

Civil Engineering X472

# Pollution Prevention and Waste Minimization

## **Instructor**

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# A Note from the Course Author

Welcome to the world of pollution prevention! I hope you find it fascinating and intellectually challenging. Pollution prevention, or the awareness of it, will change your life.

I used to manage hazardous waste in the traditional way, mostly by dealing with the waste after it was generated. The organizations I worked for spent great sums of money on end-of-pipe treatment systems, transportation and disposal costs, record keeping, and report writing, and I spent a lot of time developing procedures and policies for managing the waste. That is what we were taught to do in school and on the job.

However, the current emphasis, and rightly so, is on source reduction for all media (air, water, land). This includes nonhazardous waste, energy, and resources, as well as hazardous waste. You will find the concept of pollution prevention incorporated into more and more academic courses. It is appearing in design and process engineering, general science and technician courses, and even urban planning courses! You might say there is a revolution in environmental science and “technomanagement” instruction.

Pollution prevention is multidisciplined. It requires knowledge and skills in science, psychology, economics, law, sales, marketing, and business. It also requires interpersonal skills, writing skills, political savvy, and most of all, creativity in problem solving. For these reasons I find great satisfaction in implementing pollution prevention programs. I am able to use my advanced degrees in environmental engineering and biological science, as well as my experience in establishing and operating a small manufacturing business and establishing a division for a large computer company. I have interpreted regulations, worked with elected and appointed officials, written proposals, justified programs, solved waste problems, and “sold” the concept of pollution prevention to businesses.

Therefore, look at your vocation as an asset to you in pollution prevention, giving you a chance to problem solve with a new approach and perspective, a chance to transfer applications from one discipline to another. I work with pollution prevention pioneers and champions possessing degrees in economics; planning; history; chemical, mechanical, civil, and industrial engineering; psychology; chemistry; and so forth. Pollution prevention is infiltrating environmental management worldwide at all levels. It takes true believers and champions.

There is a place for you in the world of pollution prevention, no matter what your background is.

Donna Toy-Chen, M.S., M.A., R.E.A.

# Course Outline

## **Introduction**

**Lesson 1:** Introduction to Pollution Prevention  
Submitted Assignment 1

**Lesson 2:** Pollution Prevention Evolution  
Submitted Assignment 2

**Lesson 3:** Pollution Prevention Implementation: Part 1  
Submitted Assignment 3

**Lesson 4:** Pollution Prevention Implementation: Part 2

**Lesson 5:** Useful Technologies

**Lesson 6:** Pollution Prevention in Metal Finishing  
Submitted Assignment 4: Midcourse Examination

**Lesson 7:** The Coating Industry and Pollution Prevention  
Submitted Assignment 5: Case Study

**Lesson 8:** Solvent Use and Pollution Prevention  
Submitted Assignment 6: Term Paper Proposal

**Lesson 9:** Integrating Pollution Prevention Activities  
Submitted Assignment 7

**Lesson 10:** Pollution Prevention Measurements

**Lesson 11:** Materials Management  
Submitted Assignment 8: Term Paper

## **Final Examination Procedure**

**Lesson 12:** Pollution Prevention Case Studies

# Introduction

## **COURSE DESCRIPTION**

The purpose of this course is to acquaint you with the principles of pollution prevention, waste reduction, and cleaner production processes so you can improve the working environment through reduced chemical and raw material losses, manufacturing costs, and waste generation. The course will provide proven, practical techniques for initiating or expanding pollution prevention programs. Topics include recycling and reuse, administrative measures to overcome barriers to program implementation, process improvements and modifications, and material and end product substitution. You will learn systematic assessment methods to identify hazardous waste discharges to the air and water, processes to minimize such discharges, and techniques for evaluating the effectiveness of the program.

## **PREREQUISITES**

Environmental Behavior of Pollutants or equivalent.

## **COURSE OBJECTIVES**

After completing this course, you will:

- ❖ Understand basic principles of pollution prevention and waste minimization
- ❖ Be able to identify, evaluate, and apply pollution prevention techniques in environmental programs and manufacturing processes
- ❖ Be able to initiate or expand pollution prevention programs.

## **REQUIRED TEXT AND MATERIALS**

The following textbook and videotape are required for this course:

Textbook: Freeman, Harry M. *Industrial Pollution Prevention Handbook*, McGraw-Hill, 1995.

Videotape: *Why Waste? Waste Minimization for Today's Businesses*. California Environmental Protection Agency, Department of Toxic Substances Control.

## **INSTRUCTIONAL METHOD**

The course is divided into 12 lessons most of which involve reading specific chapters in the text together with my commentary, and viewing a videotape of pollution prevention case studies. Submitted assignment questions will help you understand the topic and applications. Assignments will include

- ❖ an exercise in which you obtain and review pollution prevention information and answer questions about it
- ❖ a case study in which you assess a given situation and then determine the appropriate waste minimization approach or method
- ❖ a term paper in which you identify wastes, prioritize them, and justify selected waste minimization methods to be practiced for a particular business or industry

You do not have to memorize all the details in the text. Use my commentary and the submitted assignments as a guide to what I think is important.

The course also contains a midcourse exam and a supervised final exam. Both are objective, open-book examinations that test your ability to understand and apply pollution prevention methodologies. The final exam covers material from the entire course.

## **PRESENTING YOUR WORK**

Complete each submitted assignment and send it to me for review and comments. Most questions can be answered thoroughly in a paragraph or two.

I would prefer that you submit only one assignment at a time. If you have a deadline to meet, please let me know with your first submission. If you're confused about the assignment or have a difficult time completing it, please contact me and we'll work it out. Don't forget to include your name at the top of each assignment you send to me, and be sure to keep a copy of everything you submit, as things do occasionally go astray.

## **HOW I RESPOND TO YOUR WORK**

I will give you "credit" or "no credit" for credit/no credit designated assignments and a numerical grade on each of the other assignments. Depending on the type of assignment, I will provide a critique of your response on a cover sheet or annotate within the text. If you think a question is unclear or ambiguous, please explain your difficulty with the question as well as the reason for your answer.

Some of the assignments ask for your suggestions or recommendations to improve a situation. I want you to understand that you will be graded on how well you express and support your recommendations, not on whether I agree with them.

## **THE COURSE GRADE**

Course grades are based on the following:

- ❖ Satisfactory completion of three question sets (credit/no credit)
- ❖ Case study paper (15%)
- ❖ Midcourse examination (25%)
- ❖ Term paper (25%)
- ❖ Final examination (35%)

You must pass the final examination to pass the course.

## Lesson 1

# Introduction to Pollution Prevention

### READING

Freeman, Chapters 1 and 2

### OBJECTIVES

After completing this lesson, you will be able to

- ❖ describe the difference between pollution prevention and waste minimization
- ❖ name general pollution prevention and waste minimization techniques
- ❖ describe benefits and tradeoffs of pollution prevention programs

### COMMENTARY

#### WHAT IS POLLUTION PREVENTION?

The term *pollution prevention* is relatively new. It has only recently been defined by the United States Environmental Protection Agency (USEPA) as

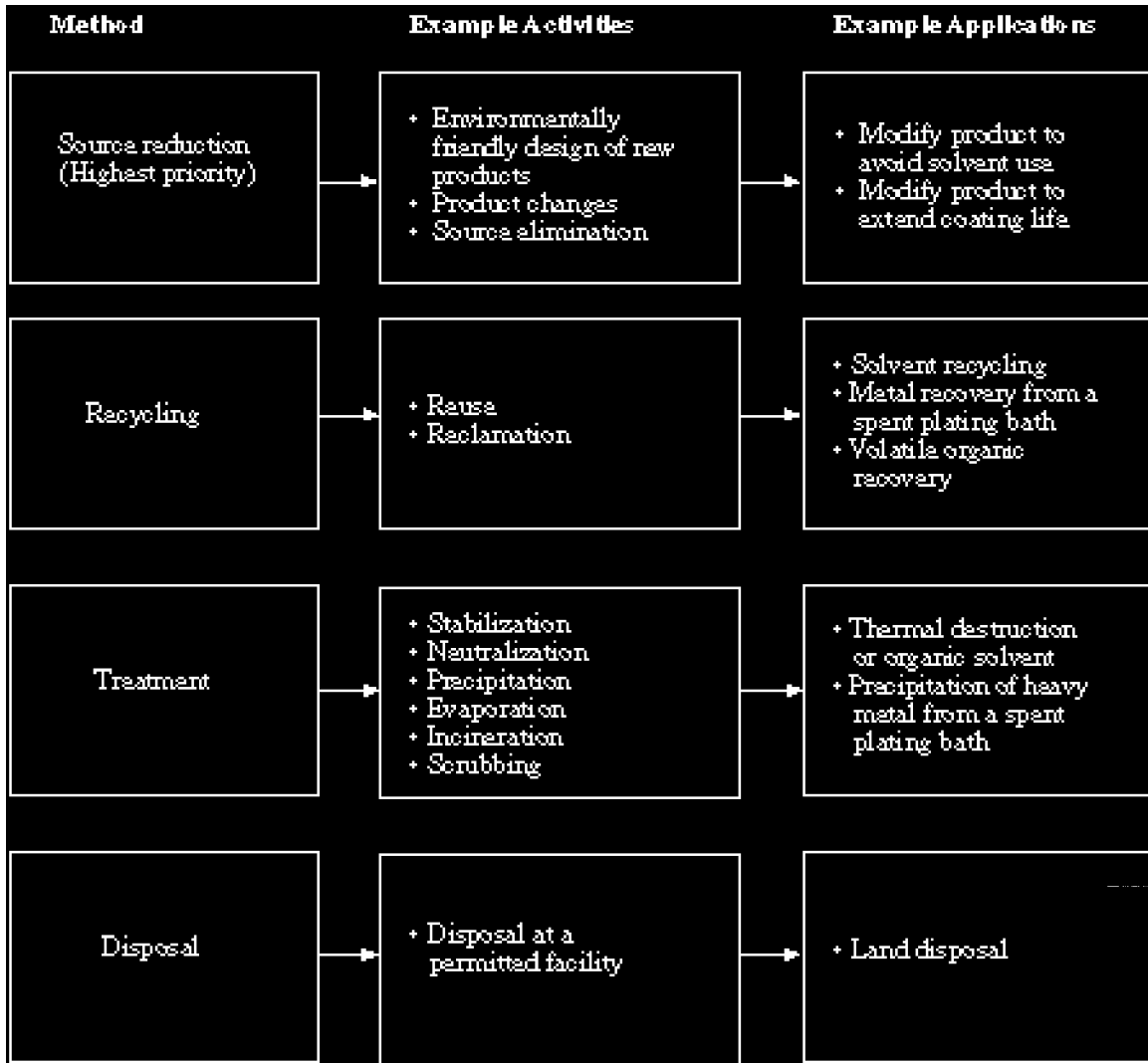
the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. It includes practices that reduce the use of hazardous and nonhazardous materials, energy, water, or other resources, as well as those that protect natural resources through conservation or more efficient use.<sup>1</sup>

As with many terms, *pollution prevention* followed a multitude of words relating to waste reduction. These include *waste avoidance*, *recycling*, and *waste minimization*. Over the years, environmental managers, USEPA policy makers, the public, and industry have used the terms fairly loosely, to refer to remediation techniques as well as recycling.

USEPA coined the term *pollution prevention* to emphasize the multimedia (air, land, and water) aspects of reducing waste. In the past, most persons hearing *hazardous waste reduction* and *hazardous waste minimization*, usually considered solid hazardous waste only. This was of concern to USEPA, which wanted to prevent any transfer of

pollutants from one medium to another. For example, contaminated groundwater is often remediated by air-stripping the volatile organic compounds. As the water passes through the air-stripping tower, the compounds volatilize and escape to the atmosphere. The result is clean water and dirty air. Thus, pollution prevention activities address nonhazardous and hazardous air, liquids, and solids and resources.

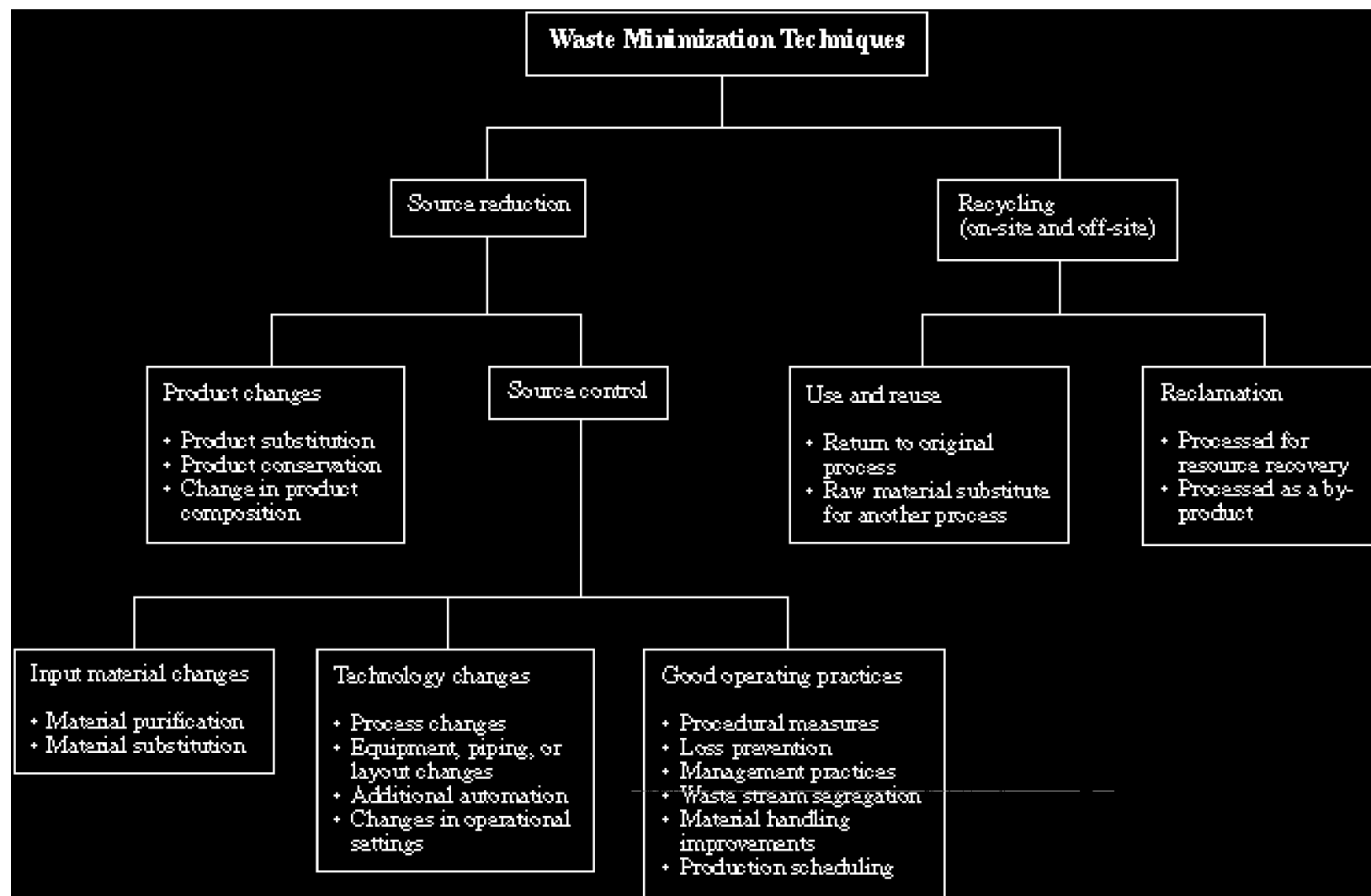
**Figure 1-1. Environmental Management Options Hierarchy**



Source: Facility Pollution Guide, Office of Solid Waste, USEPA, 1992



Figure 1-2. Waste Minimization Techniques



Source: USEPA, *Manual for Waste Minimization Opportunity Assessments*, April 1988.

*Waste minimization* is a broader hazardous waste management term that includes on-site and off-site recycling as well as source reduction. It is the next level down in the hazardous waste management hierarchy (Figure 1-1). The Pollution Prevention Act of 1990 reinforces the USEPA's environmental management hierarchy. The highest priorities are assigned to preventing pollution through source reduction and reuse.

Debate continues among USEPA and state environmental policy makers about whether to include in-process, on-site, and off-site recycling as pollution prevention or waste minimization measures. Pollution prevention practitioners, fortunately, tend to push these academic exercises aside and concentrate their energies on implementing waste minimization techniques that lead to actual source reduction or recycling.

## **POLLUTION PREVENTION AND WASTE MINIMIZATION TECHNIQUES**

According to Figure 1-2, waste minimization techniques are divided into source reduction (pollution prevention) and materials recovery (recycling).

### ***SOURCE REDUCTION***

Let's look at source reduction first. Source reduction can be accomplished by replacing the product with a substitute. Sometimes this is required by law. Asbestos, for example, can no longer be used as insulating material and is being replaced by fiberglass. Another example of legally required substitution is the replacement of polychlorinated biphenyls (PCBs) found in electrical transformers by various types of oil.

***Product changes***, whether voluntary or required, are considered carefully by businesses. Businesses cannot afford to lose their customer base. Are consumers cognizant of the benefits to the environment of an alternate product? Is it an important factor for product selection? For example, if the metal that makes up a money clip is coated with a protective layer of trivalent chrome, would the consumer still buy it? Trivalent chrome is less toxic, but has a yellowish finish compared to hexavalent chrome. In addition, plating with trivalent chrome requires more attention to plating process parameters, since trivalent chrome systems are more sensitive to fluctuations. This may increase the price of the product. Would you spend more for a product because its manufacturing had less impact on the environment? Would you buy it if the company's competitors still have cheaper hexavalent chrome money clips for sale?

***Source control*** can be accomplished through technologies, operating practices, or changes in the materials used in production.

Operating practices typically are low-cost methodologies that primarily require the use of interpersonal skills to convince management and other employees to change their procedures. This may include training sessions for handling materials differently or scheduling production differently. For instance, a paint manufacturer may want to schedule the making of light color paints first and then move on to darker colors. This will reduce the need to clean the tanks and the generation of paint-related waste. In reality, this is more difficult than it appears. Some companies do not have large order customers and their customers and contracts fluctuate widely. Therefore, the first contract may require production of a black paint, followed by a contract that calls for white paint. It is impossible to predict where the next contract will come from and what paint colors will be specified.

Another operating practice that can be useful in source control is waste segregation. It can be as simple as pouring solvent into a separate container instead of placing both solvent and oil into the same container. In another case, technologies such as evaporation or ion exchange may need to be installed to separate components. This method is often used to separate valuable metal ions from an aqueous waste stream. The result is water and metal ions, which are recirculated back to the process at separate input points.

### ***RECYCLING***

Recycling is accomplished by returning wastes as raw materials to the original or a different manufacturing line. Some recovered materials are processed for resource recovery, such as taking used motor oil and using it as a fuel blend for energy recovery. On the other hand, some recycling companies reprocess used motor oil to meet standard specifications. This oil is then returned to its original use inside a motor engine.

Waste streams are more amenable to recycling if the toxic constituents are segregated. Segregation of wastes yields purer materials that would interest off-site recycling companies. It is also easier to use the material as input in the same process or other industrial processes.

### **BENEFITS AND TRADEOFFS OF A POLLUTION PREVENTION PROGRAM**

Why would a business initiate a pollution prevention program? Some of the reasons are

- ❖ to reduce risk of liability
- ❖ to reduce operating costs
- ❖ to improve company image
- ❖ to improve employee and public health
- ❖ to protect the environment

Most smaller, less sophisticated companies tend to initiate a program in response to regulations requiring a pollution prevention program. Others see it as a cheap way to comply with other hazardous waste management requirements. In most cases, companies that have initiated a pollution prevention program experience large monetary savings in hazardous waste management and operating costs. These savings come from reductions in raw materials used and disposal costs. Important costs that are often not considered are the “hidden” costs, such as labor for report writing, record keeping, plant shutdown during inspections, permit hearings, and so forth.

Some companies will recognize the long-term benefits to company image from improvements to the environment and community health that can be associated with the company name. On the other hand, there may be tradeoffs in the implementation of some pollution prevention measures. Will this result in a higher product cost to the consumer? Will the additional automation change the responsibilities of current process operators or leave them with no work? Will the new waste reduction technique require a new set of permits? If so, what is their cost? Will these outweigh the benefits to be achieved? What is your short-term plan? Your long-term plan? What would you do if you had a small business?

### **SUBMITTED ASSIGNMENT 1**

In no more than a page or so, tell me about yourself. What is your educational background? Have you worked in the environmental management field before? If so, in what area? If not, what kind of work have you done? What is your objective in taking this course? Are you interested in any particular topic?

Don't forget to include your name and address at the top of your submission. Send it to your instructor for review.

### **REFERENCE**

1. U.S. Environmental Protection Agency, *Environmental Protection Agency Pollution Prevention Directive*, May 13, 1990.