials take, from the receiving dock, along the process flow, and ending with the product storage and shipping areas, as well as waste treatment or storage areas.
- Check the actual process against the process maps your team has created.
- Ask why things are done in a particular way. Remember, there are no dumb questions.

Ten Questions to Think About During the Walk-through

1. Does our facility show signs of poor housekeeping, e.g., cluttered walkways, unswept floors, uncovered drums?
2. Where do we notice waste being generated from the processes in our facility, e.g., dripping water or steam, leaks, spills, evaporation, drag-out?
3. Is there discoloration or corrosion on walls, work surfaces, ceiling and walls or pipes? This may indicate system leaks or poorly maintained equipment.
4. Where do we see smoke, dirt, or fumes to indicate material losses?
5. Do we smell strange odors, or experience eye, nose or throat irritation when we first enter the workplace? These symptoms might indicate system leaks, etc.
6. Are there open containers, stacked drums, shelving too small to properly handle inventory, or other indicators of poor storage procedures?
7. Are all containers labeled as to their contents and hazards?
8. Is emergency equipment (fire extinguishers, spill kits, phones) available and visible to ensure rapid response to a fire, spill, or other incident?
9. Is scrap, or are off-specification parts lying around?
10. Check inventory. Is any out dated stock, or materials still in storage that we no longer use? Is stock managed by "First in-First out" procedures?

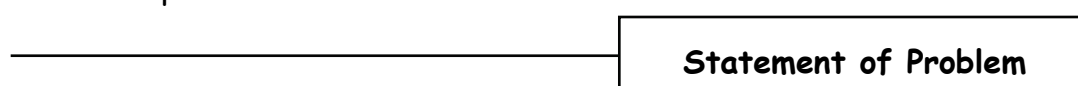
Appendix D

How to Make Cause & Effect Diagram

[Adapted from Pojasek, R. B. (1996) "Using Cause and Effect Diagrams in Your P2 Program." Pollution Prevention Review 6(3):99-105]

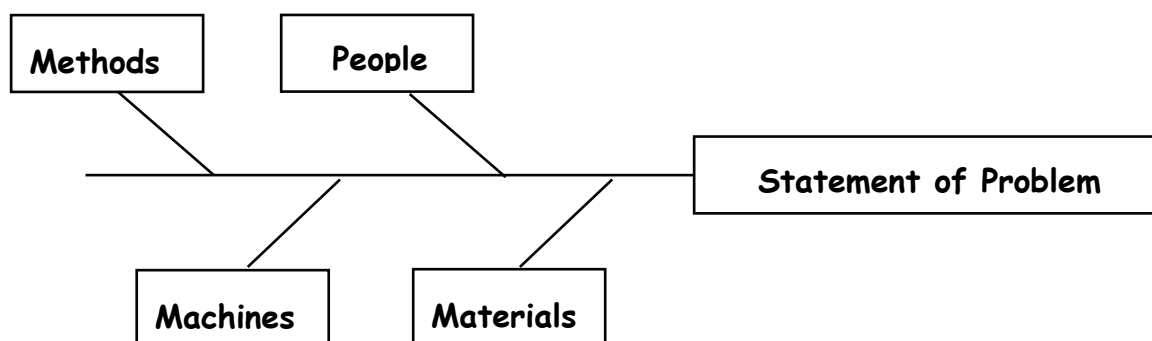
Cause and Effect Diagram

A cause and effect diagram is a valuable problem-solving tool for gathering information on common pollution prevention problems, such as losses of raw materials or hazardous constituents from a manufacturing process. To construct the diagram, draw a horizontal line with a box on the right hand side. In the box write the loss that the team has selected to focus on. It is useful to think of the loss or waste as the effect and some aspect of the production process or operation as the cause.



Cause Categories

Four basic cause categories are typically used: People, Machines, Methods and Materials. Other cause categories may be added (e.g., surroundings, measurement, policies). Cause categories are placed in boxes at the end of diagonal lines radiating out from the horizontal line.



Think about what each of these categories means.

- **People** includes all workers and managers, plus factors such as their knowledge, training, certification capabilities, and attitudes.
- **Methods** focuses on issues such as process work flow, work procedures, and standard operating procedures.
- **Machines** includes all machinery, equipment, and instrument controls, as well as factors such as adjustments, maintenance, and tooling capability.
- **Materials** includes all expendable inputs to the process and their characteristics, such as supplies, changes, and variability.

APPENDIX D (continued)

How to Make a Cause & Effect Diagram (continued)

Working through the Cause and Effect Diagram

The team can start with any major cause category to identify potential causes for the loss or waste. For example, they might start with "people." They could ask questions such as:

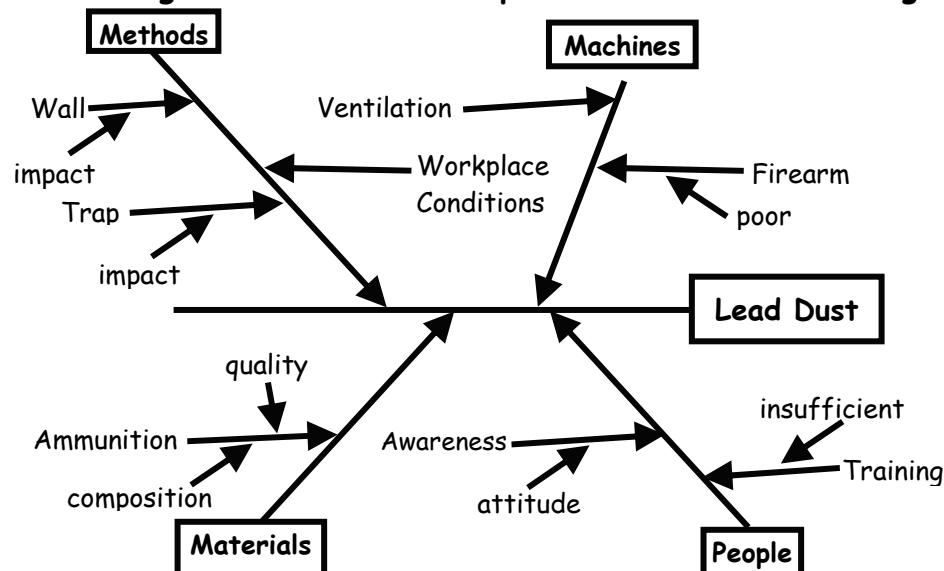
- What are people doing that cause the loss to exist?
- Why are people doing what they are doing?
- Who are the people involved, i.e., what job classification?
- When are people causing this loss?

Enter the answers to all the questions on the diagram, then move on to another cause category. Repeating sub-causes in several places is acceptable if the team feels there is a direct relationship. This effort will ensure that the team creates a complete diagram and fully understands the issues. If questions are slow in coming, use the major cause categories as catalysts. For example, "What in our methods is causing ...?" or "What in our materials is causing ...?"

Refining the Analysis

When the initial effort is complete, the team should review each major category. Look for causes that appear in more than one category. This is an indication of a "most likely cause." You can also poll the team members or estimate the percentage that a given cause contributes to the problem in order to come up with additional "most likely" causes. Circle these causes on the diagram. Next, review the most likely causes and ask: Why is this a cause? Asking the "why" question will help you get to the root cause of the problem. Show the diagram to a few other people to get their opinion. Consider posting it in an accessible location and allowing many people to get involved in working on and understanding the process. The completed cause and effect diagram can then help a team to prepare to "brainstorm" a variety of alternatives for addressing the loss.

Cause and effect diagram for a lead dust problem at an indoor firing range



APPENDIX E

Good Operating Practices

Employee Awareness and Education

Provide training for:

- Operation of the equipment to minimize energy use and material waste.
- Proper materials handling to reduce waste and spills.
- Importance of pollution prevention in terms of economic and environmental ramification.

Purchasing

- Use "just in time" ordering system.
- Establish centralized purchasing programs; track and record chemical purchases.
- Order reagent chemicals in exact amounts.
- Encourage chemical suppliers to become responsible partners, e.g., accept outdated materials.
- Review material procurement specifications.
- Avoid collecting free samples of process chemicals from vendors—only accept amounts needed for testing purposes.

Storage

- Utilize a dedicated/protected storage area.
- Space containers in storage areas to facilitate inspection.
- Label all containers.
- Stack containers according to manufacturer's instruction to prevent cracking and tearing.
- Separate incompatible materials in storage, e.g., cyanides and acids.
- Raise containers off the floor in storage area to inhibit corrosion from "sweating" concrete.

Handling/Use

- Track material use.
- Pre-inspect parts to prevent processing of obvious rejects or pre-cleaning of "clean" parts.
- Establish written procedures for process formulation and additions.
- Use a minimum of non-hazardous materials (e.g. absorbent, water) to clean up hazardous spills.
- Use process baths to the maximum extent possible.
- Implement Statistical Process Control to improve efficiency of chemical use.
- Eliminate obsolete processes and/or unused or infrequently used processes.
- Reuse cleanup solvent.
- Use mechanical wipers on mixing tanks.
- Use a cleaning system that avoids or minimizes solvents; clean only when needed.

Preventive Maintenance

- Maintain equipment history cards on equipment location, characteristics, and maintenance.
- Maintain master preventive maintenance schedule.
- Keep vendor maintenance manuals handy.
- Maintain a manual or computerized repair history file.

Good Operating Practices (*continued*)

Waste Segregation

- Prevent mixing of hazardous waste with non-hazardous wastes.
- Store material in compatible groups.
- Include careful labeling to ensure identification of wastes which have the potential for recycling or resale.

Leak/Spill Prevention and Control

- Employ a controlled method of adding makeup water to process tanks.
 - Install overflow alarms on all process tanks.
 - Construct secondary containment with segregation that would permit reuse of spilled material.
 - Prevent/contain spills and leaks by installing drip trays and splash guards around processing equipment.
-

APPENDIX F

Feasibility Checklist for Pollution Prevention Strategies

Equipment

1. Does this option have a proven track record?
2. Will the vendor guarantee this system?
3. Are materials and parts readily available?
4. Can the system be serviced easily?
5. Is there vendor support throughout system's start-up, testing, training and repair?
6. Does the system require new utilities?

Environmental

1. Will this option decrease the volume of waste or decrease the use of hazardous materials?
2. Could this option shift pollutants from one media to another (i.e. air to water)?
3. Will new permits be required?
4. Will this option decrease regulatory requirements?

Product & Production

1. Will this strategy affect production speed?
2. Will this strategy affect product quality?
3. Can the equipment fit in existing space?
4. Will installation stop production? How long?

Employees

1. Will this strategy require more staff?
2. Does the strategy reduce or increase health or safety problems?
3. Will employees require training for this strategy?
4. Will employee resistance to change be an issue?

APPENDIX G

Economic Analysis of Pollution Prevention Projects

An economic analysis of a pollution prevention project can assist a company in determining if that particular investment will add economic value to the company. This value can be assessed by calculating cash flows over the life of the project and applying measures of profitability. However, many of the costs and potential savings of pollution prevention projects are not included or are underestimated in conventional financial analysis.

Traditional cost categories include direct materials, direct labor, and overhead. Many indirect costs may be hidden in the overhead category and traditional financial analysis may underestimate the potential savings from a pollution prevention project. Also, conventional cost accounting might not evaluate the project over a sufficiently long time period and usually does not consider numerous important qualitative issues, possibly causing the pollution prevention project to be rejected.

What can you do to overcome some of these obstacles and to determine the true costs and savings of a pollution prevention project? This summary can help by covering the basic financial evaluation of a pollution prevention project, including the following steps:

1. **Collect cost information on current process and proposed project costs.**
2. **Apply measures of profitability.**
3. **Consider less tangible costs.**

Use this analysis on one small project first to see how it might work, or try portions of the analysis as your time and resources allow. Use the **WORKSHEET** at the end of Appendix G to gather cost information.

1. Collect cost information.

The first phase of the financial analysis of a pollution prevention project entails gathering complete and accurate data for costs that have a material impact on the decision and that are useful to those who evaluate the project proposal. All costs should be converted to total annual amounts in order to perform the financial analysis with common metrics. The following procedures can be used to determine these costs.

Economic Analysis of Pollution Prevention Projects (continued)

- A. Use the cost information your team gathered as part of Step 2 in this planning guide for all the labor activities, materials equipment and other operating expense items that are involved in the targeted production process and secondary processes. Be aware of costs related to the tracking, treatment and disposal of waste, and those related to purchasing, handling and using hazardous chemicals.
- B. Identify all the places where labor activities, material, equipment and other operating costs are likely to change.
- C. Determine the costs in the current process and in the proposed project for those activities and items that will change because of the proposed project.
- D. Calculate the differences between the current and proposed processes. Be sure to express the costs in after-tax amounts. For example, depreciation of equipment will reduce the taxable income of a company.

2. Apply measures of profitability.

A measure of profitability is a single number that is calculated to characterize project profitability in a concise, understandable form. There are three common methods, or measures of profitability, used to assist the decision makers in a financial analysis to determine if a pollution prevention project will add economic value to a company:

- A. Payback period**
- B. Net Present Value (NPV)**
- C. Internal Rate of Return (IRR)**

Each method is briefly explained here, including appropriate uses, advantages, and limitations. If you do not have a background in financial analysis or feel you do not have time to perform numerous calculations, don't despair! There are numerous spreadsheets and relatively straightforward computer programs that can do most of the work for you. If you have identified and collected cost and savings information, you have already done much of the work.

For example, you can download "[P2/FINANCE](#)" from EPA's website. This is a spreadsheet system for conducting financial evaluations of current and potential investments. P2/FINANCE differs from conventional capital budgeting tools because it addresses traditional obstacles to the financial justification of pollution prevention investments. It runs with either Lotus 1-2-3 Version 3.4a for DOS or Microsoft Excel Version 5.0 for Windows. (EPA 742-C-96-001/002).

P2/FINANCE web address: www.epa.gov/opptintr/acctg/download/p2finan.html

Economic Analysis of Pollution Prevention Projects (continued)

A. Payback period analysis (simple payback) measures how long it will take to return the original investment and ranks projects according to the length of the period: the shorter the period, the more attractive the project. The payback period is the amount of time required for an investment to generate enough cash flow to just cover the initial capital outlay for that investment. Depending on the nature of the cash flows, payback period can be calculated as follows:

If annual cash flows are equal, the initial investment amount is divided by the annual cash flow. For example, if the initial investment is \$12,000 and the first year annual cash flow is \$15,000, then the payback period is $\$12,000 / \$15,000 = 0.8$ years.

If the first year cash flow is greater than the initial investment, the initial investment amount is divided by the first year cash flow. If cash flows vary, and the initial investment is greater than the first year cash flow, succeeding years' cash flows are added incrementally until they equal the initial investment amount.

Payback period analysis has two drawbacks: it ignores the time value of money, and it ignores cash flows that occur after the initial investment has been recouped, not showing costs and savings past the point where the project has paid for itself. A chart that tracks the percentage payback of all cash flows over the life of the project may increase the payback method's usefulness.

Payback analysis provides a useful preliminary assessment of a project's attractiveness. If the payback is very short and the project is relatively simple, payback period analysis may be sufficient. However, this initial assessment should be verified by a Net Present Value analysis.

B. Net Present Value (NPV) analysis relies heavily on the concept of the time value of money and is the most powerful tool for assessing profitability over the life of a project. The time value of money recognizes that receiving \$100 today is not equivalent to receiving \$100 at some point in the future, because the \$100 today can be invested to earn a return. Net Present Value is the present value of the future cash flows of an investment, minus the investment's current cost.

The time value of money measures the value of money at different points in time as determined by a discount rate. The discount rate is the interest rate that is used to relate the future value of the money to the present value of the money. The discount rate is the rate of interest or return that a business or person can earn on the best alternative use of the money at the same level of risk. The discount rate is a function of what that company

Economic Analysis of Pollution Prevention Projects (continued)

must pay to acquire capital (money) and what rate of return for a given level of risk it must earn on the investment to satisfy management and shareholders. Note that discount rates are not inflation rates, although they usually incorporate the projected rate of inflation. An example of how Net Present Value can be calculated is shown below.

Net Present Value analysis should be used when initially evaluating major pollution prevention projects and for the final analysis of most projects. Advantages of Net Present Value analysis are that it considers the time value of money and it measures the risk-adjusted value added to the company. Disadvantages include that it is more information and calculation intensive, requires the estimation of cash flows over the life of the project and requires the calculation of a discount rate.

NET PRESENT VALUE CALCULATION

Present Value of an Investment

What is the value of future cash flows today? For example, what amount of money invested now at 10% will equal \$130 in two years?

$$PV = FV / (1 + r)^T$$

$$PV = \$130 / (1 + 0.1)^2$$

$$PV = FV / (1 + r)^T$$

$$PV = \$130 / 1.21$$

$$PV = \$107.44$$

PV=Present value, the value of the money received today (PV=\$107.44)

FV=Value that will be received in the future, when invested (FV=\$130)

R=The rate at which funds received today could be invested (R=10%)

T=The number of time periods in which interest is earned (T=2)

Receiving \$130 in two years is equivalent to receiving \$107.44 today and investing it two years at 10%.

Net Present Value Analysis

Net Present Value (NPV) analysis compares the PV of the cash inflows to the initial investment. How do these present values relate to the initial cash outlays? For example, in the present value analysis above, we could ask whether a projected income of \$130 in two years is worth an initial investment of \$100. To determine if this is a worthwhile investment, subtract the initial investment from the PV of the cash received in year 2, as shown here.

$$NPV = PV (\text{cash inflows}) - PV (\text{cash outflows})$$

$$NPV = \$107.44 - \$100$$

$$NPV = \$7.44$$

The NPV indicates how much extra return a project generates above the percent that is required by a firm's owners or managers. In this example, the investment generates \$7.44 in excess of the 10 percent return that is required.

- If NPV is greater than zero, the project should be accepted.
- If NPV is less than zero, the project should be rejected.
- If NPV is less than zero, the project should be rejected.

Economic Analysis of Pollution Prevention Projects (continued)

NPV can be calculated for investment that covers different time periods. Present Value tables are also available that calculate PV factors for different rates and years. Refer to the document, *Improving Your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects* (NEWMOA/OTA, 1994) for more information.

C. Internal Rate of Return (IRR) is a profitability measure, expressed in percentage terms, that is analogous to an average rate of return from an investment. IRR is the discount rate that will yield a net present value of zero for a given stream of cash flows. This method allows a comparison between the IRR of a project and a company's self-determined discount rate. A financial calculator or computer spreadsheet should be used to determine IRR. In general, if the IRR is greater than the discount rate, the project will be accepted. If the IRR is less than the discount rate, the project will be rejected.

The IRR can provide a convenient way of examining the return that a project will generate. The NPV and the IRR approach both result in the same alternative being chosen because these approaches are essentially the same. IRR shows the rate of return that a project generates, while NPV shows the present day dollar value of the return that a project generates. However, IRR analysis ignores the impact of the scale of a project. For example, a project that requires an investment of \$100 and 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. IRR should only be used to judge if a project is profitable, not for prioritizing projects. Use NPV for prioritizing and comparing projects because it yields consistently valid results.

Measures of profitability recommendations:

Of the three methods, **Net Present Value** is generally the most valuable, problem-free measure of profitability. Other indicators that consider the time value of money, such as Internal Rate of Return, are also useful. Payback should be used only for small projects, for a first-cut rough screening analysis, or to complement NPV and IRR information.

If you have accurately estimated cash flows and selected the appropriate discount rate, all projects with a positive NPV are profitable and may be worth implementing. If you have several projects competing for funding, or more than one pollution prevention option, choose the alternative with the highest NPV, not the highest IRR.

Economic Analysis of Pollution Prevention Projects (continued)

3. Consider Less Tangible Costs.

Pollution prevention projects may have other factors that affect a business that are difficult to quantify, but still have strategic significance. Issues such as product quality, productivity, market share, customer and stakeholder relations, employee health and safety, public image, a proactive environmental strategy, and criminal and financial liability can be very important criteria in the analysis of a pollution prevention project. Potential liability categories include disposal, storage, transportation, real property damage, civil actions, toxic tort suits, fines, penalties, and criminal liability.

The information for this appendix was adapted from:

Ohio Environmental Protection Agency Pollution Prevention Fact Sheet Number 33, October 1995; as adapted from:

- Northeast Waste Management Officials Association and the Massachusetts Office of Technical Assistance. 1994. "Improving Your Competitive Position: Strategic and Financial Assessment of Pollution Prevention Projects." Training manual and Instructor's guide (two separate publications). NEWMOA and MA OTA, Boston, MA; and
- White, Allen and Deborah Savage. 1995. "Environmental Cost Accounting and Capital Budgeting." Tellus Institute, Boston, MA. July 12, 1995 Videoconference, Modern Manufacturing series, National Technological University, Fort Collins, Colorado.

Economic Analysis of Pollution Prevention Projects (continued)

Worksheet for Simple Payback

Name of Alternative: _____

Capital Cost Summary:

Cost Item	Cost (\$)
Purchased Equipment: price, taxes, insurance, delivery, spare parts inventory	
Materials: electrical, structural, piping, instruments, insulation	
Installation: site demolition, clearing, vendor, contractor, in-house staff	
Utility Connections: electricity, water, refrigeration, steam, fuel, air	
Start-up & Training: engineering	
Other: permitting, fees, plant downtime, new chemicals	
TOTAL CAPITAL COSTS	\$

Operating Cost and Revenue Summary:

Cost Item	Cost (\$)
Increase/decrease in disposal cost: fees, permitting, on-site treatment, taxes	
Increase/decrease raw material cost	
Increase/decrease in utilities cost	
Increase/decrease operation & maintenance labor	
Increase/decrease operation and maintenance supplies	
Increase/decrease in insurance/liabilities cost	
Increase in revenues from increased production	
Increase in revenues from marketable by-product	
Other:	
ANNUAL NET OPERATING COST SAVINGS	\$

$\text{Payback Period} = \frac{\text{Total Capital Costs}}{\text{Annual Net Operating Cost Savings}} = \text{_____ Years}$
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(Source: Rhode Island Manual for Pollution Prevention Planning and Reporting, 1991)

APPENDIX H

Documenting Pollution Prevention Progress

Pollution Prevention Progress

Materials/Waste	Reduction Goal	Start Date	Completion Date	% Reduction	Savings
1					
2					
3					
4					
5					
6					
7					

APPENDIX I

Checklist for Pollution Prevention at Your Facility

	Yes	No
Pollution Prevention Policy and Task Force		
• Does your company have a formal written pollution prevention policy?	<input type="checkbox"/>	<input type="checkbox"/>
• Have you established a pollution prevention team/task force?	<input type="checkbox"/>	<input type="checkbox"/>
• Have you considered the opportunity to reduce your regulatory requirements by incorporating pollution prevention practices?	<input type="checkbox"/>	<input type="checkbox"/>
Publicizing Your Waste Reduction Efforts		
• Do you publicize your company's efforts to reduce waste?	<input type="checkbox"/>	<input type="checkbox"/>
• Do your marketing strategies incorporate the positive image related to waste reduction?	<input type="checkbox"/>	<input type="checkbox"/>
Waste Generation and Management		
• Are you aware of the potential harmful effects of the hazardous materials and wastes at your facility?	<input type="checkbox"/>	<input type="checkbox"/>
• Do you and your employees recognize the importance of proper management of hazardous materials and waste reduction?	<input type="checkbox"/>	<input type="checkbox"/>
• Have you conducted a facility assessment and developed a materials balance/flow diagram for your business?	<input type="checkbox"/>	<input type="checkbox"/>
• Do you maintain logs on these types and quantities of waste produced by your company so that you can target certain waste for waste reduction opportunities?	<input type="checkbox"/>	<input type="checkbox"/>
• Do you know the quantity of waste (liquid, solid, gaseous) produced by each process in your business?	<input type="checkbox"/>	<input type="checkbox"/>
• Have you reevaluated parameters (pH, temperature, concentration, flow, etc.) for the optimal condition your process needs?	<input type="checkbox"/>	<input type="checkbox"/>
Costs of Generating and Managing Wastes		
• Do you calculate the costs of generating and managing wastes? Examples: Handling and storage, analysis and reporting, treatment and disposal (including transportation), insurance, training of workers, response planning, safety, potential liabilities (lawsuits, fines, cleanup costs, customer confidence)	<input type="checkbox"/>	<input type="checkbox"/>
• Can you allocate the costs associated with waste generation to the various processes in your business? (i.e., not "lumped" into overhead)	<input type="checkbox"/>	<input type="checkbox"/>
Assessing the Cleanliness of Your Facility		
• Do you keep your shop clean and orderly to enable you to keep track of chemical handling and process operations?	<input type="checkbox"/>	<input type="checkbox"/>
• Are there noticeable spills, leaking containers, or water dripping or running?	<input type="checkbox"/>	<input type="checkbox"/>
• Is there discoloration or corrosion on walls, work surfaces, ceiling, and walls or pipes?	<input type="checkbox"/>	<input type="checkbox"/>
• Do you see smoke, dirt, or fumes to indicate materials losses?	<input type="checkbox"/>	<input type="checkbox"/>

APPENDIX I (continued)

Checklist for Pollution Prevention at Your Facility

- Do you notice any scrap or out-of-specification parts lying around?
- Are there open containers, stacked drums, shelving too small to properly handle inventory, or other indicators of poor storage procedures?

Employee Training and Involvement

- Do you continuously train employees in good housekeeping procedures? (spills, leaks, loss prevention, energy, water, and material conservation)
- Are there employee involvement or incentive programs in place to solicit suggestions on improving operations and reducing wastes?

Researching and Utilizing Alternative Products

- Are you investigating the potential for reformulating the products that require hazardous materials?
- Are you evaluating alternative methods of cleaning?
- Are you investigating the potential for reuse or recycling?
- Are all containers labeled as to their contents and hazards?

Monitoring and Recordkeeping

- Do you monitor critical parameters and carefully maintain them?
- Do you keep records on the amount of raw materials used per process to monitor process efficiently?

APPENDIX J

The NH Governor's Award for Pollution Prevention

Everyone has a role to play in preventing pollution. Organizations that have embraced pollution prevention as a way of life and as a new way of doing business deserve recognition and encouragement. To be eligible for the NH Governor's Award for Pollution Prevention, an applicant's project must reduce at the source the generation or release of pollutants; or increase efficiency in the use of raw materials, energy, water, or other resource; or protect natural resources using conservation techniques.

Award Categories	Winners' Benefits Include:
<ul style="list-style-type: none"> ❶ Business and Industry <ul style="list-style-type: none"> • Manufacturers • Trade groups • Commercial services ❷ Other Organizations <ul style="list-style-type: none"> • Environmental, community, non-profit groups • Institutions (schools, hospitals, municipalities) • Public agencies 	<ul style="list-style-type: none"> • Enhanced corporate image • Press release to NH media • Photograph with the Governor • Featured article in <i>Wastelines</i> newsletter and DES website • Attractive NH granite trophy

Selection Criteria

A diverse panel of judges, including representatives from industry, environmental organizations, academia, and government, evaluate the entries. The judges evaluate projects using the following criteria:

- Adherence to pollution prevention hierarchy.
- Quantitative measures of success, i.e., cost savings, waste prevented.
- Level of commitment and leadership in pollution prevention.
- Benefits to the community, workers, and the environment.

Application Process

Any individual or New Hampshire-based organization or facility may apply for the New Hampshire Governor's Award for Pollution Prevention. Applications for the award are submitted in January. Award recipients receive recognition from the Governor at an awards ceremony as part of the annual New Hampshire Pollution Prevention Conference held each Spring.

To receive an application or to get more information, please contact:

NH Department of Environmental Services
 NH Pollution Prevention Program
 603-271-6460 or 800-273-9469
 e-mail address: nhppp@des.nh.gov
 website: www.des.nh.gov/nhppp

APPENDIX K

References

State and Federal Pollution Prevention Guides

A Practical Guide to Toxics Use Reductions, Benefiting from TUR at your Workplace, Massachusetts EOE Office of Technical Assistance, 1992.

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