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Municipal Pretreatment Programs

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Municipal Pretreatment Programs

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Chapter 1
Introduction

With the enactment of the Pollution Prevention Act of 1990, Congress formally established pollution prevention as a national objective, placing it ahead of waste recycling, treatment, and disposal in the hierarchy of environmental management methods. The Act directs the U.S. Environmental Protection Agency (EPA) to integrate pollution prevention concepts fully into all its regulatory programs. A preventive approach to environmental protection can lead to improvements in environmental quality and economic efficiency by reducing harmful pollutants at the source through cost-effective changes in production, operation, and raw material use. This approach changes the focus from managing waste after it is generated to eliminating or minimizing the problem before it occurs.

EPA defines pollution prevention as waste reduction prior to recycling, treatment, or disposal. Recycling conducted within a process, such as closed loop rinsewater recycling, is also considered pollution prevention. Waste recycling, which takes place outside the process, is not considered pollution prevention, although when conducted in an environmentally safe manner it achieves the same goal as pollution prevention by reducing the need for treatment and disposal.

Pretreatment personnel at publicly owned treatment works (POTWs) can broaden their approach to meeting the goals of the National Pretreatment Program by encouraging pollution prevention measures among sewer users. This guide is designed to assist POTW personnel in formulating strategies for promoting pollution prevention as another tool for meeting the goals of municipal pretreatment programs. The main objective is to help pretreatment program personnel educate industrial users about the benefits of pollution prevention and encourage them to assess and implement pollution prevention in their own operations. Pollution prevention can assist industries in meeting sewer discharge limits and protecting POTW worker health and safety.

This guide provides an overview of pollution prevention concepts (Chapter 2), presents a way to identify and prioritize industries as candidates for pollution prevention (Chapter 3), and outlines a broadly applicable approach to integrating pollution prevention concepts into existing pretreatment programs (Chapter 4). Appendix A contains a comprehensive list of pollution prevention resources. Appendix B is a collection of summaries that identify pollution prevention opportunities in industries of particular concern to POTWs.

Why should POTWs encourage pollution prevention?

POTWs are the recipients of a large portion of the nation's industrial wastewater, receiving discharges from an estimated 30,000 significant industrial users. These industrial users discharge the full spectrum of heavy metals, volatile organics, and other contaminants that can degrade environmental quality and pose health and safety risks to POTW workers. Even if there were full compliance with categorical pretreatment standards, EPA estimates that categorical industrial users would continue to discharge 14 million pounds of toxic metals and 51 million pounds of toxic organic pollutants to POTWs each year (U.S. EPA, 1991c). Small industrial users, commercial establishments, domestic sources, and storm water also contribute to the waste load received by POTWs.

Personnel at POTWs have many opportunities to encourage industries to adopt pollution prevention measures. More than any other public authority, POTW pretreatment program personnel maintain close contact with local sewer dischargers and have an understanding of their specific industrial process operations and waste streams. Through requiring spill prevention plans and toxic organic management plans (TOMPs) and including best management practice (BMP) conditions in permits, POTWs are already involved in promoting pollution prevention. By further integrating pollution prevention concepts into existing pretreatment program activities, POTW personnel can help industrial and commercial facilities identify pollution prevention opportunities, encourage them to assess these opportunities in greater detail, and, in general, heighten their awareness of pollution prevention as another means of meeting their permit requirements.

Pollution prevention offers substantial benefits to POTWs. By further reducing the quantity and toxicity of user discharges, pollution prevention can help POTWs:

- Meet federal and state environmental quality standards, including sludge disposal requirements, current or future toxic air emission requirements, and National Pollutant Discharge Elimination System (NPDES) permit requirements.
- Reduce the transfer of influent contaminants from one environmental medium (e.g., wastewater) to others (e.g., land, surface and ground water, and air).
- Increase POTW worker safety and reduce collection system hazards from toxic or hazardous gases.
- Further reduce the occurrences of interference and pass-through.
- Reduce expensive sludge management costs.
- Reduce the impacts from dischargers that might view sewers as the answer to their own waste management problems.
- Maintain pollutant loads at levels that will satisfy increasing demands for sewer system services from industrial, commercial, and domestic sectors.

How does a POTW promote the benefits of pollution prevention to businesses?

Industrial and commercial facilities also can benefit from pollution prevention. In many cases, pollution prevention might be the least expensive means of reducing unacceptable toxic discharges. Pretreatment personnel can point out the benefits of pollution prevention to their sewer users. Through pollution prevention, companies can:

- Reduce waste monitoring, treatment, and disposal costs.
- Reduce raw-material use, feed stock purchases, and manufacturing costs.
- Reduce operation and maintenance costs.
- Increase productivity and reduce off-specification products.
- Reduce regulatory compliance costs.
- Reduce hazards to employees through exposure to chemicals.
- Reduce costs of environmental impairment insurance.
- Improve public image and employee morale.
- Reduce potential liability associated with toxic waste.

What are some of the impediments to promoting pollution prevention among sewer dischargers?

In implementing the General Pretreatment Regulations, POTWs should have authority to promote pollution prevention in a number of capacities, such as requiring spill control plans and TOMPs. To incorporate pollution prevention planning or other pollution prevention requirements into permitting and enforcement actions, however, POTWs might need to expand their authority. During inspections, POTW personnel can encourage industrial users to conduct pollution prevention assessments or consider specific types of measures, but it is not advisable to recommend or approve specific measures. By recommending a particular pollution prevention measure, POTW personnel may lead the facility to believe that implementing that measure will guarantee compliance. (See Section 4.1.2.3 for a discussion of issues related to giving pollution prevention advice.)

POTWs might also encounter the following impediments:

- Businesses might have assessed and implemented low-cost pollution prevention techniques already as general operating efficiency and cost-control measures. Furthering pollution prevention might involve unfamiliar techniques that require a more intensive evaluation and more capital. Companies might be skeptical of the potential benefits or might be unwilling or unable to invest the necessary funds.
- Businesses may have a predisposition to control technologies because these are familiar and traditional ways of dealing with waste problems; or a firm might have recently made substantial investments in treatment technologies. In these cases, pretreatment personnel can educate business personnel about how pollution prevention alternatives can increase removal efficiencies and reduce operating and maintenance costs of existing treatment systems.
- POTWs might have difficulty persuading municipal officials that activities promoting pollution prevention are integral to meeting the goals of the local pretreatment program and that funding for pollution prevention initiatives is needed to meet these goals. Training resources and additional support will enhance greatly the ability of the POTW to effectively promote pollution prevention among its users.

What are the key elements to successful integration of pollution prevention into pretreatment programs?

As POTWs begin to incorporate the concepts of pollution prevention into municipal pretreatment programs, success will depend on a few key elements. Each POTW will face unique challenges, both internally and externally, as it moves to integrate pollution prevention into its daily program activities. Regardless of the uniqueness of the challenges faced by each POTW, key elements for succeeding will likely be consistent for all POTWs.

POTWs will increase the chances of successful and, more importantly, effective use of pollution prevention concepts by keeping in mind the following:

- Seek to integrate pollution prevention into existing program activities, rather than viewing the adoption of pollution prevention concepts as an additional program requirement. In this manner, pollution prevention will be incorporated into the program in an efficient manner.
- While every effort should be made by POTWs to integrate pollution prevention into ongoing pretreatment program activities, additional time and resources will be needed to modify existing pretreatment program activities and provide assistance and direction to industrial and commercial sewer users. At first, POTW personnel can slowly phase in changes to existing activities. This approach requires minimal new resources and will allow the pollution prevention mindset to take hold through an evolutionary process. POTW pollution prevention efforts may be eligible for grants available at the federal and state level. POTWs should contact their EPA regional office and state pollution prevention programs (see Appendix A) for information on available grants.
- Define goals and measure success in small, attainable increments. This is especially important during the initial stages of adopting pollution prevention concepts. This can be best accomplished, as described later, with short-term, narrowly focused efforts that can illustrate the benefits of pollution prevention and build support for a more broadly applied program. Guidance has been developed to assist in measuring the success of pollution prevention efforts (U.S. EPA, 1989).
- Provide a wide range of incentives to industrial and commercial sewer users to adopt pollution prevention as part of their environmental control programs. These incentives should cover the wide range of options and use the authorities available to the POTW. Public recognition programs that use some type of "green industry" moniker can be used. In addition, the POTW can use enforcement discretion, which is inherent in a pretreatment program, to provide incentives to pursue pollution prevention projects. Regardless of the nature of the incentives used, they can be effective tools for persuading sewer users to investigate pollution prevention measures.

Chapter 2
Overview of Pollution Prevention Concepts

Pollution prevention encompasses both source reduction and in-process recycling. The Pollution Prevention Act of 1990 defines source reduction as any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream (including fugitive emissions) prior to recycling, treatment, or disposal, and that reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. The Act declares that governments, businesses and industries, and individuals should prevent or reduce pollution at its source wherever feasible. Where source reduction cannot be achieved, the Act advocates that responsible parties reuse and recycle to reduce the quantity of hazardous waste requiring treatment. If there are no feasible pollution prevention alternatives, environmentally sound treatment should be applied with disposal used only as a last resort. Techniques that merely transfer contaminants from one medium to another without a net reduction in the quantity and toxicity of hazardous constituents do not meet the definition of pollution prevention. This chapter describes and gives examples of the various pollution prevention measures encompassed in source reduction and recycling. Pollution prevention techniques related to specific industries are described in Appendix B.

2.1 Source Reduction

Source reduction lessens or eliminates the quantity of hazardous and toxic wastes generated and the expense and environmental impacts associated with managing these wastes. In addition, source reduction usually results in significant cost savings realized from raw material conservation. Source reduction encompasses good operating practices, technology changes, input material substitutions, and product changes (see Figure 2-1).

2.1.1 Good Operating Practices

In general, industries can realize a high return from a minimal investment by implementing good operating practices. Good operating practices are procedural, administrative, and institutional measures, which include improving inventory control, preventing accidental spills, segregating waste streams, and scheduling production runs that maximize production and minimize waste. Getting management to commit to pollution prevention is a first step toward instituting an effective source reduction program. This commitment might be demonstrated by a written policy statement circulated to company employees and posted in visible locations and by encouraging employees to adopt the principles of pollution prevention. Demonstrating management's dedication to pollution prevention and its importance to company operations can galvanize the work force and help employees view pollution prevention as a priority in their everyday work activities. Other management and personnel practices, such as employee training, incentives, and bonuses, also can encourage employees to reduce waste.

Maintaining an orderly inventory system and proper storage conditions can greatly reduce material waste from deterioration, inefficient use, and spills. For example, an inventory system that employs a "first-in/first-out" management method and keeps a 1- or 2-month supply of materials is less likely to result in material disposal because of product expiration. Implementing a materials tracking system that tracks material use by individual employees or work groups allows managers to identify individuals or production teams with above-average materials use. Using tight-fitting lids and spill-proof containers with spigots, minimizing traffic, and employing proper environmental controls in storage areas also will extend material supplies and prevent spills. Frequent inventory inspections will result in early detection of leaks and spills.

Other good housekeeping practices include containing and reusing materials dripped from parts as they are transferred during a process and providing funnels or other equipment that avoids spills when transferring materials. Regularly scheduled preventative maintenance reduces the occurrence of malfunctions and leaks, which will reduce the volume of wastes discharged to the sewers. Modifying production schedules to minimize required equipment changeovers will reduce the quantity of wastes generated by

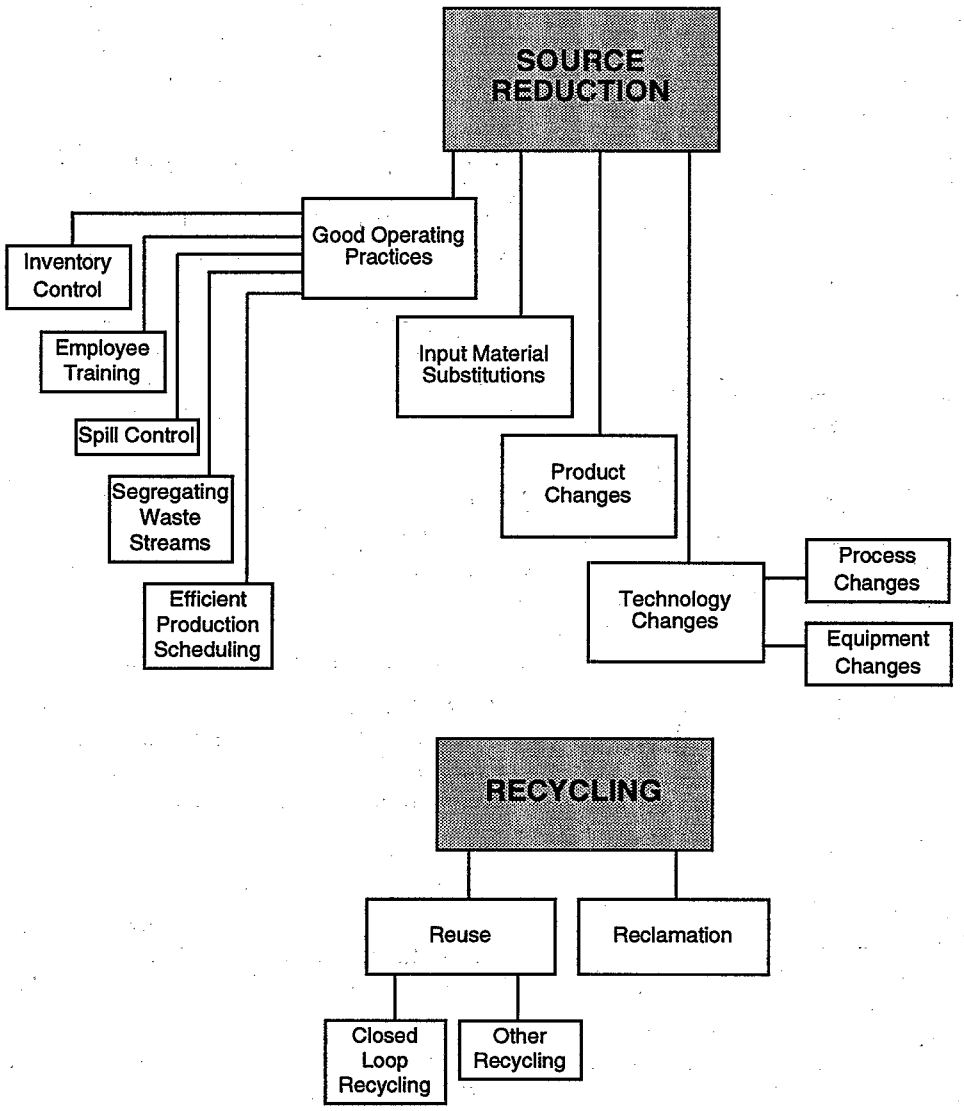


Figure 2-1. Pollution prevention.

equipment cleaning. Segregating hazardous and nonhazardous waste streams avoids making the entire waste stream hazardous and reduces the volume of waste requiring treatment or costly disposal. Also, maintaining separate waste streams can enhance the industry's ability to reuse or reclaim waste materials. For example, by not mixing two different spent solvents, the purity of the waste materials is maintained, making recycling easier.

Another action, often overlooked, is examining the cleaning products (e.g., cleaners, degreasers, and floor finishes) used by a company to determine whether they are contributing to the toxic loadings in wastewater when discharged through sink and floor drains. Cleaning products with toxic constituents can be replaced with substitutes that do not contain harmful elements. A good housekeeping program should include a review of the cleaning products used in house.

Many companies use good operating practices as a first step toward reducing toxic materials use; for example:

A large consumer product company in California adopted a corporate policy to minimize hazardous waste generation. To implement the policy, the company created quality circles made up of employees from each area that generated hazardous waste within the plant. With their considerable knowledge of particular manufacturing and administrative procedures, these quality circles were able to suggest a number of institutional changes, such as the adoption of proper maintenance procedures. The teams supervised the implementation of these procedures in their own production areas. The use of proper maintenance procedures alone led to a 75 percent reduction in hazardous and nonhazardous waste generation (U.S. EPA, 1988).

2.1.2 Technology Changes

Technology changes can range from minor modifications to existing processes, to major investments in new manufacturing equipment. Technology changes involve changes in any of the following areas:

- Production processes.
- Equipment, layout, or piping.
- Use of automation.
- Process operating conditions, such as flow rates, temperatures, pressures, and residence times.

Production processes can be modified to eliminate the need to change over equipment if a unit can be dedicated to one process. Mechanical methods can be used in lieu of solvent use for cleaning and stripping parts. Various process changes can be implemented to reduce drag-out of process solutions, including adjusting the speed of withdrawal of the part from the process solution, allowing more time for the part to drip, and positioning the part to maximize runoff of the solution.

Many companies have experimented with technology changes to prevent pollution. Here are just a few examples:

Hill Air Force Base, in Ogden, Utah, strips paints from its aircraft with plastic bead "sand blasting," rather than using more traditional toxic solvents. The Air Force base can use the plastic beads over and over. In 1986, the Air Force base estimated that, for each plane, mechanical stripping saved 302 person hours, $5,076 in raw materials, $935 in disposal costs, $1,485 in wastewater treatment costs, and $104 in energy costs (Sherry, 1988b).

In July 1989, Ford Motor Company in Plymouth, Michigan, implemented a cyanide-free, no-rinse chromate coating process for its aluminum parts. The previous chromate coating process produced 14,000 to 17,000 gallons of wastewater per day, which was sent to the plant's pretreatment facility. The pretreatment process produced waste sludge containing between 0.1 to 0.5 percent total cyanide, which exceeds allowable limits for disposal in landfills. The no-rinse system produces only 3,000 gallons of wastewater per day, has eliminated all forms of cyanide from the process and wastewater sludge, and achieves superior coating application results. Ford has realized savings in reduced pretreatment costs and elimination of cyanide-contaminated sludge disposal costs. Ford has since implemented the no-rinse system in three other plants (U.S. EPA, 1991a).

New Dimensions Plating, Inc., in Hutchinson, Minnesota, electroplates a variety of metals with chromium, copper, and nickel. Although New Dimensions was meeting current pretreatment regulations, the facility decided to investigate drag-out reduction techniques in order to reduce pretreatment costs. To reduce chromium drag-out, New Dimensions constructed drip bars to allow for greater drip time. The facility also constructed several evaporators to reduce the volume of water in the plating and stagnant rinse tanks to allow all of the spray rinse solution and some of the rinsewater to be returned to the rinse tank each day. Recovered drag-out solutions pass through an electropurification module to remove contaminants before returning to the original plating bath. As a result of the new plating system, chromium drag-out has been reduced from 7 pounds per day to 1 pound per day. New Dimensions has benefitted from reduced chromium content in pretreatment sludge and savings of $7,000 annually in reduced chromium and treatment chemical purchases (MPCA and WLSSD, 1992).

2.1.3 Input Material Substitutions

This technique involves replacing the input material that contains a problem pollutant with a different material that performs the same function without generating a toxic or hazardous waste. Input material substitutions reduce or eliminate the problem pollutants that enter the production process. Input modifications that avoid the generation of problem wastes during production also fall under this source reduction category. Process changes might sometimes be required to accommodate input material changes. Examples of input material substitution include:

United Piece Dye Works of Edenton, North Carolina, met stringent effluent discharge limits on phosphorus by making chemical substitutions in the production process rather than building expensive treatment systems. The company conducted a detailed evaluation of production processes, process chemistry, and the chemicals used to identify sources of phosphorus. It then made process modifications to reduce use of phosphate chemicals by substituting chemicals not containing phosphate. For example, the use of hexametaphosphate was reduced and the use of phosphoric acid was eliminated. These chemical substitutions reduced the level of phosphorus in the company's wastewater from 7.7 mg/l to less than 1 mg/l. This reduction was achieved without any capital expenditures for phosphorus removal (PPIC, 1992).

IBM's Research Triangle Park plant in Durham, North Carolina, established an active program to reduce the generation of waste through material substitutions and process modifications. IBM eliminated the discharge of wastewater containing toxic biocides by using ozone rather than biocides to control algae and bacterial growth in cooling towers. This substitution has eliminated the presence of toxic biocide concentrations

in the plant's wastewater and hence reduced IBM's pretreatment costs. IBM estimates it saves $120,000 per year in sludge dewatering costs alone (PPIC, 1992).

In an effort to reduce chrome concentrations in wastewater, Granite State Leathers modified its leather tanning process to accommodate a new tanning agent, which contains roughly two-thirds less chromic oxide than the previous tanning agent. In addition, the need for chrome retanning has been eliminated because chrome retention in the first tanning wash is 10 times better. The concentration of chromic oxide in the wastewaters has been reduced from about 10 ppm to less than 1 ppm. Granite State estimates it saves between $40,000 and $50,000 per year in avoided wastewater treatment costs (PPIC, 1992).

Garnkonst Metalworking Company in Landskrona, Sweden, implemented material substitutions in one process to make possible a material substitution in another process. Garnkonst replaced mineral oil-based metalworking fluids with a vegetable oil-based substitute. This substitution allowed the facility to substitute an alkaline detergent solution in place of toxic trichloroethylene and mineral solvents for parts degreasing. The substitutions have reduced trichloroethylene and mineral solvent concentrations in air and wastewater dramatically. The switch to vegetable-based oil from mineral oil saves $5,000 per year in material costs and the company saves $59,000 annually in avoided trichlorethylene waste-management costs (PPIC, 1992).

2.1.4 Product Changes

A final source reduction technique consists of product modifications. By altering the product in such a way that the problem pollutant is no longer required in the production process, businesses can eliminate generating the problem waste. Product modifications also can reduce environmental releases of problem pollutants related to the use of a particular product. Product change generally falls into one of three categories: product substitution (e.g., an entirely new product); changes in product composition (e.g., minor modification to an existing product); and product conservation (e.g., increasing the working life of an existing product). Examples of product changes include:

The paint manufacturing industry has taken steps to reformulate its products to reduce hazardous constituents. Paint manufacturers have continued to improve water-based paints and find applications for them that were previously dominated by solvent-based paints. Water-based paints do not contain toxic or flammable solvents that contribute to the potential hazards of solvent-based paints. The use of water-based paints eliminates discharge to sewers of volatile organics in rinsewater from production-line cleaning operations. In addition, volatile organics are not released to the atmosphere by water-based paints (U.S. EPA, 1988).

In 1988, at its Waltham, Massachusetts, plant, Polaroid began manufacturing batteries without mercury. These batteries are imbedded into film packs. Although eliminating the mercury in the batteries reduces slightly the voltage and the shelf life of the batteries, these changes in product attributes do not affect product performance. Polaroid originally made this change to the product at other plants in response to regulations in another country that forced them to remove the mercury. At the Waltham plant, mercury in the wastewater from the battery manufacturing process has been eliminated (MWRA, 1992).

2.2 Recycling

Recycling options involve the reuse and reclamation of spent input materials, such as solvents, detergents, inks, and other chemicals (see Figure 2-1). Reuse substitutes spent input materials for new input materials in the manufacturing process. Reclamation, on the other hand, recovers valuable material from spent input materials for incorporation in some other process or product. Recycling can be integrated within the process through a closed loop system or can be conducted separately, using centralized onsite waste recycling systems or commercial materials recyclers. Waste reprocessed or reclaimed can be used on site or sold or given to other businesses for use in their operations. Some states maintain networks to facilitate waste exchanges (see Appendix A). The following examples illustrate recycling initiatives:

Maola Milk and Ice Cream Company in New Bern, North Carolina, recovers ice cream and milk products for reuse in ice cream products and animal feed. Initial reuse activities in 1986 prevented the loss of over 17,000 pounds of milk and decreased 5-day biochemical oxygen demand (BOD_5) by 17,000 pounds over a 4-month period. Soon after Maola began recovering milk and ice cream wastes, the City of New Bern's treatment plant showed a 14.7 percent reduction in BOD_5 and a 22.8 percent decrease in suspended solids. The recovery and reuse program also has translated into reduced chemical usage, less sludge accumulation, and reduced power requirements for the New Bern treatment plant. In 1988, Maola estimated it saved $24,000 per month in wastewater treatment costs and recovered product. Upon full implementation of the reuse and recovery program, Maola hopes to recover as much as 2,410 gallons per day of ice cream ingredient valued at $480,000 annually (PPIC, 1992).

Kinnear Door/Wayne-Dalton Corporation in Centralia, Washington, mills, joins, and glues wood parts for

building products. The primary waste stream of the wood processing plant is wastewater containing glue wash-down. The company analyzed a number of different options to properly dispose of the wastewater, including pretreatment in settling ponds and ultimate treatment at the local POTW. The company estimated the cost to dispose of the 2,500 gallons of wastewater generated each month would have totaled $10,000 annually. Employees at the plant, however, determined that the glue wash-down water could be reused in glue formulation. This discovery eliminated the need for constructing a costly pretreatment system and sending a potentially toxic effluent to the local POTW (U.S. EPA, 1991a).

Many industries conserve water in areas of the country where fresh water is in short supply or where local regulations limit the quantity of effluent discharged to POTWs. Industries employing recycling to achieve water conservation might increase effluent concentrations risking noncompliance with concentration-based effluent limits. To encourage water conservation, some POTWs have implemented mass-based limits that allow a certain mass of toxic discharges over a specified period of time. With mass-based, as opposed to concentration-based, limits, businesses can conserve water while maintaining compliance with discharge requirements. Section 4.2.1.3 discusses the use of mass-based limits.

In summary, this chapter describes several pollution prevention approaches and presents the experiences of several industrial and commercial facilities that have successfully applied pollution prevention methods. By communicating the benefits of pollution prevention to owners and operators of industrial and commercial facilities, POTW personnel can motivate facility personnel to seek pollution prevention technical information and assistance. The next chapter outlines a strategy POTW personnel can use to effectively focus efforts to promote pollution prevention at industries and commercial businesses to maximize the beneficial effects on receiving water quality, POTW performance, and worker health and safety.

Chapter 3
Targeting Pollution Prevention Efforts

POTW personnel can promote pollution prevention by integrating new concepts and approaches with existing activities. By making industries aware of the advantages of pollution prevention, POTW personnel will start to shift their thinking from treatment and cross-media pollution transfer to multimedia pollution prevention. The benefits of pollution prevention to pretreatment programs is twofold: (1) to assist in addressing current and anticipated compliance problems, and (2) generally to try to encourage opportunities to reduce toxic loadings to the sewers. The first step a POTW should take is to develop a policy statement that affirms the POTW's commitment to promoting pollution prevention in all its capacities (see Figure 3-1). Then POTWs should target their pollution prevention efforts on problem contaminants and identify the industrial, commercial, or domestic sources of concern. A relatively small-scale effort focused on one problem contaminant provides a well-defined goal for an initial effort. The experience gained from a small-scale effort can provide the foundation for future expanded pollution prevention efforts. This chapter outlines the preliminary steps POTWs should take to set priorities that maximize the usefulness of pollution prevention efforts (see Figure 3-2). These steps are to (1) identify pollutants of concern (see Section 3.1), (2) identify users that are sources of problem pollutants (see Section 3.2), and (3) prioritize sewer users that could reduce the discharge of problem pollutants through pollution prevention (see Section 3.3).

Pretreatment personnel should consult with other local, state, and federal agencies (e.g., local board of health, local planning and fire departments, state agencies governing pollution and hazardous waste management, and EPA regional offices) before embarking on a full-scale effort (see Section 3.4). This will ensure that they:

- Keep pollution prevention goals consistent with other applicable regulations and programs.
- Avoid unnecessary duplication of effort.
- Share information.
- Coordinate dealings with users.
- Fully utilize local, state, and regional technical and financial resources.

This chapter also reviews the types of resources available from federal, state, and local agencies that can assist with POTW efforts to promote pollution prevention.

3.1 Identifying Pollutants of Concern

Pollution prevention provides users with another tool to comply with local limits developed to prevent or remediate problems at the POTW related to specific pollutants in wastewater discharges. Problems related to specific contaminants can be divided into three broad categories:

- Environmental permit and disposal requirements
  - NPDES permit limits
  - Clean Air Act permit standards
  - Sludge disposal requirements.
- POTW worker safety concerns.
- POTW operational problems (e.g., an industrial pollutant adversely affects the microorganism population at the plant).

Most often, POTWs target a specific contaminant for pollution prevention because of problems in achieving compliance with their current NPDES permit, or because they anticipate problems in meeting future NPDES permit limits. In general, NPDES requirements will become more restrictive in the future as standards for sewage sludge use and disposal and ambient sediment quality are established, and ambient water quality criteria become more restrictive. Pretreatment coordinators can consider pollution prevention options first when drafting a strategy for achieving compliance with increasingly stringent discharge levels.

For example, investigators in southern Massachusetts believed that elevated levels of copper in surface water and sediments posed unreasonable risks to human health and the environment locally. This finding caused EPA to issue a copper discharge limit of 9 parts per billion (ppb) to the Fall River POTW. Fall River, in turn,

POTW RESOLUTION FOR DEVELOPING A POLLUTION PREVENTION PROGRAM TO REDUCE INDUSTRIAL POLLUTANT DISCHARGES TO THE SEWERS

WHEREAS pollution prevention includes reducing the use of toxic substances, reducing the generation of toxic waste at the source, and recycling toxic waste; and

WHEREAS pollution prevention strategies can substantially reduce toxic pollutant loads to the sewers, without transferring those same pollutants to the air or land; and

WHEREAS pollution prevention saves businesses money by increasing productivity while reducing treatment and disposal costs, sewer fees, long-term liability, and chemical feedstock costs; and,

WHEREAS the industrial and commercial pollutants currently discharged to POTWs can work their way into the environment through receiving water pass-through, sludge disposal, air evaporation, and collection system leaks, causing potential environmental problems; and

WHEREAS future regulatory pressures and economic growth are likely to increase significantly the current industrial pollutant load to the sewers; and

WHEREAS, due to increasingly stringent state and federal laws, POTWs in the future will have to limit significantly the toxic pollutants in their sludge, receiving water, and air emissions;

NOW THEREFORE BE IT RESOLVED that the _____ (name of the POTW) establishes a pollution prevention program to assist area businesses in reducing their toxic pollutant discharges to the sewers; and

BE IT FURTHER RESOLVED that the _____ (lead dept. or division) develops and implements this pollution prevention program; and

BE IT FURTHER RESOLVED that, in developing this program, the _____ (lead dept. or division):

- Identifies specific industrial dischargers and water-borne pollutants for priority attention;
- Sets percentage reduction goals for those water-borne toxic pollutants identified as a priority;
- Confers with other local agencies that regulate the same industries; and
- Evaluates the feasibility of each of the following program options: educational outreach, technical assistance, and regulations; and

BE IT FURTHER RESOLVED that the _____ (lead dept. or division) submits a proposed work program to this Board by _____ (date) that identifies the pollution prevention activities selected for implementation, along with a timetable and required financial support; and,

BE IT FURTHER RESOLVED that the _____ (lead dept. or legal division) recommends to this Board by _____ (date) any changes to the existing sewer use ordinance necessary to implement the pollution prevention program as proposed.

Source: Adapted from Sherry, 1988b.

Figure 3-1. Sample POTW pollution prevention policy statement.

had to tighten its pretreatment standards for copper. Most of the local textile mills indicated that they could not afford copper treatment systems and would have to shut down, thus threatening the local economy. In response, the Fall River POTW aggressively pursued pollution prevention opportunities with the affected textile mills to reduce copper discharges without necessitating enormous capital outlays. Many approaches were evaluated:

- Lowering the speed of cloth movement through the dye baths.
- Being attentive to additives that keep copper in solution.
- Educating textile buyers to accept products with low- or no-copper dyes.
- Educating dyers on the shop floor as to which dyes are copper free.
- Controlling pH, temperature, salt concentrations, and fixatives to increase dye efficiency.
- Replacing part of a metalized dye with nonmetalized dyes.
- Avoiding use of copper sulfate after treatments.
- Avoiding floor spillage.

Copper loadings entering the Fall River POTW have fallen as a result of these measures; however, additional

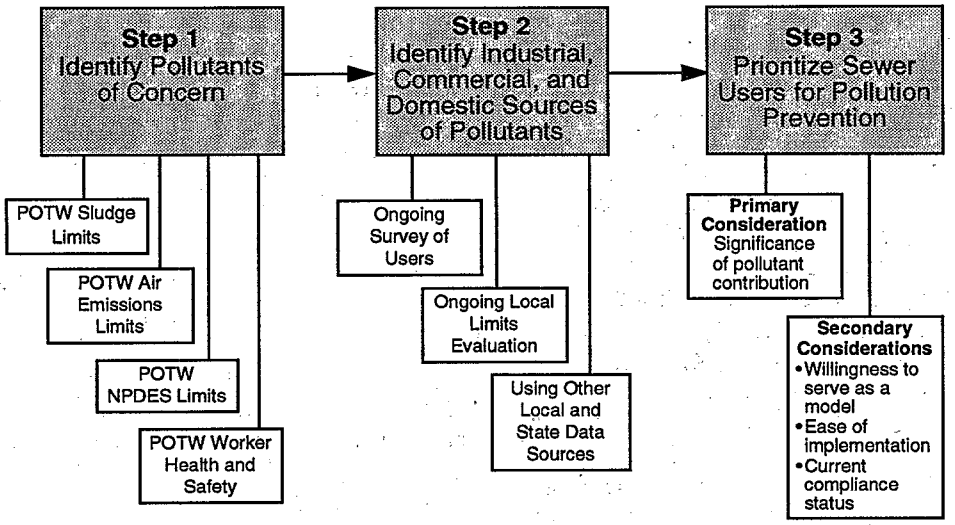


Figure 3-2. Setting pollution prevention priorities.

actions will be necessary to achieve full compliance with the limit.

In another example, the Western Lake Superior Sanitary District (WLSSD) anticipated that it would not meet its future NPDES permit level for mercury. After determining that major industrial facilities do not significantly contribute to mercury loadings, WLSSD focused its mercury abatement efforts on unpermitted commercial establishments and residential users. Investigators determined that discharges from dental offices and laboratories, as well as mercury-containing products in solid waste from commercial and residential sources constituted significant sources of mercury. The local solid waste incinerator's control system uses water to "scrub" volatilized mercury from air emissions. This scrubber water is discharged to the POTW. The WLSSD formed working groups representing dentists and laboratories, two groups of sewer users believed to be collectively significant generators of mercury waste. The purpose of the working groups is to identify means of reducing mercury discharges through use of BMPs and other measures. Also, a local advisory group is exploring the possibility of implementing a thermostat collection program for local construction and demolition companies to reduce this source of mercury in solid waste that is incinerated. The details of the WLSSD program are presented in Section 4.3.2.

3.2 Identifying Users of Concern

Once a POTW has targeted a particular contaminant for pollution prevention, the POTW must determine which industrial, commercial, and domestic sources discharge the contaminant. It might not be obvious which dischargers are the major sources of the contaminant, especially if the chemical is an integral part of many different industrial and commercial processes, or if it is used primarily by unpermitted users about which the POTW has little information. In ongoing local limit evaluations, pretreatment personnel perform influent toxic-loading studies that can identify significant differences in the influent loadings of toxic pollutants and the known industrial/commercial/domestic loadings to the sewer system. Where there is a significant difference, the POTW will need to resurvey industrial or commercial groups to identify the previously unknown additional sources of toxic pollutants.

3.2.1 Industrial Users

The POTW should have a wealth of information on its categorical and other significant industrial users from recent inspections, existing and past permits, and the POTW's pretreatment program industrial waste surveys. Under the General Pretreatment Regulations, POTWs also should have been notified about the types and volumes of hazardous wastes generated and disposed of by their users (40 CFR 403.12[p]).

Determining which significant industrial users discharge the contaminant of concern should be a relatively simple matter since POTWs routinely collect and receive data on these industrial users. In the Fall River case (see Section 3.1), the pretreatment personnel immediately recognized that its permitted textile mills used copper dyes and hence were likely significant contributors of copper to the POTW.

To help locate new or unknown dischargers, pretreatment personnel generally contact local and state agencies to cross-reference records on water users, new utility connections, and building permits. Observation of changes in local businesses while out in the field also provides information about new users.

3.2.2 Commercial Users

Many POTWs have discovered that commercial dischargers account for a large percentage of the toxic pollutants in a POTW's influent. As the pretreatment program achieves lower levels of toxic pollutants in industrial discharges, commercial and domestic sources will account for a larger percentage of the POTW's total toxic influent load. EPA estimates that 15 percent of all priority pollutants currently entering POTWs originate in commercial and unpermitted small industrial facilities. EPA further estimates that commercial and domestic establishments might eventually account for as much as two-thirds of the toxic metals discharged to POTWs nationwide (GAO, 1991). While the concentration of pollutants in nonindustrial effluent might be relatively low compared to that in industrial effluent, the volume of nonindustrial effluent is approximately six times larger than the volume from industrial sources at most POTWs (GAO, 1991).

Unfortunately, POTWs often have little information about their commercial dischargers since they do not actively inspect them and might not have included them in the initial waste survey. As a first step, the POTWs could develop a comprehensive list of commercial processes that generate the contaminant in question and what types of commercial establishments employ those processes. For example, if mercury is a particular problem, likely commercial contributors could include dental offices and laboratories. Table 3-1 lists common commercial establishments and the types of pollutants they typically produce.

To define further which commercial establishments produce and discharge the contaminant of concern, the POTWs could survey commercial establishments in the POTW service area that are likely to be discharging that contaminant. Cross-referencing records of businesses with other agencies will help identify previously unknown or new commercial users to include in the survey. The survey will refine the list of potential commercial contributors, estimate average discharge concentrations and flows from each facility, and provide information about the pollution prevention measures the facilities already employ. A well-defined survey instrument will yield enough data on which to base further actions and assess the potential usefulness of pollution prevention in those commercial establishments. The survey instrument need not be particularly lengthy or complicated. Figure 3-3 is the form used by the Palo Alto, California, POTW in its silver reduction program.

The Palo Alto POTW's Silver Reduction Pilot Program is an excellent example of using pollution prevention to drastically reduce commercial discharges of a specific contaminant. This POTW discharges to South San Francisco Bay (South Bay), which, over many decades, has become severely polluted by heavy metals. The Palo Alto POTW received permission from the Regional Water Quality Board to conduct a source reduction pilot program targeted at silver, a particular problem in South Bay. At the outset of the program, the Palo Alto POTW discharge concentrations of silver were more than 3.5 times the proposed South Bay limits, and silver concentrations in South Bay clams were many times higher than levels observed in other areas of the Bay.

Initial sampling and mass balance audits conducted by the Palo Alto POTW revealed that small businesses contributed up to 70 percent of the POTW's influent silver loading, regulated industries contributed 25

Table 3-1. Commercial Establishments and Their Potential Discharges of Concern (adapted from U.S. EPA, 1991d)

Type of Facility	Discharges of Concern
Automotive repair and service	Chemical oxygen demand, heavy metals, solvents, paints, surfactants, oil, and grease
Car washes	Chemical oxygen demand, zinc, lead, and copper
Truck cleaners	Chemical oxygen demand, total dissolved solids, cyanide, phosphate, phenol, zinc, aluminum, chromium, lead, and copper
Dry cleaners	Total dissolved solids, chemical oxygen demand, phosphate, butyl cellosolve, N-butyl benzene sulfonamide, perchloroethylene, iron, zinc, and copper
Laundries	Chemical oxygen demand, ethyl toluene, n-propyl alcohol, isopropyl alcohol, toluene, m-xylene, p-xylene, ethylbenzene, bis(2-ethylhexyl)phthalate, iron, lead, zinc, copper, chromium, phosphate, and sulfide
Hospitals	Total dissolved solids, chemical oxygen demand, phosphate, surfactants, formaldehyde, phenol, fluoride, lead, iron, barium, copper, mercury, silver, and zinc
Photoprocessors	Chemical oxygen demand, ammonia, cyanide, sulfur, phosphates, silver, arsenic, chromium, phenol, and bromide
Laboratories	Chemical oxygen demand, mercury, silver, and toxic organics
Dental offices	Copper, zinc, silver, and mercury

FACILITY SURVEY OF PHOTOGRAPHIC ACTIVITIES

1. DOES YOUR FACILITY PROCESS ANY PHOTOGRAPHIC MATERIALS ON SITE?

   YES_____ NO_____

2. BRIEFLY DESCRIBE YOUR OPERATION:

   _____

   _____

   _____

   IF ANSWER TO QUESTION #1 IS "NO" GO TO #8

3. WHICH OF THE FOLLOWING DOES YOUR FACILITY PROCESS ON SITE?

	COLOR	BLACK & WHITE
FILM	_____	_____
PAPER	_____	_____
MOVIE	_____	_____
X-RAYS	_____	_____

   OTHER: _____

4. WHAT IS THE TOTAL VOLUME OF FIXER AND BLEACH-FIX USED PER MONTH?

   _____ 5 GALLONS _____ 26-100 GALLONS _____ 500 GALLONS (AMOUNT: _____)

   _____ 6-25 GALLONS _____ 101-500 GALLONS

5. DOES YOUR FACILITY REMOVE SILVER FROM THESE SOLUTIONS ON SITE?

   _____ FIX _____ WASHWATER _____ BLEACH-FIX

   RECOVERY SYSTEM INFORMATION (IF APPLICABLE):

   MANUFACTURER: _____

   MAKE & MODEL: _____

6. DOES YOUR FACILITY SEND EITHER OF THESE MATERIALS OFF SITE FOR SILVER RECOVERY?

   _____ SPENT CARTRIDGES _____ SPENT SOLUTIONS

7. COMMENTS/QUESTIONS: _____

   _____

   _____

8. FACILITY CONTACT INFORMATION:

   BUSINESS NAME: _____

   ADDRESS: _____

   TELEPHONE: _____

   CONTACT NAME: _____ TITLE: _____

PLEASE RETURN TO RWQCP IN THE ENCLOSED ENVELOPE WITHIN 10 DAYS:

REGIONAL WATER QUALITY CONTROL PLANT
2501 Embarcadero Way
Palo Alto, CA 94303

Source: City of Palo Alto, 1992.

Figure 3-3. Example of a commercial facility survey form.

percent, and residential users contributed 5 percent. POTW personnel already had a solid understanding of the nature of the industrial silver discharges and concluded that commercial dischargers deserved their focus. They surveyed 650 businesses in the service area suspected of processing photographic materials, X-rays, and photographic films and negatives—the principal silver-producing commercial processes. More than 50 percent of the establishments that returned the survey indicated that they produced silver-bearing photographic wastes. The affirmative responses were received from many small graphic artists, photoprocessors, printers/publishers, medical facilities, and dental offices. About 80 percent of these facilities indicated that they produced less than 5 gallons per day of silver-bearing photoprocessing wastes. The survey data provided the basis for calculating local limits for commercial photoprocessors and for requiring photoprocessors to implement a variety of pollution prevention measures (see case study in Section 4.2.1.2).

3.2.3 Domestic Users

Households regularly discharge many problem wastes and products, such as used oil, drain cleaners, detergents, paint and paint thinners, and solvents, directly to household drains and storm drains. EPA estimates that households contribute approximately 15 percent of all priority pollutants discharged to the nation's POTWs (GAO, 1991). As with commercial establishments, EPA expects that household sources will account for a larger share of priority pollutant discharges to POTWs as industrial sources come under stricter regulation. Studies have shown that households account for the majority of total discharges for some pollutants (GAO, 1991). Table 3-2 lists consumer products and the problem pollutants they contain.

In the early 1980s, Seattle initiated a program to control domestic sources of toxics in wastewater entering its POTWs. Studies indicated that up to 64 percent of the arsenic in Seattle's sewage sludge comes from households. As much as 40 percent of the arsenic from domestic sources originates in common household powdered laundry detergents, dishwashing soap, and bleach.

Metro, Seattle's POTW authority, created an independent committee of local environmental and citizen groups and personnel from local and state wastewater, solid waste, and health agencies. The committee developed rating criteria that focused on the near-term toxicity, long-term toxicity, flammability/reactivity, and environmental hazards associated with commercial products. Based on the product's evaluation under each of these categories, the committee assigned the product a color ranging from green, representing the least risk to the environment, to black, indicating the greatest risk. A product's overall rating is based on the least favorable rating it gets in any given category. As of late 1991, the committee had rated more than 250 products and disseminated fact sheets containing these rankings to local retailers and consumers (GAO, 1991).

3.3 Prioritizing Users of Concern

Generally, pretreatment personnel will want to focus on the industrial, commercial, or domestic source contributing the largest share of a given contaminant of concern to the POTW influent. Once the primary sources have been established, they can be prioritized based on secondary considerations:

- *Selection of model facility.* Certain industries or commercial groups might be willing to undertake pollution prevention programs as a model for other dischargers. This could provide excellent publicity for all parties while achieving the desired reductions in toxic discharges at a potentially lower cost than pursuing strictly a treatment solution.
- *Ease of implementation.* Pollution prevention opportunities might be more obvious and readily implemented in certain industries. For example, BMPs, which are easily implemented generally, might achieve greater source reduction in some industries, while other industries might need to make more radical process or product changes to achieve a similar level of pollution prevention. Targeting the pollution prevention program at industries that could achieve large reductions from simple pollution prevention measures will provide greater assurance of success, provide valuable experience for approaching more difficult industries, and impose a lesser burden on the POTW and the industry.
- *Current compliance status.* Industries currently out of compliance with pretreatment standards might be excellent candidates for pollution prevention. In many cases, pollution prevention can be incorporated into enforcement agreements. For example, the POTW could consider a company's willingness to implement pollution prevention measures when establishing penalties and developing compliance schedules (see Section 4.2.2).

3.4 Utilizing Pollution Prevention Resources

Pretreatment personnel should consult and coordinate with the appropriate federal, state, and local agencies prior to embarking on a major pollution prevention initiative. Environmental managers for every medium have begun to explore the potential benefits of pollution prevention. A coordinated effort with other federal, state, and local programs could lessen substantially the

Table 3-2. Consumer Products and Their Potentially Toxic or Hazardous Constituents (adapted from URI, 1988)

Product	Toxic or Hazardous Constituents
Antifreeze (gasoline or coolant systems)	Methanol, ethylene glycol
Automatic transmission fluid	Petroleum distillates, xylene
Battery acid (electrolyte)	Sulfuric acid
Degreasers for driveways and garages	Petroleum solvents, alcohols, glycol ether
Degreasers for engines and metal	Chlorinated hydrocarbons, toluene, phenols, dichloroperchloroethylene
Engine and radiator flushes	Petroleum solvents, ketones, butanol, glycol ether
Hydraulic fluid (brake fluid)	Hydrocarbons, fluorocarbons
Motor oils and waste oils	Hydrocarbons
Gasoline and jet fuel	Hydrocarbons
Diesel fuel, kerosene, #2 heating oil	Hydrocarbons
Grease, lubricants	Hydrocarbons
Rustproofers	Phenols, heavy metals
Carwash detergents	Alkyl benzene sulfonates
Car waxes and polishes	Petroleum distillates, hydrocarbons, heavy metals
Asphalt and roofing tar	Hydrocarbons
Paints, varnishes, stains, dyes,	Heavy metals, toluene
Paint and lacquer thinner	Heavy metals
Paint and varnish removers, deglossers	Methylene chloride, toluene, acetone, xylene, ethanol, benzene, methanol
Paintbrush cleaners	Hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones
Floor and furniture strippers, polishes, and waxes	Xylene, heavy metals
Metal polishes	Petroleum distillates, isopropanol, petroleum naphtha
Laundry soil and stain removers	Petroleum distillates, tetrachloroethylene
Spot removers and dry-cleaning fluid	Hydrocarbons, benzene, trichloroethylene, 1,1,1-trichloroethane
Other solvents	Acetone, benzene
Rock salt	Sodium chloride
Refrigerants	1,1,2-trichloro-1,2,2-trifluoroethane
Bug and tar removers	Xylene, petroleum distillates
Household cleansers, oven cleaners	Xylenols, glycol ethers, isopropanol
Drain cleaners	1,1,1-trichloroethane, inorganic acids
Toilet cleaners	Xylene, sulfonates, chlorinated phenols
Cesspool cleaners	Xylene, sulfonates, chlorinated phenols
Disinfectants	Cresol, xylenols, phenols
Pesticides (all types)	Naphthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons
Photochemicals	Phenols, sodium sulfite, silver halide, potassium bromide, thiocyanate, ferricyanide, dichromate bleaches, phosphate, ammonium compounds
Printing ink	Heavy metals, phenol-formaldehyde
Wood preservatives	Pentachlorophenols
Swimming pool chlorine	Sodium hypochlorite
Lye or caustic soda	Sodium hydroxide
Jewelry cleaners	Sodium cyanide

financial burden and avoid unnecessary duplication of effort among environmental and public health agencies. In addition, a coordinated effort might be met with less confusion and animosity on the part of targeted industries.

With a statutory mandate to incorporate pollution prevention into all federal environmental programs, EPA has established the Office of Pollution Prevention and Toxics (OPPT) and the Pollution Prevention Information Clearinghouse (PPIC). PPIC functions as a national depository for technical, policy, programmatic, legislative, and financial information on pollution prevention. The PPIC hotline and on-line computerized data base, the Pollution Prevention Information Exchange System (PIES), contain a wealth of readily accessible information on pollution prevention. EPA's Risk Reduction Engineering Laboratory and the Center for Environmental Research Information (CERI), both in Cincinnati, Ohio, also are excellent sources of technical information. Many EPA offices (including OPPT) issue special grants to state and local entities interested in implementing a pollution prevention program. Appendix A provides more information about these and other federal pollution prevention resources.

Also, federal, state, and local organizations sponsor pollution prevention training sessions and workshops. Workshops focus on pollution prevention in general or specific opportunities within certain industries. Often they are open to both industry and regulators and provide an excellent forum for POTW pretreatment personnel to receive input from their users in an informal setting. Personnel can contact the state pollution prevention or hazardous waste office for information about pollution prevention training opportunities in the local area. Pollution prevention conference and training information also can be obtained on line from the PIES.

Many states have an active pollution prevention program that can provide technical assistance to POTWs and industrial and commercial users that wish to learn more about pollution prevention in general or need specific technical pollution prevention advice (see Table 3-3). State programs most often include one or more of the following elements:

- *Pollution prevention or toxics use reduction goals.* States establish goals to reduce toxic discharges in the state by some specified percentage. These goals serve as targets against which to measure progress.
- *Industry reporting.* Chemical manufacturers and users file annual reports detailing chemical use and existing inventories.
- *Industry planning.* Hazardous waste generators assess their facilities for pollution prevention opportunities and file a detailed pollution prevention plan with the state. In many states these plans are available to state officials and the general public.
- *Technical assistance.* Programs provide hands-on technical assistance to firms and state facilities seeking to implement pollution prevention measures and technologies.
- *Research and development.* Some states fund university-based pollution prevention institutes to engage in research, establish pilot and demonstration projects, conduct training, and act as pollution prevention clearinghouses.
- *Grants.* Programs provide pollution prevention grants to localities, state facilities, and firms interested in demonstrating innovative pollution prevention technologies and regulatory programs.
- *Training.* Many state agencies hold workshops and provide training materials on industry-specific pollution prevention technologies.

Various states have been extremely active in assisting POTWs with pollution prevention programs. In California, North Carolina, Minnesota, Connecticut, and Massachusetts, for example, state technical assistance and general programmatic support have been instrumental in helping industrial dischargers achieve significant pollution prevention goals. POTWs in Massachusetts often refer their industrial and commercial dischargers to the Office of Technical Assistance (OTA), created with the passage of Massachusetts' Toxics Use Reduction Act (TURA). OTA serves as a technical pollution prevention clearinghouse and often takes part in actual POTW inspections at the request of both the POTW and industry. OTA also has been active in sponsoring pollution prevention workshops and providing pollution prevention training for state and local environmental compliance inspectors.

Minnesota's Technical Assistance Program (MnTAP) offers pollution prevention assistance to Minnesota's smaller industries. One of the more innovative aspects of MnTAP is its internship program, which pays a salary to an appropriately qualified engineering student to work with a company in implementing a pollution prevention program or in identifying and assessing a specific pollution prevention technology. As part of its mission, MnTAP also provides technical assistance and training and participates in multimedia inspections.

Many states now require industrial facilities to submit detailed pollution prevention reporting and planning data. For example, Tennessee requires facilities that generate more than 220 pounds of hazardous waste per year to submit pollution prevention plans by 1994. The plans must include:

- A policy statement of management's commitment to pollution prevention.
- Specific goals of the plan, including numeric performance goals.
- Technically and economically practical pollution prevention options and a schedule for their implementation.
- An accounting of hazardous waste management costs.
- A description of pollution prevention training programs for employees.
- A rationale for stated performance goals.

POTW officials could use this type of information to prepare for site visits and learn more about industry-specific waste streams and pollution prevention opportunities. Some facility data are considered proprietary, and, depending on state laws, POTW personnel might have access to this information. Table 3-3 shows the states that have either enacted or proposed pollution prevention laws that require hazardous waste generator reporting and pollution prevention planning.

Cooperative ventures between POTWs and state and local solid waste, air, and water agencies are becoming more and more common. The state and federal focus on multimedia transfers has led to a greater integration of specific environmental media programs. Some states now operate multimedia inspection programs in which a team of inspectors from the principal environmental program offices examines an industrial facility for compliance but also with a heightened awareness of multimedia transfers and pollution prevention. Section 4.1.4 discusses multimedia inspections. Teaming up with local public health officials, drinking water treatment personnel, or solid waste management personnel to promote pollution prevention in the community also might be advisable in some cases.

Please refer to Appendix A for a list of federal, state, and local pollution prevention resources.

In summary, to protect against the pass-through of toxic pollutants to receiving waters and to maintain proper treatment plant performance, POTW personnel identify and prioritize pollutants and sewer users for control. Pollution prevention methods have been shown to be the most cost-effective and environmentally sound means of controlling waste management problems. This chapter presents an approach for focusing POTW pollution prevention efforts. The following chapter explains ways pretreatment personnel can encourage indirect dischargers to adopt pollution prevention measures. POTW personnel can accomplish this by integrating pollution prevention concepts into ongoing program activities.

Table 3-3. States with Existing or Proposed Pollution Prevention Technical Assistance and Facility Planning and Reporting Requirements (WRITAR, 1992; PPIC, 1992)

State	Existing Technical Assistance Programs	Existing Facility Planning and Reporting Requirements	Proposed Technical Assistance Programs*	Proposed Facility Planning and Reporting Requirements*
Alabama	✔			
Alaska	✔			
Arizona	✔	✔		
Arkansas	✔			
California	✔	✔		
Colorado	✔			
Connecticut	✔			
Delaware	✔			
Florida	✔			
Georgia	✔	✔		
Hawaii	✔			
Illinois	✔			
Indiana	✔			
Iowa	✔	✔		
Kentucky	✔			
Louisiana	✔	✔		
Maine	✔	✔		
Maryland	✔			
Massachusetts	✔	✔		
Michigan			✔	
Minnesota	✔	✔		
Mississippi	✔	✔		
Nebraska	✔			
Nevada	✔			
New Hampshire	✔			
New Jersey	✔	✔		
New Mexico	✔			
New York	✔	✔		
North Carolina	✔	✔		
Ohio	✔			✔
Oregon	✔	✔		
Pennsylvania	✔			
Rhode Island	✔			
South Carolina	✔			✔
South Dakota	✔			
Tennessee	✔	✔		
Texas	✔			
Vermont	✔	✔		
Virginia	✔			
Washington	✔	✔		
West Virginia	✔			
Wisconsin	✔	✔		
Wyoming	✔			

Note: A list of telephone numbers and addresses of state pollution prevention contacts is supplied in Appendix A.
* Proposed as of March 1992.

Chapter 4
Promoting Pollution Prevention Among Regulated and Unregulated Sewer Users

Once a POTW has identified problem contaminants and prioritized industrial, commercial, and domestic users accordingly, it can focus on how pollution prevention can be incorporated into inspection, permitting, and enforcement activities as a full or partial solution to identified problems. This chapter explores several options for incorporating pollution prevention into existing inspection (Section 4.1) and regulatory activities (Section 4.2). In addition, Section 4.3 suggests some ways a POTW can publicize pollution prevention through public outreach, workshops, forums, user awards programs, and domestic hazardous waste collection programs. Some of these activities are more resource intensive than others, and those that are most appropriate for a given POTW will depend on the types of sources and contaminants the POTW wishes to target and the POTW's available staff and financial resources. In many cases, it might be best to begin with a simple activity and use the experience gained to launch more complex pollution prevention efforts in the future.

4.1 Inspections

One of the most effective ways to identify and promote pollution prevention is to explore opportunities during routine facility inspections. Because a POTW's staff usually has a close relationship with local industry and commercial establishments, they are in a unique position to educate businesses on the advantages of pollution prevention. POTW personnel that routinely visit industries can heighten a business' awareness of pollution prevention and promote it as a viable alternative to more traditional treatment technologies or more costly disposal.

Incorporating pollution prevention into existing POTW inspections is not a substitute for performing a pollution prevention audit. States may sponsor multimedia audit programs or industries and commercial businesses can conduct their own audits to explore pollution prevention options that affect all facility waste streams. Either way, a pollution prevention audit involves a comprehensive evaluation of a facility's processes and operations. This section presents guidance on how to identify areas in industrial and commercial processes, during routine POTW inspections, where facility owners and operators could further evaluate the potential for applying pollution prevention measures.

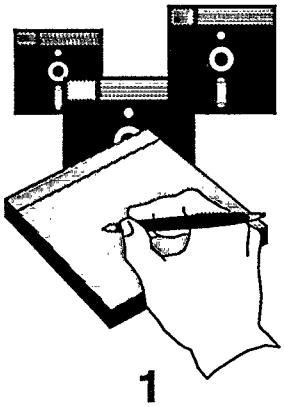
Pollution prevention can be incorporated into POTW facility inspections. By asking investigative questions, disseminating basic pollution prevention information, and offering sources of further technical assistance, POTW personnel can point out pollution prevention opportunities that are mutually beneficial to both parties. This section describes an approach that incorporates pollution prevention into preinspection activities (Section 4.1.1), the inspection itself (Section 4.1.2), and postinspection followup (Section 4.1.3). Figure 4-1 depicts how pollution prevention concepts can be integrated into the three stages of performing facility inspections. Section 4.1.4 discusses the usefulness of multimedia inspections in identifying and promoting pollution prevention.

4.1.1 Preinspection Activities

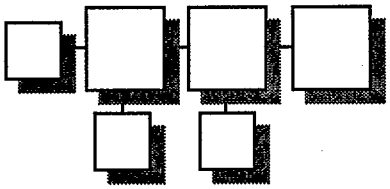
Preinspection activities can be divided into three categories: (1) initial data gathering efforts, (2) identifying specific areas in the process that would benefit most from pollution prevention measures, and (3) assembling information on pollution prevention techniques that seem to be applicable to the facility to be inspected based on the preinspection analysis.

4.1.1.1 Gathering Facility-Specific Data

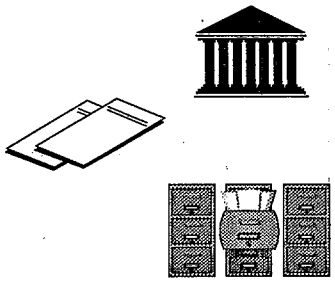
With a solid understanding of many industrial processes, the types of inputs they require, and the waste streams they generate, POTW personnel can help identify potential problem areas and initiate discussions with facility personnel about implementing pollution prevention measures. Much of the required information and data are readily available at the POTW. For example, POTW personnel collect process information and waste stream monitoring data on significant industrial users to develop permits and prepare for traditional user inspections. In addition, the revised General Pretreatment Regulations require dischargers to report to wastewater authorities the types and quantities of certified hazardous chemicals they



1
Data gathering on facility activities

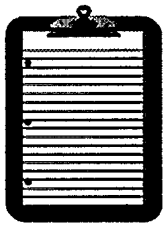


2
Creating & evaluating a process-flow diagram



3
Collecting information on applicable pollution prevention measures from EPA & state technical assistance programs

Preinspection



1
During inspection, consider pollution prevention solutions

What leads to the generation of this waste?

What prevents you from using an alternative input material?

2
Ask open-ended questions about potential applicability of pollution prevention techniques

Onsite Inspection

1
Supply available information on applicable pollution prevention techniques

For further information call...

2
Refer to sources of additional information on pollution prevention

3
Postinspection followup

Postinspection

Figure 4-1. Using onsite inspection to promote the benefits of pollution prevention.

generate and discharge to the sewer (40 CFR 403.12[p]). With a full picture of the process and the materials used, POTW personnel can better understand how and why a given waste stream is generated and what types of pollution prevention measures would effectively reduce pollutant loads to the sewers. The more POTW personnel know, the more focused the inspection will be.

POTWs interested in inspecting unpermitted industries and commercial facilities might have greater difficulty obtaining current, facility-specific process data. Options in such cases include:

- Reviewing industrial waste survey data.
- Contacting other federal, state, and local environmental and public health program offices that might have collected facility-specific information.
- Requesting process data and information directly from the facility (under the pretreatment program, POTWs have the authority to collect facility-specific information from any discharger).

In addition, POTW personnel can gather information about the process in question from general sources, such as EPA guidance documents and other technical manuals. POTW personnel also can contact the PPIC, state technical assistance offices, and trade groups to find out more about specific industrial and commercial processes and applicable pollution prevention techniques (see Appendix A for a listing of information sources).

For permitted facilities, POTW personnel should review information relating to the facility's compliance history. Compliance data can help POTW personnel focus preinspection information-gathering efforts on pollution prevention options that address the facility's greatest compliance problems. For example, if POTW personnel know that the facility is having or has had problems meeting pretreatment standards for copper, they can make a special effort to investigate pollution prevention measures that have succeeded in reducing copper discharges in similar facilities. POTW personnel also should be aware of any impending pretreatment standards or POTW restrictions that will either require more stringent discharge limits for a particular contaminant or address a previously unregulated contaminant that the facility in question currently discharges. With this knowledge, POTW personnel can advise facilities to start thinking about pollution prevention as a means of meeting future discharge limits.

Knowledge of the facility's present or past pollution prevention activities can help POTW personnel target other areas of the facility that could potentially use improvements. POTW personnel also will have a better understanding of how much facility operators already know about pollution prevention and the types of information the facility might find useful. Acknowledging the facility's current pollution prevention accomplishments can help set the tone for a positive discussion of additional measures the facility could take.

Facilities might have already submitted to state agencies waste minimization plans that POTW personnel can review to obtain relevant information for their inspection. Table 3-3 lists states that currently require such plans. State laws vary as to the level of confidentiality accorded waste minimization plans.

4.1.1.2 Identifying Areas That Would Benefit from Pollution Prevention Measures

Drawing on the information gathered from the sources discussed, the following four-step approach will assist in identifying areas of the facility's process where pollution prevention measures could reduce toxic loadings to the sewers:

1. Construct a simple process-flow diagram of the operation. Show all inputs and outputs to the process, including raw materials inputs, product outputs, material recovery, and waste streams.
2. Perform a materials balance assessment to identify significant material losses occurring in the process.
3. Evaluate the sources of identified losses.
4. Identify areas other than process areas, such as storage areas or garages, where losses typically occur.

As the first step, POTW personnel can develop a flow diagram that depicts the sequence and function of all the unit processes and the materials going into and coming out of each unit. This diagram will help POTW personnel define the operation and form the basis for tracking the materials as they go through the process and ultimately end up in the product, recovered materials, or the waste stream. POTW personnel can verify the accuracy of the process-flow diagrams during the inspection. Figure 4-2 is an example of a process-flow diagram for a photoprocessing operation. (This photoprocessing example will be used to illustrate the application of the four steps outlined above).

The next step is to account for the majority of the material flows into and out of the process. Based on the process flow diagram, POTW personnel can track the pollutant of concern from its point of origin in the raw material inputs to the resulting products and waste streams. It is helpful to make a list of all input and output materials. For the photoprocessing example, Table 4-1 itemizes the material inputs and outputs and identifies areas where losses are occurring and wastes are generated. Using raw materials purchasing records,

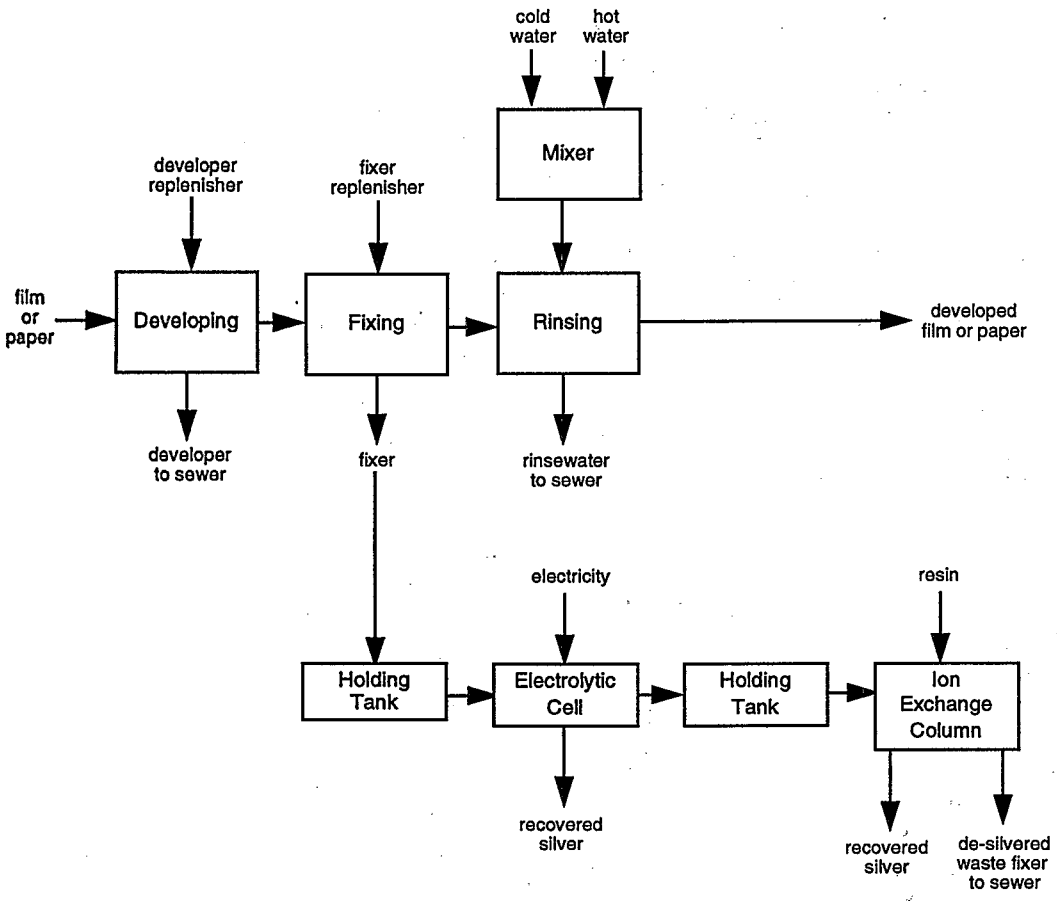


Figure 4-2. Sample flow diagram of photoprocessing operation.

Table 4-1. Sample Materials Accounting List for a Photoprocessing Example

Material Inputs	Material Outputs	Losses/Wastes
Photographic Film	Developed Film and Paper	Waste Developer
Photographic Paper	Recovered Silver	De-silvered Waste Fixer
Developer Replenisher		Waste Rinsewater
Fixer Replenisher		
Stabilizer		
Iron		
Cold Water		
Hot Water		

waste stream monitoring and flow data, and product data, POTW personnel can quantify the mass of materials going through the process. For the photoprocessing example, the tracking of silver mass is illustrated in Figure 4-3. This is similar to, but not as rigorous as, an engineering mass balance exercise. The mass of input materials should approximate the combined mass of materials output in the product, recovered materials, and the waste streams. Although the mass balance will be unequal due to the variability in waste stream sampling and flow data and errors in estimating input and output masses, it should be within an acceptable margin of error. The acceptable margin of error varies with the known precision and accuracy of information used to estimate the material mass at each stage. A substantial difference between materials input and output from the process indicates losses of materials that should be investigated. Figure 4-4 illustrates a material balance calculation tracking the mass of silver going into and out of the photoprocessing example. In this example, the material balance was not exact, but was judged to be within an acceptable margin of error.

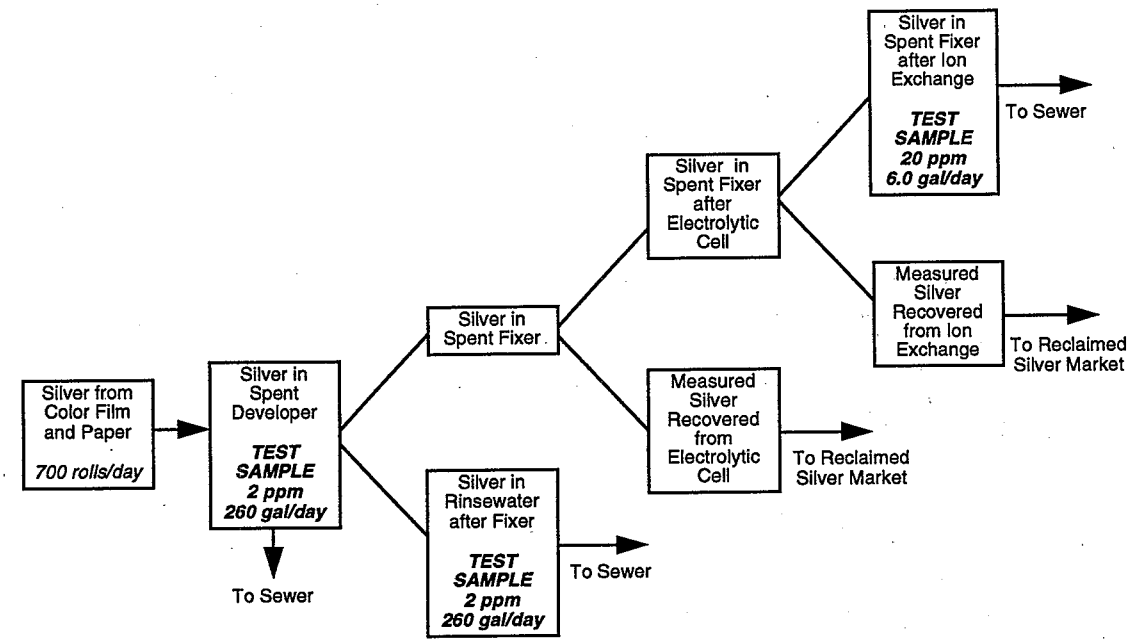


Figure 4-3. Tracking the silver material balance in a color photoprocessing operation.

Losses can occur during the process for several reasons. They can be related to inefficiencies in the production process itself, maintenance procedures, inventory controls, or internal management of waste residuals. POTW personnel can speculate about the sources of losses before the inspection; however, at the inspection, through observing operations and questioning facility personnel, POTW personnel will be better able to draw more informed conclusions regarding the source of and possible pollution prevention solutions to the materials losses.

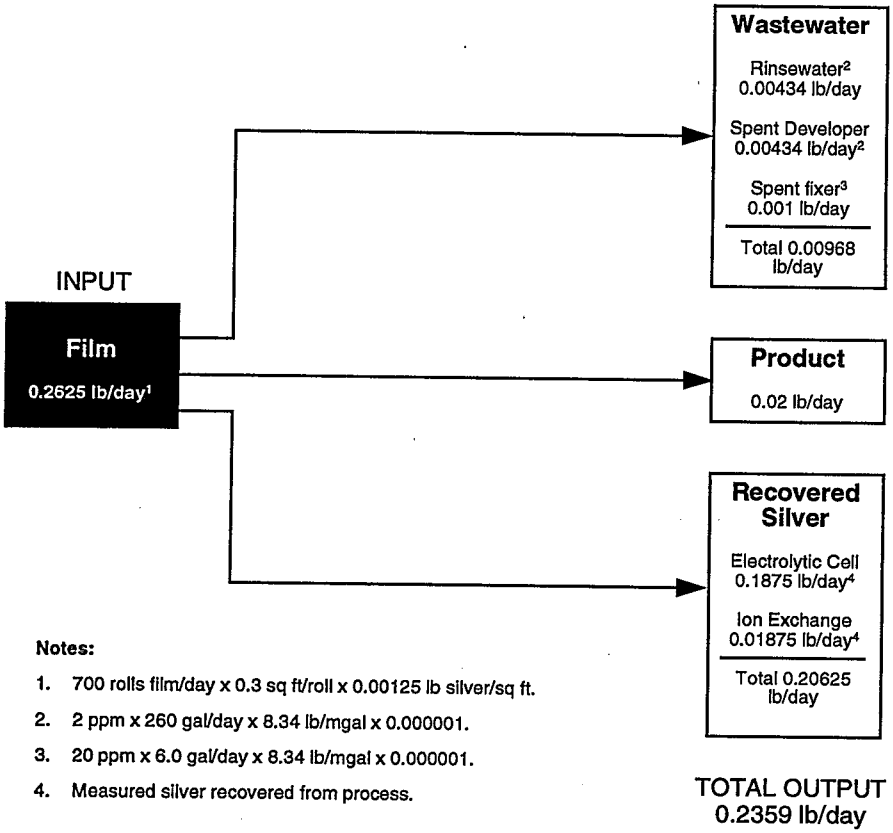
In addition to the process areas, POTW personnel should investigate the existence of storage areas, pumping stations, laboratories, boiler areas, garages, pollution control equipment, and power generating facilities. These are areas that should be observed during the inspection to determine whether good operating practices are being applied to prevent or minimize the discharge of pollutants to the POTW, especially through floor drains, and whether further improvements in existing practices or other pollution prevention options might be appropriate. In addition, based on knowledge of the industry, POTW personnel can identify any periodic maintenance activities, such as equipment or tank cleaning, boiler blow down, and motor fluid changes, that can periodically generate significant waste streams potentially discharged to the sewer. Improving operating practices for these activities should be encouraged and applying specific pollution prevention measures may also be appropriate.

4.1.1.3 Assembling Information on Applicable Pollution Prevention Techniques

Once a preliminary assessment of materials losses is conducted, POTW personnel should compile a "laundry list" of possible pollution prevention alternatives that would reduce or eliminate losses. Investigators should focus on collecting as much information as possible about the pollution prevention opportunities available for the industry under investigation. The information can be used for the purpose of educating facility owners and operators about the usefulness of pollution prevention measures, supplying available documents and other materials on pollution prevention, and encouraging facility owners to conduct their own pollution prevention assessment of all potentially feasible options. The final decision about the applicability of any pollution prevention measure will be made by the facility based on economic, technical, and feasibility factors.

Many federal, state, local, and private sources provide excellent summaries of known pollution prevention techniques implemented by specific industrial and commercial groups. These sources are listed in Appendix A. To start, POTW personnel should refer to the industry-specific pollution prevention summaries compiled in Appendix B.

POTW personnel also should assemble relevant case study information. Facility owners might be more likely to investigate seriously a pollution prevention technique if they know that a similar facility has realized a savings using the same method. PIES is an on-line source for case study material catalogued by type of pollution



Notes:

1. 700 rolls film/day x 0.3 sq ft/roll x 0.00125 lb silver/sq ft.
2. 2 ppm x 260 gal/day x 8.34 lb/mgal x 0.000001.
3. 20 ppm x 6.0 gal/day x 8.34 lb/mgal x 0.000001.
4. Measured silver recovered from process.

Figure 4-4. Comparing silver input and output in a photoprocessing operation.

prevention technique, industrial process, and industry group (see Appendix A for information on how to access PIES). State and federal pollution prevention technical assistance offices also can help POTW personnel with specific pollution prevention questions or information requests. Many of these technical offices sponsor pollution prevention workshops for industry and state personnel interested in learning about pollution prevention opportunities in a given industry.

Table 4-2 lists some potential pollution prevention measures identified for the photoprocessing example illustrated in this chapter. The options are organized according to the major waste streams from the developing and fixing steps and the rinsing unit. There are also some general facility options listed.

4.1.2 Inspection Procedures

The inspection provides an opportunity for pretreatment personnel to view facility operations and encourage pollution prevention to the fullest extent. One of the goals of the inspection is to leave an industrial user with a good idea of which areas of the facility can potentially employ pollution prevention measures to help achieve compliance with discharge limits and reduce toxic loadings to the sewer. These goals can be accomplished by (1) setting the appropriate tone, (2) making observations and asking the right questions, (3) giving appropriate advice, and (4) highlighting pollution prevention in the exit meeting.

4.1.2.1 Setting the Appropriate Tone

Most routine facility inspections begin with a meeting. At this time, POTW personnel can inform facility personnel that the POTW is promoting pollution prevention as a means of reducing toxic discharges to the sewers and achieving long-term compliance with pretreatment standards. Topics to cover in the opening meeting include:

- What pollution prevention is and why it is important to the POTW. POTW personnel could emphasize how the facility might benefit from increased source reduction and recycling.
- Current and potential future user compliance problems based on existing and anticipated POTW compliance needs and how pollution prevention could help address these problems.
- The types of pollution prevention measures the facility has already adopted and what sort of

Table 4-2. Sample Pollution Prevention List for Photoprocessing Example

Process/Process Step	Opportunity	Option
Developing and fixing steps	Reduce chemical use (to reduce chemical loading to POTW)	1. Adjust replenishment rates. 2. Install silver recovery fixer recirculator. 3. Use squeegees to minimize chemical carryover from developer and fixer. 4. Evaluate recycling fixer. 5. Monitor silver recovery units to ensure maximum operating efficiency. 6. Use low silver-containing rapid access (RA) chemicals. 7. Route fixer overflow drains to silver recovery. 8. Segregate high and low silver-bearing streams to enhance silver recovery. 9. Check storage areas daily for spills. Chemical storage area could be diked and absorbent pillows could be made available to contain spills.
Rinsing	Reduce water use (to reduce water use, water heating, and silver discharge to POTW)	1. Install water recirculator. 2. Evaluate recycling rinsewater, including recovering silver. 3. Check storage areas daily for spills. Chemical storage area could be diked and absorbent pillows could be made available to contain spills.
General facility	Good operating practices	1. First-in/first-out inventory control. 2. Inventory inspection for leaks and spills. 3. Use lids or other means to minimize chemical contact with air.

successes and problems the facility has had with those measures.

- The objective of identifying some additional pollution prevention measures that the facility could consider and encouraging the facility to adopt pollution prevention measures wherever feasible.

4.1.2.2 Identifying Pollution Prevention Opportunities Through Observation and Asking the Right Questions

During the inspection, POTW personnel should look for pollution prevention opportunities by examining current administrative, operating, maintenance, and storage practices. POTW personnel can observe the flow of the facility's process, following the train of events that leads to the disposal of contaminants to the sewer and verifying the accuracy of the process flow diagram constructed prior to the inspection. If user or POTW compliance issues were identified prior to the inspection, reducing the sources of problem contaminants very likely will be the primary focus of the inspection. If the materials balance calculations indicated substantial losses of certain materials, identifying the sources of these losses and reducing them very likely will be another major focus of the inspection.

Beyond the process itself, controlling spills and leaks, modifying poorly designed storage facilities, improving the efficiency of outdated and poorly maintained machinery, and other pollution prevention opportunities falling under the general category of good operating practices can be observed. These types of opportunities will generally be easier to identify than process-related opportunities because they are somewhat generic to all businesses.

The key to getting facility owners and operators thinking about pollution prevention and how it might work in their facility is to ask open-ended questions about why they use a certain process or input, or why some current practice could or could not be changed. POTW personnel should formulate open-ended questions that solicit thoughtful answers and stimulate further discussion. Ultimately, such discussions might lead to the discovery of a feasible pollution prevention opportunity. Open-ended questions prompt users to think about why they have chosen a given process or input and what prevents them from changing to another process or input. Close-ended, or "yes/no," questions tend to be more accusatory and solicit one-word answers that can effectively end the discussion and might close a potentially promising pollution prevention angle entirely (Greiner and Richard, 1992).

Examples of both types of questions follows:

Open-ended Questions

- What is the company's policy with regard to pollution prevention?
- How are employees trained to perform their jobs?
- What makes this input so valuable? What limits you from using an alternative?
- What leads to the generation of this discharge?
- How could the facility try to recover and purify some of its solvents?

- What would happen if you converted to countercurrent rinsing?

Close-ended Questions

- Is management committed to pursuing pollution prevention? Does the company have a written pollution prevention policy statement?
- Can you use a different manufacturing process?
- Have you experimented with other inputs?
- Do you have to use this degreaser?

POTW personnel can use the results of their process-flow analysis as a basis for their questions. In addition, published pollution prevention information (see Appendix A) and the industry-specific pollution prevention summaries in Appendix B can help formulate pollution prevention questions that touch on the facility's major operations. Published pollution prevention checklists can be helpful guides; however, POTW personnel should not be overly reliant on checklists since no single checklist can account for the variations in standard processes and operating practices that investigators will encounter in the field. Checklists are generally designed to provide a convenient pollution prevention outline.

4.1.2.3 Giving Advice and Making Recommendations

POTW personnel must be careful about giving pollution prevention advice. In general, investigators should refrain from specifying products or suggesting that if the firm implements a certain pollution prevention measure, it will achieve compliance with pretreatment standards. POTW personnel should give limited, basic advice in an informal manner and provide examples of other companies that have experimented with a given pollution prevention measure. Here are some examples of how and how not to give pollution prevention advice:

Recommended Approach

- "Drag-out in plating operations is a serious problem for many circuit board manufacturers. Many manufacturers have experimented with lowering the viscosity of their plating baths, which reduces the volume of excess plating material that clings to the circuit board. Others have changed the orientation of the plated part and increased the time they allow for plated parts to drain before rinsing. Another circuit board manufacturing facility I have visited claims that these and other measures have reduced drag-out and increased the life of their plating baths considerably. Here's the number of the state technical assistance office; I'm sure they can tell you more about these and other drag-out reduction techniques."
- "I was over at another facility the other day and noticed that they use countercurrent rinsing and have installed a rinsewater recycling unit. This has cut their water consumption by over 30 percent, lowered their water and sewer bills, and helped reduce the amount of silver discharged to our POTW. Perhaps you could call the people at the state technical assistance office for more information. It could save you some money and help us meet our NPDES permit limit for silver."

Approach Not Recommended

- "Your silver discharges are quite high and might exceed new pretreatment standards. The ACME Silver Recovery Unit is a great buy. Many local photoprocessors currently use one and make a great return on the recovered silver. You should probably get one."
- "I attended this pollution prevention workshop for commercial printers a couple of months ago. ACME, Inc., was advertising this new soy-based ink that apparently is just as effective as traditional petroleum-based inks and is entirely biodegradable and nontoxic. Because of your current compliance problems, I would advise you to switch to these new inks."

This does not mean that POTW personnel should refer all questions to a technical assistance office and refrain from discussing a pollution prevention technology altogether. POTW personnel should simply avoid leaving the impression that they are endorsing a given product, service, or technique and that adopting specific pollution prevention measures will somehow ensure compliance. Ultimately, the facility will need to conduct a detailed cost-benefit analysis to determine whether a given pollution prevention measure is a viable option for reducing the generation of problem pollutants.

POTW personnel should be careful about revealing the identity of firms that have implemented pollution prevention measures that seem applicable to other similar facilities. Some of this information might be considered confidential; therefore, POTW personnel should check with facility managers before giving out company names for illustration purposes.

4.1.2.4 Exit Meeting

As part of the usual exit meeting, POTW personnel can summarize preliminary findings with respect to compliance and pollution prevention and receive the facility's initial response to those findings and any comments they might have about the inspection process. At this meeting, POTW personnel might wish to disseminate any applicable published pollution prevention information (e.g., EPA or state industry-specific pollution prevention handbooks, fact sheets, summaries from Appendix B) and inform owners

and operators of state technical assistance offices and other pollution prevention resources such as PPIC and the PIES on-line service. It should be clear that POTW personnel are not making recommendations about specific measures to implement but rather summarizing applicable information based on what was observed during the inspection.

4.1.3 Postinspection Followup

As part of the normal inspection report, the investigator should include observations about pollution prevention measures for the facility to consider and put forward more detailed information about measures that seem particularly promising and suggest some additional contacts and references for more information. POTW personnel also might wish to contact the facility after an appropriate amount of time to see if the facility has given any further consideration to the identified pollution prevention opportunities and to discover what problems or successes, if any, the company has had. This information could be very useful in future inspections.

4.1.4 Multimedia Inspections

As emphasized earlier, pollution prevention using source reduction and recycling is an environmental management method that can help avoid cross-media transfers of environmental contaminants. Multimedia inspections can greatly improve the ability of environmental regulators to recognize cross-media transfers at particular industrial and commercial facilities and identify pollution prevention measures to mitigate such transfers. For example, an onsite wastewater pretreatment system could transfer volatile organics from an open mixing tank to the air. Conversely, air pollution technologies using wet scrubbers to cleanse air emissions of toxic compounds could transfer contaminants to the facility's wastewater. Coordination among local hazardous and solid waste, air, water, and POTW officials through multimedia inspections can often uncover complicated cross-media transfers.

Multimedia inspection programs are generally initiated at the state level, since they require planning and coordination among state and local agencies. In most cases, POTWs will not have the resources to initiate such an inspection program. POTWs can help start a multimedia inspection program, however, by contacting the appropriate regional, state, and local offices to garner support for the concept and suggest the formation of a planning group. POTW personnel should have a strong say in how the inspection program will operate, since they inspect more facilities than most other state and local agencies.

A number of states have initiated multimedia inspection pilot programs. Members of Massachusetts' highly successful multimedia inspection program, the "Blackstone Project," have inspected hundreds of industrial facilities. Industries generally approve of the program, since it reduces the number of inspections they must accommodate each year and often offers sound technical pollution prevention advice that saves them money. Massachusetts' POTWs play an integral role in the ongoing program.

The Western Lake Superior Sanitary District (WLSSD), mentioned in Chapter 3, participates in the Lake Superior Partnership Compliance Assistance Program (CAP) in conjunction with the Minnesota Pollution Control Agency (MPCA), EPA, and industry. To begin with, CAP visited 15 companies discharging to the WLSSD POTW for voluntary multimedia compliance inspections that promoted pollution prevention and the mitigation of cross-media transfers. While the inspections evaluated companies for compliance with existing permits, CAP hoped to form a strong partnership with permitted facilities to strengthen industry's ability to maintain long-term compliance with state and federal environmental regulations through pollution prevention.

Each inspection begins with a preinspection conference, during which CAP inspectors (including air, water, and hazardous waste officials, and the WLSSD POTW staff) brief facility personnel about the inspection process, the pollution prevention focus, and technical assistance and address any concerns industry staff might have about the inspection. WLSSD also requests that the facility submit a list of pollution prevention activities that the company has either explored or fully implemented prior to the inspection. This helps the inspectors identify and research pollution prevention opportunities that the company has not yet considered and about which the facility might have limited information.

The CAP inspections generally last a full day and are conducted in a manner similar to single-media inspections. Because inspectors represent all environmental media, however, the inspections are more likely to recognize cross-media transfers of environmental contaminants and the need for pollution prevention measures rather than more traditional environmental control technologies. Conflicting answers among various media regulators are resolved immediately, thereby enhancing mutual trust between industry and environmental regulators. The inspections conclude with an exit interview where inspectors comment on the facility's current conditions and areas that need improvement. Inspectors also indicate where pollution prevention opportunities might exist and suggest sources of further information. The inspection team submits formal written comments and

recommendations to the company about which pollution prevention opportunities seem worthy of further study.

Overall, CAP has achieved an unprecedented level of cooperation among industry, state environmental regulators, and local POTW personnel and has greatly enhanced the prospects for meaningful pollution prevention in the WLSSD area.

4.2 Encouraging Pollution Prevention Through Regulatory Activities

POTW personnel can encourage pollution prevention through existing regulatory activities. These activities include developing and issuing user permits (see Section 4.2.1) and responding to user noncompliance (see Section 4.2.2).

4.2.1 Issuing User Permits

POTWs have authority to require users to meet discharge limits and other requirements to prevent pass-through of toxic contaminants and disruptions of normal wastewater treatment operations. In general, setting local limits covering a wide range of contaminants and industrial and commercial sources provides a strong incentive for implementing pollution prevention measures. The cost of treatment generally rises with the stringency of local limits; as this occurs, pollution prevention becomes a more desirable means to assist industrial and commercial users in meeting local limits.

POTWs with the appropriate authority, usually established in sewer use ordinances, can use the permitting process as an effective mechanism for instituting pollution prevention as a local requirement for industrial and commercial users. This section discusses three permitting strategies that either directly require facilities to adopt certain pollution prevention practices or create incentive structures that indirectly promote pollution prevention. These approaches are:

- Requiring pollution prevention plans and implementation of BMPs (Section 4.2.1.1).
- Controlling discharges from small industrial and commercial users (Section 4.2.1.2).
- Employing mass-based local limits (Section 4.2.1.3).

4.2.1.1 Requiring Pollution Prevention Plans and Implementation of Applicable BMPs

POTW pretreatment personnel can heighten interest in and awareness of pollution prevention as a means of meeting pretreatment standards by requiring industrial and commercial users to develop and submit pollution prevention plans as part of the permitting process. As stated earlier, POTWs may need to amend or enact sewer use ordinances to provide them with the authority to require submission of pollution prevention plans. Pollution prevention plans contain detailed and systematic assessments of a facility's ability to reduce the volume and toxicity of discharges through pollution prevention activities. A pollution prevention assessment or audit conducted by facility owners and operators can be the single most effective means for identifying technically and economically feasible pollution prevention opportunities capable of achieving long-term reductions in the generation of toxic waste streams.

Many industrial users are already subject to pollution prevention planning requirements. For example, under the current federal pretreatment regulations, some industrial users are required to develop and implement TOMPs and spill prevention plans, which address some types of pollution prevention measures. As part of toxics use reduction legislation, a number of states require certain generators of hazardous wastes to submit pollution prevention or waste minimization plans (see Table 3-3). Also, some Resource Conservation and Recovery Act (RCRA) provisions require certain hazardous waste generators to conduct pollution prevention or waste minimization planning. Pretreatment personnel should contact appropriate state and local agencies to determine whether any of the POTW's users have filed pollution prevention plans to meet existing federal or state requirements.

If users have not already developed pollution prevention plans that address the waste streams destined for the sewers, a local pretreatment program should consider exploring the possibility of incorporating a pollution prevention planning provision into the permitting process. Such a provision could require that a facility interested in renewing an existing permit or obtaining a new permit must submit a detailed pollution prevention plan. Pollution prevention plans should consist of the following elements:

- A process-flow diagram showing where toxic constituents enter and exit the manufacturing process.
- An estimate of the amount of regulated waste generated by each process.
- An assessment of current and past pollution prevention activities, including an estimate of the reduction in amount and toxicity of regulated waste achieved by the identified actions.
- A review of pollution prevention opportunities applicable to the facility's operations.
- Identification of technically and economically feasible pollution prevention opportunities, including an assessment of the cost, benefits, and cross-media impacts of the identified opportunities.
- An implementation timetable.

POTW personnel can assist their industrial and commercial dischargers in developing pollution prevention plans by pointing out pollution prevention opportunities during inspections, coordinating meetings between state technical assistance personnel and facility owners and operators, and providing published materials such as EPA's *Waste Minimization Opportunity Assessment Manual, Software and User Manual for the Strategic Waste Minimization Initiative (SWAMI computer program), and Facility Pollution Prevention Guide* (see Appendix A for full references).

New or expanding facilities or those with existing compliance problems are the most likely to benefit from pollution prevention planning. Facilities conducting pollution prevention audits prior to the construction or modification of a facility might find it more feasible to incorporate innovative process and building designs that reduce toxic waste discharges than a more established facility that has already invested in more traditional manufacturing and treatment equipment. Facilities that have failed to meet discharge limits with traditional treatment technologies might be more inclined to invest in pollution prevention planning than a facility that successfully meets pretreatment standards. Of course, any facility is likely to benefit from pollution prevention planning and should be encouraged to do so.

For many years, the Suffolk County, New York, POTW has required its users to identify waste minimization methods when applying for a discharge permit. Engineering reports submitted with permit applications must contain a section outlining the types of pollution prevention actions the facility has considered, along with the outcome of those evaluations. POTW personnel review the pollution prevention statements and suggest additional pollution prevention actions the facility might consider. The POTW reports that, in some cases, pollution prevention plans have identified source reduction opportunities that reduced the toxic discharges of users to levels where a permit was no longer necessary.

POTWs also can require their dischargers to adopt BMPs such as inventory controls, employee training, and basic maintenance and inspection activities (see Section 2.1.1). BMPs generally can be implemented at little or no cost and often can achieve significant reductions in toxic discharges. Most industries have implemented some level of BMPs in an effort to run more efficient operations. Small industrial and commercial facilities, however, may not be aware of these simple steps to cleaner, more efficient operations and could benefit from the POTW's guidance. The most direct means for achieving widespread implementation of BMPs is to require pollution prevention planning as a precondition for obtaining or renewing a discharge permit.

In an effort to reduce metal and organic contamination in South San Francisco Bay, the Palo Alto POTW recently passed an ordinance requiring BMPs for automotive-related industries (i.e., facilities that repair automobiles, trucks, buses, airplanes, boats, etc.; or that perform services such as parts cleaning, body work, vehicle washing, fuel dispensing, or radiator, muffler, or transmission repair). Palo Alto offered these facilities the option of either sealing floor drains and implementing BMPs or installing treatment systems and meeting local limits. Palo Alto drafted the ordinance with the belief that automotive facilities can virtually eliminate toxic waste discharges by implementing inexpensive BMPs, thereby eliminating the need to apply for permits and install costly treatment systems.

The ordinance stipulates that automotive facilities meet the following requirements:

- No person shall directly or indirectly dispose of vehicle fluids, hazardous materials, or rinsewater to storm drains.
- Spilled rinsewater, hazardous waste, and vehicle fluids must immediately be cleaned up.
- Vehicle fluid removal must take place where spilled fluid will be in an area of secondary containment.
- No person shall leave unattended drip pans or other open containers containing vehicle fluids.
- Vehicle service areas shall be cleaned using methods that ensure that no materials are discharged to sanitary or storm drains except in accordance with pretreatment standards. Facilities that use the following three-step process for cleaning floors will not require a permit:
  1. Clean up spills with rags or other absorbent materials.
  2. Sweep floor using dry absorbent materials.
  3. Discharge dirty water from mopping floors to the sanitary sewer via a toilet or sink.
- Spill prevention and cleanup equipment and absorbent materials shall be kept on hand at all times.
- Owners and operators shall ensure that all employees are trained regarding BMPs upon hiring and annually thereafter.

The Palo Alto POTW took several steps to ensure that automotive facilities were aware of the new ordinance and that facilities had access to technical assistance prior to the effective date of the ordinance. For example, they distributed a handbook describing automotive

facility BMPs that reduce toxic waste discharges (Santa Clara Valley, 1991). If requested by the user, POTW personnel were available to go to the facility to answer questions about the new ordinance and give guidance on the implementation of BMPs. Palo Alto awarded public recognition to automotive facilities that achieved full compliance with pretreatment standards through use of BMPs and other pollution prevention methods by October 1, 1992.

Palo Alto plans to develop similar ordinances in the near future emphasizing BMPs for laboratories, machine shops, and cooling towers.

4.2.1.2 Controlling Discharges from Small Industrial and Commercial Users

Commercial and small industrial dischargers, such as laundries, dental offices, laboratories, hospitals, printing and publishing operations, photoprocessing facilities, wood refinishers, and motor vehicle operations, are sometimes not required to obtain discharge permits. These facilities, however, may represent a significant portion of the total loading of a toxic pollutant entering a POTW. In this situation, a POTW could benefit greatly from imposing local limits on and promoting pollution prevention at commercial and small industrial users. In some cases, a sewer use ordinance alone can provide the necessary control over small industrial and commercial users; however, an ordinance does not allow a POTW to set user-specific requirements that can be incorporated into individual discharge permits.

The Palo Alto POTW has been very active in permitting commercial dischargers. Elevated levels of silver in South San Francisco Bay led the Palo Alto POTW to investigate which of its commercial and industrial users contributed to silver loadings to the POTW (see Section 3.2.2). Based on industrial effluent data and commercial facility survey data, Palo Alto determined that photoprocessors accounted for up to 70 percent of the total silver loadings entering the plant.

In response to this investigation, the Palo Alto POTW decided to impose local commercial and industrial silver limits designed to achieve a POTW effluent NPDES limit of 2.3 µg/l. Along with the new local limits, permitted facilities must also comply with various pollution prevention provisions designed to reduce the use and discharge of silver. For example, affected industrial facilities must now conduct studies identifying pollution prevention opportunities for reducing silver discharges as part of the permitting process. Through onsite inspections and workshops, Palo Alto encourages photoprocessors and industrial generators of silver wastes to adopt pollution prevention methods wherever practicable to achieve compliance with local limits.

The program has been immensely successful. The average silver concentration of POTW effluent has decreased by about 75 percent in the 2 years since local limits were imposed and is now well below the NPDES permit limit of 2.3 µg/l. Palo Alto estimates the cost of the source reduction project to the POTW at about $320 per pound of silver. This is extremely cost effective when compared to the $2,700 per pound cost Palo Alto estimated for an end-of-the-pipe reverse osmosis treatment unit at the POTW.

4.2.1.3 Mass-based Limits

Currently, most POTWs issue pretreatment permits specifying the allowable concentrations of certain contaminants in wastewater discharged to sanitary sewers. Concentration limits are generally expressed in mg/l and are averaged over some specified period of time to allow for normal fluctuations in production. Mass-based limits, an alternative approach, provide dischargers with a specific quantity of a given contaminant (usually expressed as pounds per day) that they can discharge over a specified period of time. The mass discharge rate of a contaminant can be calculated by knowing the flow rate of the waste stream and its average concentration. For example, a waste stream of 10,000 gallons per day, averaging 2.5 mg/l of copper, translates into 0.21 pounds of copper per day:

$$10{,}000 \text{ gal/day} \times 3.785 \text{ l/gal} \times 2.5 \text{ mg/l} \times 1 \text{ lb}/453{,}600 \text{ mg} = 0.21 \text{ lb/day}$$

There are many institutional impediments to applying mass-based limits to industrial users. EPA provides guidance on the use of mass-based limits in its 1987 *Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program.*

In terms of pollution prevention, mass-based limits offer an alternative to the more traditional concentration-based limits. Eliminating one part of a waste stream through pollution prevention or reducing water consumption might cause a facility to increase pollutant concentrations, even though the total mass of the pollutant does not increase and might even decrease. For example, in Figure 4-5, a hypothetical facility must comply with a discharge limit of 0.161 mg/l copper. The facility has two waste streams that combine before discharge to the POTW: waste stream A discharges 132,100 gal/day containing 0.066 mg/l copper and waste stream B discharges 158,520 gal/day containing 0.228 mg/l copper. Through pollution prevention, the facility eliminates waste stream A entirely and thus has achieved a reduction in the total mass of copper discharged (from 0.37 lb/day to 0.30 lb/day); however, the facility now finds itself exceeding its concentration-based limit. An alternative mass-based

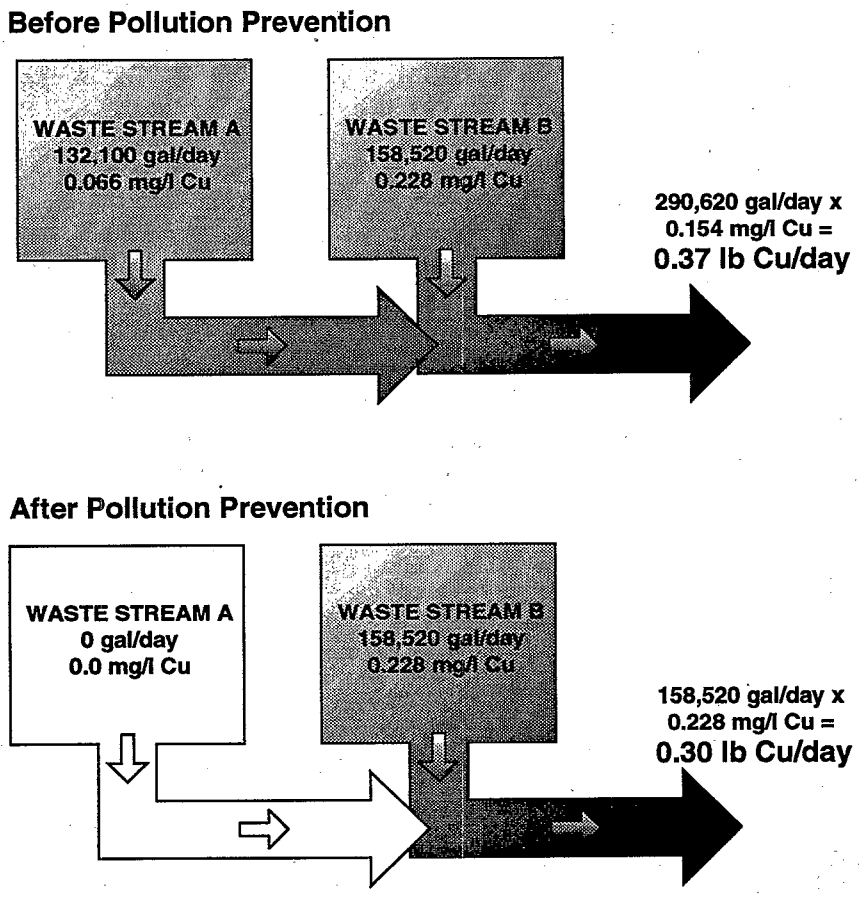


Figure 4-5. Hypothetical waste stream concentrations before and after pollution prevention.

limit of 0.39 lb/day would have provided the same level of protection and allowed for the increase in concentration due to the reduction in flow.[1]

To monitor facilities accurately for compliance with mass-based limits, POTWs must have reliable data on industrial flow along with the concentrations of pollutants in the wastewater. While reliable concentration data are relatively easy to collect, accurate flow data may be more difficult to obtain. In some cases, flow meters may have to be installed.

4.2.2 Responding to User Noncompliance

POTWs can encourage pollution prevention by taking full advantage of their authority to deal with users in noncompliance with pretreatment requirements. As part of the normal program activities of issuing permits and conducting inspections, POTWs can encourage pollution prevention, but they cannot require specific measures beyond those considered BMPs. In response to user noncompliance, however, a POTW can require specific pollution prevention measures as part of a mutually agreed upon compliance schedule with the user.

In requiring the development of a corrective action plan, POTWs can require facilities in noncompliance to conduct pollution prevention planning, to identify cost-effective pollution prevention measures, and to develop an implementation schedule with interim and final milestones. The implementation schedule can then be incorporated into a binding compliance schedule. The user in noncompliance can be required to evaluate pollution prevention options, but should be allowed the flexibility to develop a corrective action plan that includes the most effective mix of pollution prevention measures and traditional treatment options. An example of a compliance schedule that includes pollution prevention and recycling requirements is provided in Figure 4-6.

4.3 Community Education and Outreach

POTWs can play a central role in communicating the need for greater pollution prevention in businesses and

[1] Mass-based limit calculated based on facility flow and current discharge limit of 0.161 mg/l copper: 0.161 mg/l copper x 290,620 gal/day x 8.34 lb/million gal x 0.000001 = 0.39 lb/day copper.

COMPLIANCE SCHEDULE FOR USER IN NONCOMPLIANCE WITH PERMIT LIMITS

A. By July 1, 1992

The user shall submit a preliminary report on corrective action measures to be taken to maintain consistent compliance with permit conditions. At a minimum, the report shall include:

- A detailed process-flow diagram that identifies and characterizes the input of raw materials, the outflow of products, and the generation of wastes.
- Any steps taken to reduce the concentrations and/or mass of regulated pollutants in the user's discharge to the sewer.
- Preliminary findings of corrective action planning, including the identification of any pollution prevention, recycle/reuse, and treatment measures that are being considered for implementation.

B. By August 15, 1992

The user shall submit to the POTW a corrective action plan for its discharge to the sewer system. The plan shall present an implementation schedule that outlines the steps to be taken to bring the user's discharge into consistent compliance with permit conditions by December 31, 1992. In developing the corrective action plan, the user shall evaluate and identify, for implementation, all cost-effective pollution prevention measures. Once developed, and if deemed technically sound by the POTW, the implementation schedule shall be incorporated into this compliance schedule.

Figure 4-6. Example of compliance schedule that incorporates pollution prevention.

the community by educating and directing people to sources of further information. In many cases, simply being made aware of the benefits of pollution prevention techniques is all that is needed to prompt businesses to pursue these options. Pollution prevention education and outreach activities are relatively inexpensive and simple to implement and capable of yielding reductions in toxic discharges to a POTW.

Many POTWs have either initiated or participated in education and outreach programs that stress pollution prevention. POTW pretreatment program personnel may want to collaborate with other state and local agencies to develop outreach programs of this nature. In many cases, programs of this sort may already exist in the POTW's region, in which case the POTW may want to join in the effort by providing input and support from the wastewater sector. Consider the following education and outreach alternatives.

4.3.1 Sponsoring Workshops and Training

Workshops and training are excellent means for conveying detailed pollution prevention information and can provide opportunities for all parties to discuss pollution prevention in an informal atmosphere. Workshops and training can address pollution prevention in general or can focus on pollution prevention in a specific industry. These might also include exercises in how to identify pollution prevention opportunities and perform cost-effectiveness analyses. Some of these events link industry personnel with companies that manufacture and design recycling and waste minimizing equipment.

A number of POTWs in Massachusetts, including Haverhill and the Massachusetts Water Resources Authority, have sponsored workshops in conjunction with the OTA. These workshops have been designed for both POTW and industry personnel and have covered pollution prevention in general as well as targeted specific industries such as machine shops, photoprocessing operations, and laboratories. A recent OTA conference on reducing the use of solvents included a trade show of solvent recyclers and manufacturers of nontoxic solvent substitutes allowing solvent users to obtain firsthand information about solvent recycling and source reduction.

4.3.2 Convening Local Pollution Prevention Forums

A pollution prevention forum might be composed of individuals from diverse groups of interested parties, such as POTWs, regulators, and local businesses, that want to explore the potential for various regulatory and nonregulatory pollution prevention initiatives to achieve reductions in toxic discharges and solve specific environmental problems.

WLSSD was instrumental in obtaining state and federal support for Minnesota's Lake Superior Partnership (LSP) advisory group, which consults with WLSSD and the MPCA on regulatory and nonregulatory initiatives to promote pollution prevention among industries discharging to the Western Lake Superior watershed. The LSP advisory group consists of representatives from industry, commerce, state and local governments, environmental groups, academia, and other interested citizens. The group's function is twofold: (1) to provide feedback to the MPCA and WLSSD regarding pollution prevention initiatives and (2) to serve as a vehicle for the transfer of pollution prevention and other relevant information among its various members. The group

explores issues of mutual interest to its members and makes recommendations about possible pollution prevention programs. The full LSP advisory group meets on a quarterly basis. Members involved in specific projects meet more frequently.

Part of the impetus for the formation of the LSP advisory group was to address mercury contamination in Western Lake Superior. The WLSSD POTW anticipated that it would not meet its future NPDES permit level for mercury without reducing influent mercury loadings to the POTW. WLSSD believed that various unpermitted commercial and domestic sources were contributing to the bulk of the POTW's mercury loadings. WLSSD determined that dental offices, laboratories, mercury thermostats, batteries, and fluorescent light bulbs were the principal sources of mercury contamination. Mercury in municipal solid waste is transferred to the scrubber water from the municipal solid waste incinerator, which in turn is discharged to the POTW.

With the help of the LSP advisory group, WLSSD formed two working groups: the Dental Mercury Work Group, with representatives of the Northeast Dental Society, and the Laboratory Mercury Work Group, with local laboratory staff. WLSSD hopes that the working groups will identify means by which dentists and laboratories can significantly reduce their mercury discharges through implementation of BMPs and other pollution prevention measures and thus avoid the need to directly permit these establishments in the future. In addition, the advisory group has explored the possibility of forming a mercury thermostat collection program for local construction/demolition companies and is investigating the impact of fluorescent light disposal on mercury levels in the POTW's effluent.

4.3.3 Publicly Recognizing Pollution Prevention Achievements

Recognizing pollution prevention achievements among the POTW's dischargers through an award and public announcement provides an incentive for users to voluntarily reduce toxic discharges, improves public relations, and demonstrates the POTW's commitment to furthering pollution prevention in the community.

The Maine Wastewater Control Association (MWCA), which represents pretreatment POTWs in Maine, awards the MWCA Pretreatment Excellence Award each year to the industrial facility that best demonstrates its commitment to reducing toxic discharges. MWCA judges facilities according to the following criteria:

- Wastewater pretreatment processes used by the facility.
- The percentage of the facility's process water being recycled.
- The percentage of the facility's waste residual material (i.e., sludge) being reused.
- Availability of adequately trained staff and financial resources.
- Innovative ideas the facility has used to reduce pollutants in its wastewater.
- The facility's system(s) for effectively recording and tracking compliance monitoring data.
- The types of spill control procedures/devices (e.g., secondary containment) the facility employs to prevent accidental chemical spills from entering the sewer system.
- Ability of the facility to stay abreast of modifications to applicable environmental laws.
- The environmental and/or economical benefits or successes derived from implementing pollution prevention methods.

As part of its effort to control toxic discharges from automobile-related facilities (see Section 4.2.1.1), Palo Alto instituted the Clean Bay Business Award. Palo Alto publicly recognized automobile facilities in compliance with the new discharge ordinances prior to the required date of October 1, 1992, with the Clean Bay Business Award. Palo Alto hopes that consumers will be predisposed toward businesses that have won the award.

4.3.4 Compiling and Distributing Pollution Prevention Information

POTWs can educate industrial, commercial, and domestic users with a range of existing pollution prevention publications from technical documents on specific pollution prevention techniques, to more general pamphlets on BMPs or household hazardous waste management. POTWs also can develop their own materials that address specific concerns in their communities. Many POTWs are active in supplying information resources; here are just a few examples:

- The POTW in Melbourne, Florida, obtains pollution prevention documents from the PIES (see Appendix A for more information on PIES) and distributes them at inspections. The Melbourne POTW has also created its own posters and bumper stickers designed to "spread the word" on pollution prevention throughout the community.
- In addition to distributing pollution prevention information during inspections and periodic mailings to targeted audiences, the Orange County Sanitation District in California operates a pollution prevention library available to its industrial dischargers.

- The Louisville and Jefferson County Metropolitan Sewer District (MSD) in Kentucky publishes its own newsletter entitled *Stream Line.* MSD distributes the newsletter to all of its industrial dischargers and covers pollution prevention as well as other issues pertinent to pretreatment and the POTW.
- The City of Vacaville, California, distributes two hazardous waste minimization booklets (the California Waste Exchange's *Directory of Industrial Recyclers* and *Waste Minimization: Environmental Quality with Economic Benefits*) to wastewater dischargers as a routine part of pretreatment inspections (Sherry, 1988a).
- The Palo Alto Regional Water Quality Control Plant provides guidance on how to improve compliance with pretreatment standards using simple BMPs.

4.3.5 Publicizing Household Hazardous Waste Collection Programs and Industrial Waste Exchanges

Household hazardous waste collection programs have been highly successful in preventing the indiscriminate disposal of hazardous waste by domestic sources. Industrial waste exchanges, which help match industrial waste from one facility with other facilities that can use that waste in another process, have been successful in promoting greater industrial waste reuse. (Appendix A lists a few existing waste exchanges.) While a POTW may not have the resources to form such programs itself, it can inform its domestic, commercial, and industrial dischargers of the availability of such programs. POTWs also can work cooperatively with other agencies to develop and maintain household hazardous waste collection programs and industrial waste exchanges. The Louisville and Jefferson County MSD, for example, helps several local agencies publicize and staff the local household hazardous waste collection days.

Chapter 5
References

EPA documents with a number that begins with 600 or 625 can be ordered from EPA's Office of Research and Development:

Center for Environmental Research Information
Document Distribution Section (G-72)
26 West Martin Luther King Drive
Cincinnati, OH 45268
513-569-7562 (phone)
513-569-7566 (fax)

When an NTIS number is cited in a reference, that document is available from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
703-487-4650

City of Palo Alto. 1992. Silver Reduction Pilot Program; Palo Alto Regional Water Quality Control Plant. Palo Alto, CA.

Greiner, T.J., and P.H. Richard. 1992. Facility inspections: obstacles and opportunities. Unpublished.

MPCA and WLSSD. 1992. Minnesota Pollution Control Agency and Western Lake Superior Sanitary District. Lake Superior Partnership; Compliance Assistance Program: a multimedia and pollution prevention inspection program. October 1, 1991 through April 30, 1992. Semiannual progress report to U.S. Environmental Protection Agency.

MWRA. 1992. Massachusetts Water Resources Authority. Telephone conversation between Eric Renda, MWRA, and Lynn Knight, Eastern Research Group, Inc. November 11.

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Santa Clara Valley Nonpoint Source Pollution Control Program. 1991. Best management practices for automotive-related industries. San Jose, CA.

Sherry, S. 1988a. Minimizing hazardous wastes: regulatory options for local governments. Sacramento, CA: Local Government Commission.

Sherry, S. 1988b. Reducing industrial toxic wastes and discharges: the role of POTWs. Sacramento, CA: Local Government Commission.

URI. 1988. University of Rhode Island, Department of Natural Sciences. Natural resource facts: household hazardous waste. Factsheet 88-3. Providence, RI: URI.

U.S. EPA. 1992. U.S. Environmental Protection Agency. Facility pollution prevention guide. Washington, DC: Office of Research and Development. EPA/600/R-92/088. NTIS PB92-213206.

U.S. EPA. 1991a. U.S. Environmental Protection Agency. Interim policy on the inclusion of pollution prevention and recycling in enforcement settlements. Memo from James A. Strock, Assistant Administrator. Washington, DC.

U.S. EPA. 1991b. U.S. Environmental Protection Agency. Environmental research brief: waste minimization assessment for a manufacturer of printed circuit boards. Cincinnati, OH: Risk Reduction Engineering Laboratory. EPA/600/S-92/008. NTIS PB92-196344.

U.S. EPA. 1991c. U.S. Environmental Protection Agency. Achievements in source reduction and recycling for ten industries in the United States. Washington, DC: Office of Research and Development. EPA/600/2-91/051. NTIS PB92-13747.

U.S. EPA. 1991d. U.S. Environmental Protection Agency. Supplemental manual on the development and implementation of local discharge limits under the pretreatment program. 21W-4002. Washington, DC: Office of Water.

U.S. EPA. 1991e. U.S. Environmental Protection Agency. Report to Congress on the National Pretreatment Program. Washington, DC: Office of Wastewater Enforcement and Compliance.

U.S. EPA. 1989. U.S. Environmental Protection Agency. Pollution prevention benefits manual: vol. 1 the manual, phase 2. NTIS PB93-164101. Washington, DC: Office of Solid Waste. October.

U.S. EPA. 1988. U.S. Environmental Protection Agency. Waste minimization opportunity assessment manual. Cincinnati, OH: Hazardous Waste Engineering Research Laboratory, Center for Environmental Research Information. EPA/625/7-88/003. NTIS PB92-216985.

U.S. GAO. 1991. U.S. General Accounting Office. Water pollution: nonindustrial wastewater pollution can be better managed. Washington, DC.

WRITAR. 1992. Waste Reduction Institute for Training and Applications Research, Inc. Survey and summaries: state legislation relating to pollution prevention. Minneapolis, MN: WRITAR.

Appendix A
Pollution Prevention Resources

Many federal, state, and local agencies have years of experience with the technical and organizational aspects of pollution prevention. POTWs will find these resources invaluable as they initiate or expand pollution prevention in their existing operations. This chapter lists pollution prevention contacts at the federal and state levels and highlights some of the many currently available publications addressing pollution prevention.

Federal Technical Assistance Resources

Pollution Prevention Information Clearinghouse (PPIC)/Pollution Prevention Information Exchange (PIES) Network

PPIC provides technical, policy, programmatic, legislative, and financial information relevant to pollution prevention. Through a computer network and experienced technical personnel, PPIC can assist POTWs and other interested parties in establishing pollution prevention programs; compiling general and industry-specific pollution prevention information; locating and ordering documents; and identifying grant and project funding, pertinent legislation, and upcoming pollution prevention conferences, workshops, and trainings.

The electronic PIES network provides access to a wide range of pollution prevention-related information, including case studies, bibliographies, pertinent state and federal pollution prevention legislation, calendar of events, directory of experts, and topical miniexchanges. PIES also features an on-line document ordering system.

To learn more about PPIC services and how to hook up to the PIES network, phone:

PPIC Technical Assistance Phone: 703-821-4800 (9 a.m. to 5 p.m., EST, Mon. through Fri.), or Fax: 703-442-0584

Pollution Prevention Information Exchange System (PIES): 703-506-1025

RCRA/Superfund Hotline: 800-424-9346

Small Business Ombudsman Hotline: 800-368-5888

Or write:

Pollution Prevention Information Clearinghouse (PPIC)
c/o SAIC
7600-A Leesburg Drive
Falls Church, VA 22043

U.S. EPA Offices

U.S. EPA Office of Solid Waste
Waste Management Division (OS-320W)
401 M Street, SW.
Washington, DC 20460
703-308-8402

U.S. EPA Office of Solid Waste and Emergency Response (OS-100)
401 M Street, SW.
Washington, DC 20460
703-821-4789

U.S. EPA Office of Pollution Prevention and Toxics (TS-792)
401 M Street, SW.
Washington, DC 20460
202-260-3810

U.S. EPA Office of Air and Radiation (ANR-443)
401 M Street, SW.
Washington, DC 20460
202-260-7400

U.S. EPA Office of Water (WH-556)
401 M Street, SW.
Washington, DC 20460
202-260-5700

U.S. EPA Office of Research and Development
Center for Environmental Research Information
26 West Martin Luther King Drive
Cincinnati, OH 45268
513-569-7562

U.S. EPA Office of Research and Development
Risk Reduction Engineering Laboratory
Pollution Prevention Research Branch
26 West Martin Luther King Drive
Cincinnati, OH 45268
513-569-7529

U.S. EPA Regional Offices

Region 1 (CT, MA, ME, NH, RI, VT)
John F. Kennedy Federal Building
One Congress Street
Boston, MA 02203
617-565-3420

Region 2 (NJ, NY, PR, VI)
Jacob K. Javits Federal Building
26 Federal Plaza
New York, NY 10278
212-264-2657

Region 3 (DC, DE, MD, PA, VA, WV)
841 Chestnut Building
Philadelphia, PA 19107
215-597-9800

Region 4 (AL, FL, GA, KY, MS, NC, SC, TN)
345 Courtland Street, NE.
Atlanta, GA 30365
404-347-4727

Region 5 (IL, IN, OH, MI, MN, WI)
77 West Jackson Blvd.
Chicago, IL 60604
312-353-2000

Region 6 (AR, LA, OK, NM, TX)
First Interstate Bank
Tower at Fountain Place
445 Ross Avenue, Suite 1200
Dallas, TX 75202
214-655-6444

Region 7 (IA, KS, MO, NE)
726 Minnesota Avenue
Kansas City, KS 66101
913-551-7000

Region 8 (CO, MT, ND, SD, UT, WY)
999 18th Street, Suite 500
Denver, CO 80202-2405
303-293-1603

Region 9 (Amer. Samoa, AZ, CA, NMI, Guam, HI, NV)
75 Hawthorne Street
San Francisco, CA 94105
415-744-1305

Region 10 (AK, ID, OR, WA)
1200 Sixth Avenue
Seattle, WA 98101
206-553-4973

State Pollution Prevention Contacts

Alabama

Alabama Department of Environmental Management
1751 Dickinson Drive
Montgomery, AL 36130
205-260-2777

Alaska

Pollution Prevention Office
Alaska Department of Environmental Conservation
3601 C Street, Suite 1334
Anchorage, AK 99503
907-563-6529

Arizona

Pollution Prevention Unit
Arizona Department of Environmental Quality
2005 North Central Avenue
Phoenix, AZ 85004
602-207-4233

Arkansas

Hazardous Waste Division
Arkansas Department of Pollution Prevention and Ecology
P.O. Box 8913
Little Rock, AR 72219-8913
501-570-2861

California

California Environmental Protection Agency
555 Capitol Mall, Suite 235
Sacramento, CA 95814
916-445-3846

Department of Toxic Substances Control
Office of Pollution Prevention and Technology Development
400 P Street
P.O. Box 806
Sacramento, CA 95812-0806
916-322-3670

Colorado

Colorado Department of Health
HMWMD-B2
4300 Cherry Creek Drive South
Denver, CO 80222
303-692-3309

Department of Mechanical Engineering
Colorado State University
Fort Collins, CO 80523
303-491-5317

Connecticut

Connecticut Technical Assistance Program
(CONNTAP)
Connecticut Hazardous Waste Management Service
900 Asylum Avenue
Suite 360
Hartford, CT 06105-1904
203-241-0777

Delaware

Pollution Prevention Program
Department of Natural Resources and Environmental Control
P.O. Box 1401
Kings Highway
Dover, DE 19903
302-739-5071/3822

Florida

Pollution Prevention Coordinators
Waste Reduction Assistance Program
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
904-488-0300

Georgia

Municipal Permitting Program
Environmental Protection Division
Georgia Department of Natural Resources
4244 International Parkway, Suite 110
Atlanta, GA 30334
404-656-4988

Hawaii

State of Hawaii Department of Health
Solid and Hazardous Waste Branch
Five Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813
808-586-4226

Idaho

Division of Environmental Quality
Idaho Department of Health and Welfare
1410 North Hilton Street
Boise, ID 83706-1290
208-334-5879

Illinois

Office of Pollution Prevention
Illinois Environmental Protection Agency
2200 Churchill Road
P.O. Box 19276
Springfield, IL 62794-9276
217-782-8700

Illinois Hazardous Waste Research and Information Center
One East Hazelwood Drive
Champaign, IL 61820
217-333-8940

Indiana

Office of Pollution Prevention and Technical Assistance
Indiana Department of Environmental Management
105 South Meridian Street
P.O. Box 6015
Indianapolis, IN 46206-6015
317-232-8172

Iowa

Iowa Waste Reduction Center
University of Northern Iowa
Cedar Falls, IA 50614-0185
319-273-2079

Kansas

Bureau of Waste Management
Kansas Department of Health and Environment
Forbes Field, Building 740
Topeka, KS 66620-0001
913-296-1603

Hazardous Waste Engineering Extension Program
Ward Hall
Manhattan, KS 66506-2508
913-532-6026

Center for Environmental Education and Training
Kansas University
P.O. Box 25936
Overland Park, KS 66225-5936
913-864-3284

Kentucky

KY PARTNERS—State Waste Reduction Center
Ernst Hall, Room 312
University of Louisville
Louisville, KY 40292
502-588-7260
(Inside KY: 1-800-334-8635 x7260)

Louisiana

Louisiana Department of Environmental Quality
P.O. Box 82663
Baton Rouge, LA 70884-2263
504-765-0720

Maine

Office of Pollution Prevention
Department of Environmental Protection
State House Station #17
Augusta, ME 04333
207-287-4152

Department of Environmental Protection
State House Station #17
Augusta, ME 04333
207-287-7767

Maryland

Office of Strategic Planning and Policy Coordination
Maryland Department of the Environment
2500 Broening Highway
Baltimore, MD 21224
410-631-3114

Massachusetts

Office of Technical Assistance for Toxic Use Reduction
Executive Office of Environmental Affairs
100 Cambridge Street, Room 2109
Boston, MA 02202
617-727-3260

Toxics Use Reduction Institute
University of Lowell
1 University Avenue
Lowell, MA 01854
508-934-3275

Michigan

Office of Waste Reduction Services
Michigan Department of Commerce and Natural Resources
P.O. Box 30004
116 West Allegan Street
Lansing, MI 48909-7504
517-335-1178
(Inside MI: 1-800-662-9278, Waste Reduction Clearinghouse)

Minnesota

Environmental Assessment Office
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
612-296-8643

Minnesota Technical Assistance Program
School of Public Health
Division of Environmental and Occupational Health
University of Minnesota
1313 5th Street, SE., Suite 207
Minneapolis, MN 55414
612-627-4646

Mississippi

Mississippi Technical Assistance Program and Mississippi Solid Waste Reduction Assistance
P.O. Drawer CN
Mississippi State, MS 39762
601-325-8454

Waste Reduction/Waste Minimization Program
Mississippi Department of Environmental Quality
P.O. Box 10385
Jackson, MS 39289-0385
601-961-5171

Missouri

Hazardous Waste Program
Division of Environmental Quality
Missouri Department of Natural Resources
205 Jefferson Street
P.O. Box 176
Jefferson City, MO 65102
314-751-3176

Montana

Solid and Hazardous Waste Bureau
Montana Department of Health and Environmental Services
Cogswell Building
Helena, MT 59620
406-444-2821

Nebraska

Hazardous Waste Section
Nebraska Department of Environmental Quality
1200 N Street, Suite 400
P.O. Box 98922
Lincoln, NE 68509-8922
402-471-4217

Nevada

Business Environmental Program
Nevada Small Business Development Center
University of Nevada - Reno
Reno, NV 89557-0100
702-784-1717

New Hampshire

WasteCap Program
New Hampshire Business and Industry Association
122 N. Main Street
Concord, NH 03301
603-224-5388

New Hampshire Pollution Prevention Program
New Hampshire Department of Environmental Services
6 Hazen Drive
Concord, NH 03301
603-271-2901

New Jersey

Office of Pollution Prevention
New Jersey Department of Environmental Protection and Energy
CN-423
401 East State Street, Floor 2
Trenton, NJ 08625
609-777-0518

New Mexico

Municipal Water Pollution Prevention Program
New Mexico Environment Department
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
505-827-0152

New York

Pollution Prevention Unit
New York State Department of Environmental Conservation
50 Wolf Road, Room 538
Albany, NY 12233-8010
518-457-7267

Erie County Office of Pollution Prevention
95 Franklin Street, Room 1077
Buffalo, NY 14202
716-858-6370

North Carolina

Pollution Prevention Program
Office of Waste Reduction
North Carolina Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
919-571-4100

North Dakota

Environmental Health Section
Division of Waste Management
North Dakota Department of Health and Consolidated Laboratories
P.O. Box 5520
1200 Missouri Avenue, Room 201
Bismarck, ND 58502-5520
701-221-5150

Ohio

Center for Applied Environmental Technologies
Institute of Advanced Manufacturing Sciences
1111 Edison Drive
Cincinnati, OH 45216-2265
513-948-2050

Pollution Prevention Section
Division of Hazardous Waste Management
Ohio Environmental Protection Agency
P.O. Box 1049
1800 Watermark Drive
Columbus, OH 43266-0149
614-644-3469

Ohio's Thomas Edison Program
Ohio Department of Development
77 South High Street, 25th Floor
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614-466-3887

Oklahoma

Customer Assistance Division
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1000 Northeast 10th Street
Oklahoma City, OK 73117-1299
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Environmental Health Administration, 0200
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503-229-5913

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Pennsylvania Department of Environmental Resources
P.O. Box 8472
Harrisburg, PA 17105-8472
717-787-7382

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Office of Environmental Coordination
Rhode Island Department of Environmental Management
83 Park Street
Providence, RI 02903
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Clemson, SC 29633
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South Carolina Department of Health and Environmental Control
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Office of Waste Management
Division of Environmental Regulations
South Dakota Department of Environment and Natural Resources
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Center for Industrial Services
University of Tennessee
226 Capitol Boulevard Building, Suite 606
Nashville, TN 37219-1804
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Center for Hazardous and Toxic Waste Studies
Texas Tech University
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806-742-1413

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168 North 1950 West, Bldg. 2
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Monroe Building, 14th Floor
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Waste Reduction, Recycling, and Litter Control Program
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Olympia, WA 98504-7600
206-438-7871

West Virginia

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Waste Management Section
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Hazardous Waste Minimization
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Wisconsin Department of Natural Resources
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608-267-3763

Wyoming

Solid and Hazardous Waste Division
Wyoming Department of Environmental Quality
122 West 25th Street
Herschler Building
Cheyenne, WY 82002
307-777-7752

Published Pollution Prevention Materials

U.S. EPA

EPA documents with a number that begins with 600 or 625 can be ordered from EPA's Office of Research and Development:

Center for Environmental Research Information
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26 West Martin Luther King Drive
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513-569-7562 (phone)
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703-487-4650

Documents with an EPA document number that begins with 530 are available from the Resource Conservation and Recovery Act (RCRA) Hotline. The national toll-free number is 800-424-9346 or, for the hearing impaired, TDD 800-553-7672. In the Washington, DC, area, call 703-412-9810. Or write to:

RCRA Information Center
U.S. Environmental Protection Agency
Office of Solid Waste (OS-305)
401 M Street, SW.
Washington, DC 20460

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Guides to Pollution Prevention: The Pesticide Formulating Industry. EPA/625/7-90/004. NTIS PB90-192790.

Guides to Pollution Prevention: The Paint Manufacturing Industry. EPA/625/7-90/005. NTIS PB90-256405.

Guides to Pollution Prevention: The Fabricated Metal Products Industry. EPA/625/7-90/006. NTIS PB91-110015.

Guides to Pollution Prevention: The Printed Circuit Board Manufacturing Industry. EPA/625/7-90/007. NTIS PB90-256413.

Guides to Pollution Prevention: The Commercial Printing Industry. EPA/625/7-90/008. NTIS PB91-110023.

Guides to Pollution Prevention: Selected Hospital Waste Streams. EPA/625/7-90/009. NTIS PB90-256421.

Guides to Pollution Prevention: Research and Educational Institutions. EPA/625/7-90/010. NTIS PB90-256439.

Guides to Pollution Prevention: The Photoprocessing Industry. EPA/625/7-91/012. NTIS PB92-129121.

Guides to Pollution Prevention: The Automotive Repair Industry. EPA/625/7-91/013. NTIS PB91-227975.

Guides to Pollution Prevention: The Fiberglass-Reinforced and Composite Plastics Industry. EPA/625/7-91/014. NTIS PB91-227967.

Guides to Pollution Prevention: The Marine Maintenance and Repair Industry. EPA/625/7-91/015. NTIS PB91-228817.

Guides to Pollution Prevention: The Automotive Refinishing Industry. EPA/625/7-91/016. NTIS PB92-129139.

Guides to Pollution Prevention: The Pharmaceutical Industry. EPA/625/7-91/017. NTIS PB92-100080.

In addition, ORD has developed research briefs on specific pollution prevention topics:

Waste Reduction Activities and Options for a:

Printer of Legal Forms and Supplies. EPA/600/S-92/003. NTIS PB92-217496.

Nuclear Powered Electric Generating Plant. EPA/600/S-92/025. NTIS PB92-235654.

State DOT Maintenance Facility. EPA/600/S-92/026.

Local Board of Education in New Jersey. EPA/600/S-92/027. NTIS PB92-238476.

Manufacturer of Finished Leather. EPA/600/S-92/039. NTIS PB93-123115.

Manufacturer of Paints for Metal Finishing. EPA/600/S-92/040. NTIS PB93-123143.

Manufacturer of Writing Instruments. EPA/600/S-92/041. NTIS PB93-123131.

Manufacturer of Room Air Conditioning Units and Humidifiers. EPA/600/S-92/042. NTIS PB93-123149.

Autobody Repair Facility. EPA/600/S-92/043. NTIS PB93-123156.

Fabricator/Finisher of Steel Computer Parts. EPA/600/S-92/044. NTIS PB93-123164.

Manufacturer of Artists' Supply Paints. EPA/600/S-92/045. NTIS PB93-123172.

Manufacturer of Wire Stock for Metal Items. EPA/600/S-92/046. NTIS PB93-123180.

Manufacturer of Commercial Refrigeration Units. EPA/600/S-92/047. NTIS PB93-123198.

Transporter of Bulk Plastic Pellets. EPA/600/S-92/048. NTIS PB93-123206.

Manufacturer of Electroplated Wire. EPA/600/S-92/049. NTIS PB93-123214.

Manufacturer of Systems to Produce Semiconductors. EPA/600/S-92/050. NTIS PB93-123220.

Remanufacturer of Automobile Radiators. EPA/600/S-92/051. NTIS PB93-123230.

Manufacturer of Fire Retardant Plastic Pellets and Hot Melt Adhesives. EPA/600/S-92/052. NTIS PB93-123248.

Printing Plate Prep Section of Newspaper. EPA/600/S-92/053. NTIS PB93-126563.

General Paints and Painting Supplies. EPA/600/S-92/054. NTIS PB93-126316.

Manufacturer of Fine Chemicals Using Batch Processes. EPA/600/S-92/055. NTIS PB93-126308.

Laminator of Paper and Cardboard Packages. EPA/600/S-92/056. NTIS PB93-126290.

Manufacturer of Hardened Steel Gears. EPA/600/S-92/057. NTIS PB93-126282.

Scrap Metal Recovery Facility. EPA/600/S-92/058. NTIS PB93-126266.

Manufacturer of Electroplating Chemical Products. EPA/600/S-92/059. NTIS PB93-126258.

Manufacturer of Plastic Containers by Injection Molding. EPA/600/S-92/060. NTIS PB93-126241.

Fossil Fuel-Fired Electrical Generating Plant. EPA/600/S-92/061. NTIS PB93-126233.

Manufacturer of Commercial Dry Cleaning Equipment. EPA/600/S-92/062. NTIS PB93-126225.

Electrical Utility Transmission System Monitoring and Maintenance Facility. EPA/600/S-92/063. NTIS PB93-126639.

Manufacturer of Orthopedic Implants. EPA/600/S-92/064. NTIS PB93-126217.

Waste Minimization Assessment for a Manufacturer of:

Printed Plastic Bags. EPA/600/M-90/017. NTIS PB91-179036.

Metal Parts Coating Plant. EPA/600/M-91/015. NTIS PB91-234492.

Outdoor Illuminated Signs. EPA/600/M-91/016. NTIS PB91-234500.

Rebuilt Railway Cars and Components. EPA/600/M-91/017. NTIS PB91-234518.

Brazed Aluminum Oil Coolers. EPA/600/M-91/018. NTIS PB91-234484.

HVAC Equipment. EPA/600/M-91/019. NTIS PB91-234476.

Bumper Refinishing Plant. EPA/600/M-91/020. NTIS PB91-234526.

Multilayered Printed Circuit Board Manufacture. EPA/600/M-91/021. NTIS PB91-234534.

Printed Circuit Boards. EPA/600/M-91/022. NTIS PB91-234542.

Paint Manufacturing Plant. EPA/600/M-91/023. NTIS PB91-234559.

Compressed Air Equipment Components. EPA/600/M-91/024. NTIS PB91-234567.

Aluminum Cans. EPA/600/M-91/025. NTIS PB91-234575.

Refurbished Railcar Boarding Assemblies. EPA/600/M-91/044. NTIS PB92-104348.

Prototype Printed Circuit Boards. EPA/600/M-91/045. NTIS PB92-104355.

Speed Reduction Equipment. EPA/600/M-91/046. NTIS PB92-104363.

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A Dairy. EPA/600/S-92/005. NTIS PB92-217264.

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Auto AC Condensers and Evaporators. EPA/600/S-92/007. NTIS PB92-188739.

Printed Circuit Board Manufacturer. EPA/600/S-92/008. NTIS PB92-196344.

Components for Auto Air Conditioners. EPA/600/S-92/009. NTIS PB92-217272.

Aluminum Extrusions. EPA/600/S-92/010. NTIS PB92-192137.

Galvanized Steel Parts. EPA/600/S-92/011. NTIS PB92-189695.

Commercial Ice Machines and Storage Bins. EPA/600/S-92/012. NTIS PB92-196351.

Water Analysis Instrumentation. EPA/600/S-92/013. NTIS PB92-217280.

Can Manufacturing Equipment. EPA/600/S-92/014. NTIS PB92-196385.

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Military Furniture. EPA/600/S-92/017. NTIS PB92-217256.

Aluminum Extrusions Manufacturer. EPA/600/S-92/018. NTIS PB92-196393.

Metal-Plated Display Racks. EPA/600/S-92/019. NTIS PB92-189703.

Motor Vehicle Exterior Mirrors. EPA/600/S-92/020. NTIS PB92-192806.

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Treated Wood Products. EPA/600/S-92/022. NTIS PB92-196401.

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Custom Molded Plastic Parts. EPA/600/S-92/034. NTIS PB93-123024.

Sheet Metal Components. EPA/600/S-92/035. NTIS PB93-123016.

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State and Local Agencies

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Wigglesworth, D. 1986. Profiting from Waste Reduction in Your Small Business. Anchorage, AK: Alaska Health Project.

Waste Exchanges

National Materials Exchange Network

The National Materials Exchange Network (NMEN), developed by Pacific Materials Exchange under an EPA grant, is an electronic network of virtually all of the waste exchanges in North America. Currently, the network has over 5,000 listings of waste materials available and

wanted. The system has 17 categories of wastes and allows sorting by geographic area.

For more information, call Patrick Moctezuma at 509-325-0507, or write:

National Materials Exchange Network
1522 North Washington, Suite 202
Spokane, WA 99201-5424

For computer modem access, dial: 1-800-858-6625.

Local or Regional Waste Exchanges

Alberta Waste Materials Exchange
Provincial Building, #303A
4920-51st
Red Deer, AB T4N 6K8
403-297-7505

AR Industrial Development Commission
#1 Capitol Mall
Little Rock, AR 72201
501-682-1370

Arizona Waste Exchange
4725 E. Sunrise Drive
Suite 215
Tucson, AZ 85718
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B.A.R.T.E.R.
2512 Delaware Street, S.E.
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612-627-6811

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Canadian Chemical Exchange
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Hawaii Waste Exchange
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172 20th Avenue
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Industrial Materials Exchange Service
P.O. Box 19276
2200 Churchill Road, #31
Springfield, IL 62794-9276
217-782-0450

Iowa Waste Reduction Center
75 BRC-University of Northern Iowa
Cedar Falls, IA 50614-0185
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Louisiana/Gulf Coast Waste Exchange
1419 CEBA
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Manitoba Waste Exchange
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MN Technical Assistance Program
1313 5th Street, Suite 307
Minneapolis, MN 55414
612-627-4555

Montana Industrial Waste Exchange
Montana Chamber of Commerce
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Helena, MT 59624
406-442-2405

Northeast Industrial Waste Exchange
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Syracuse, NY 13202
315-422-6572

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405-271-5338

Ontario Waste Exchange
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Mississauga, ON L5K 1B3
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Pacific Materials Exchange
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Spokane, WA 99205
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Portland Chemical Consortium
P.O. Box 751
Portland, OR 97207-0751
503-725-3811

RENEW
Texas Water Commission
P.O. Box 13087
Austin, TX 78711-3087
512-463-7773

SEMREX
171 W. 3rd Street
Winona, MN 55987
507-457-6460

Southeast Waste Exchange
Urban Institute, UNCC Station
Charlotte, NC 28223
704-547-2307

Southern Waste Information Exchange
P.O. Box 960
Tallahassee, FL 32302
800-441-SWIX

Appendix B
Pollution Prevention Summaries On Specific Industries

This chapter is a collection of summaries regarding the processes, waste streams, and potential pollution prevention opportunities for specific industries of concern to POTWs. The summaries contain a brief description of the processes and waste streams associated with the industry, along with a description of pollution prevention measures that may be applicable. Also, the summaries include a case study example, if available, of a firm's experience with pollution prevention efforts. Sources of further information are provided at the end of each summary.

The summaries are formatted so that POTW personnel can extract and copy specific summaries of interest for their own use or for their users' information.

Summaries are provided for the following industries:

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Pollution Prevention Summary:

Automotive-Related Industry

Process Description

The automotive-related industry includes facilities that perform mechanical repairs, maintenance, collision and body repair, and painting of automotive vehicles. The industry includes commercial repair and body shops, new car dealerships, fleet operators, and diesel engine repair shops. As part of the general maintenance of automobiles, these shops replace motor oil, coolants, transmission fluid, and brake fluid. If improperly disposed of, these materials can create problems for POTWs. Automotive refinishing operations use thinners, paints, fillers, and catalysts to prepare, prime, and refinish automotive surfaces. During the course of repairing and replacing automotive parts, a variety of solvents, cleaners, and degreasers are used to clean tools, equipment, and parts.

Waste Streams

Automotive shops are the leading small-quantity generators of hazardous wastes based on both volumes generated and the number of such operations. Table B-1 provides a brief summary of the pollutants that may be generated in automotive shops. The replacement of automotive fluids represents the largest waste-generating activity in the industry. These fluids must be disposed of properly or recycled professionally, since spills and mismanagement can lead to potential discharges to sewer systems. Automotive shops utilize various solvents for parts cleaning, paint thinning, and degreasing, resulting in spent solvents and residuals. Caustic floor cleaners and clarifiers are used to clean shop floors. When the floors are washed with water, these cleaners, along with particulate matter, such as asbestos dust from brake shoes, body filler dust, and metal filings, may wash down drains. Painting operations also generate large volumes of liquid waste, including thinners, unused paints, and residues. Other waste streams include miscellaneous fluids, such as hydraulic and lubricating fluids used in body repair machinery and shop lifts. The hazardous liquids generated in this industry are generally stored in drums on site until they can be professionally disposed of or recycled; however, when improperly managed, these wastes can find their way down sinks, floor drains, and storm sewers.

Pollution Prevention Options

Good Operating Practices

Numerous pollution prevention options are available to automotive shop owners. Good operating practices begin with the proper management of material inventories. Inventories should be maintained on a "first-in/first-out" basis. This avoids the need to dispose of materials with expired shelf lives. Inventory controls,

Table B-1. Wastes Generated from Automotive Shops

Process	Waste Material	Composition
Auto maintenance	Motor oil	Oil and grease, heavy metals
	Transmission fluid	Oil and grease, heavy metals
	Engine coolant	Ethylene glycol, lead, copper, zinc
	Batteries	Sulfuric acid, heavy metals
	Brake fluid	Chlorinated compounds, metals
Shop cleanup	Outdated supplies	Solvents, caustic cleaners, automotive fluids
	Acid floor cleaners	Acids, heavy metals
	Alkaline floor cleaner	Caustics, oil and grease, heavy metals
	Clarifier sludge	Oil and grease, heavy metals
Parts cleaning	Solvents	Petroleum distillates, mineral spirits, naphtha, chlorinated compounds, oil and grease, heavy metals
	Aqueous cleaners	Acids and alkali, oil and grease, heavy metals, blended heavy oils, heavy metals
Auto refinishing	Paint waste	Petroleum distillates, heavy metals

such as requiring employees to return empty fluid containers before obtaining new supplies, can help minimize the amount of supplies discarded unnecessarily. Maintaining a computerized inventory system can help minimize the quantity of hazardous materials kept in storage and help prevent expired shelf lives. Inventories should be inspected periodically to ensure that spills or leaks are not occurring. When materials are purchased, the shop operator should purchase materials that can be recycled (e.g., avoid transmission and brake fluids that contain chlorinated hydrocarbons if another type is satisfactory) and work with suppliers that may offer collection and recycling services.

Maintaining good operating practices or good housekeeping measures also can prevent the discharge of hazardous materials to the sewer system. Some specific techniques include:

- Provide employee training and incentives to increase awareness of the need for and benefits of pollution prevention.
- Post signs at sinks and drains to prevent the improper discharge of oils, solvents, and other fluids.
- Use drip pans whenever there is a potential for fluids to leak from vehicles. These pans should not be left unattended. Instead, the fluids should be promptly transferred to appropriate storage containers.
- Store waste materials in a segregated area, preferably within a bermed or diked enclosure.
- Use self-closing faucets on material containers and waste collection tanks.
- Clean up leaks, drips, and other spills promptly, preferably without the use of water. Use rags for small spills, a damp mop for general cleanup, and dry absorbent materials for larger spills. Clean up all spills before they reach drains.
- Reuse or recycle fluids wherever possible. For instance, fluids used to flush cooling systems can often be reused. Similarly, spent antifreeze and motor oils can usually be recycled through the supplier or a fluid recycling firm.
- To prevent the discharge of particulate matter, such as asbestos dust, metal filings, body filler, or dust from abrasives, use a dry cleanup method to prevent washing the materials down a drain.

Minimize Solvent Use

The use of solvents is prevalent in this industry. Operators can take various low-cost steps to minimize the quantities of solvents that are wasted or discarded. The major approaches to limiting solvent waste include the following:

- Eliminate the need for solvents (e.g., determine whether a particular part truly requires cleaning or at least use a mechanical cleaning technique, such as a wire brush, to limit the quantity of solvent needed).
- Find aqueous-based or less-toxic alternatives (e.g., terpene cleaners can replace standard halogenated solvents for many applications; alternative carburetor cleaners are available as a substitute for 1,1,1-trichloroethane [TCA]; detergent-based cleaners can be substituted for more hazardous caustic-based cleaners; use water-based solvents wherever possible; avoid halogenated compounds, petroleum-based cleaners, and cleaners with phenols).
- Minimize losses associated with solvent use (e.g., avoid disposing of solvents prematurely, utilize employee training to prevent spills, operate solvent sinks properly).
- Segregate, recycle, recover, and reuse waste solvents.

Efforts also can be taken to minimize the amount of thinner and paint used in the refinishing process. Ensuring that employees are properly trained at applying automotive finishes can minimize waste generation and reduce material costs. When cleaning painting equipment, paint residues should be scraped off mechanically before using solvents. Additionally, Teflon-coated paint cups are available, which allow for more effective manual cleaning and reduced solvent usage.

Automotive shops can contract with outside companies to recover spent fluids or invest in onsite recycling equipment for both recovering solvents and reclaiming antifreeze. Highly efficient parts washers and degreasers that minimize solvent use also are available. Oil and grease traps can be installed in storm and floor drains to prevent discharge of oil and grease to the sewer. These systems remove the bulk of floating oily wastes. Shop operators can install roofs over fueling or outdoor work areas to keep storm water away from potentially contaminated surfaces. The downspout should be routed directly to the storm drain to prevent runoff from contacting surrounding areas.

For Further Information

Pollution Prevention Information Exchange System (PIES)
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U.S. EPA. 1991. U.S. Environmental Protection Agency. Guides to pollution prevention: The automotive repair industry (EPA/625/7-91/013. NTIS PB91-227975.) and The automotive refinishing industry (EPA/625/7-91/016. NTIS PB92-129139.).

The Santa Clara Valley Nonpoint Source Pollution Control Program, Best Management Practices for Automotive-Related Industries, 5750 Almaden Expressway, San Jose, CA, 95118, 408-265-2600 (phone), 408-266-0271 (fax).

Preventing Pollution in the Auto Repair Business. A pollution prevention manual published under a cooperative outreach program. Available from the sources listed below:

American Automobile Association, Public Affairs
1050 Hingham Street
Rockland, MA 02370-1090
1-800-222-8252

Automotive Service Association
P.O. Box 529
Bedford, TX 76095-0929
817-283-6205

National Automobile Dealers Association, Regulatory Affairs
8400 Westpark Drive
McClean, VA 22102
703-821-7040

Pollution Prevention Summary:

Commercial Printing

Process Description

Commercial printing operations print and publish newspapers, books, periodicals, and other materials. In printing, ink impressions are transferred to a substrate, such as paper, wood, fabric, plastic, glass, or metal. There are many types of printing techniques available, all of which follow four steps: (1) image processing, (2) platemaking, (3) printing, and (4) finishing. In image processing, the artwork or text copy is arranged and photographed to produce transparencies. If the printing is to be full color, color separations are made to provide a single-color image for each color. The processes used to develop the film with the image are similar to those used to develop photographs; developers, fixers, and rinses are used. Chemical reducers and intensifiers may be used to change the image contrast on the film.

Plates that carry the image to be printed accept ink from a roller and transfer the ink image to a rubber blanket, which is then transferred to the paper or other substrate. Plates can be produced using a variety of techniques. Photomechanical processes produce plates using light-sensitive coatings, such as diazo and photopolymers, that create an etched image on the plate after exposure to light and processing. Lithographic printing plates also use coated plate surfaces that, after photochemical processing, create an image through ink-receptive and ink-resistant areas on the plate. Gravure printing uses cylinders that are machined or chemically etched and plated. Letterpress and flexography relief plates use light-sensitive coatings to capture the image and then acid solutions to etch nonimage areas. Various organic and inorganic chemicals and materials are used for plates, as coatings on the plates, and for developing or plating the plates or cylinders.

The final steps are printing and finishing. In printing, the image is transferred to the substrate. Finishing involves the final trimming, folding, collating, binding, laminating, and embossing operations necessary to complete the final product.

Waste Streams

Almost 98 percent of the total wastes generated by commercial printers is waste paper. Wastewater streams discharged to the sewers, which are the focus of these summaries, include spent photoprocessing chemicals that have significant biochemical oxygen demand and silver concentrations. Platemaking wastes, such as acids and alkalis used to clean or develop the plates, must be pretreated before being discharged to the sewer or must be stored in drums for disposal. Fountain solutions, used in lithography, either evaporate during use or remain on the product, and therefore are not discharged to the sewer. Table B-2 lists the wastewater generated from printing processes.

Table B-2. Wastewater Generated by Printing Processes

Process	Description
Image processing	Photographic chemicals, silver (if not recovered)
Platemaking	Acids, alkalis, solvents, plate coatings (may contain dyes, photopolymers, binders, resins, pigments, organic acids), developers (may contain isopropanol, gum arabic, lacquers, caustics), and rinsewater
Printing	Spent fountain solutions (may contain chromium)

Pollution Prevention Options

Good Operating Practices

Commercial printers can apply general good operating practices to prevent pollution, including waste stream segregation, employee training, inventory control, efficient production scheduling, and loss prevention practices. Since many photoprocessing and plate-developing chemicals are sensitive to temperature and light, proper storage is essential to prevent spoilage and to maximize the shelf life of these raw materials. Inventory control, using the "first-in/first-out" system, will reduce the possibility of expired chemicals requiring disposal. Expired raw materials can be tested for effectiveness before being discarded. Also, restricting traffic through storage areas reduces the likelihood of contamination or spillage of stored materials.

Image Processing

Photographic materials that do not contain silver are available. Diazo and vesicular films have been used for many years. These films are made of a polyester base coated with thermoplastic resin and a light-sensitive diazonium salt. Diazo and vesicular films are slower to

develop than films containing silver. More recently, photopolymer and electrostatic films, which do not contain silver, have been used. Photopolymer films are composed of carbon black instead of silver and are processed in weak alkaline solution that is neutralized before being discharged. Electrostatic films, which are as fast as silver films and have high resolution, use an electrostatic charge to make them light sensitive; then a liquid toner is used to develop the image.

Photoprocessing wastes can be reduced by extending the life of the fixing baths. This can be accomplished by adding ammonium thiosulfate (which allows the concentration of silver buildup in the bath to be doubled), using an acid stop bath prior to the fixing bath, and adding acetic acid to the fixing bath as needed to keep the pH low.

In manual processing systems, squeegees can be used to reduce the chemical carryover from one process bath to the other. Countercurrent rinsing systems can replace parallel tank systems and can reduce substantially the wastewater generated. Countercurrent systems use water from the previous rinsings for the initial film-washing stage rather than fresh water. Fresh water is used only at the final rinse stage, after most of the contamination has been already rinsed away.

Silver recovery techniques, including metallic replacement and electrolytic recovery, can be used to remove silver from spent developing and fixing solutions. Electrolytic recovery units, which are widely used, use a low-voltage current between a carbon anode and stainless steel cathode to recover silver from the spent solutions. Metallic replacement systems use a cartridge containing steel wool in which an oxidation-reduction reaction causes the iron in the wool to replace the silver in solution. The silver settles to the bottom of the cartridge as a sludge.

Plate Processing

Replacing metal etching or plating processes with alternative processes can reduce the problems associated with toxic wastes from these processes. Alternative techniques include presensitized lithography, using plastics or photopolymers, and hot metal printing. If changing the process is not feasible, a number of measures can be taken to reduce the toxicity of wastewater discharges. In addition to the pollution prevention options discussed here, options related to metal fabrication may apply to plate-processing operations, particularly for gravure printing where the cylinders are chrome plated. The waste solutions from metal-etching or metal-plating operations and from rinsing operations usually require treatment before being discharged to the sewer. To reduce wastewater generated by rinsing, countercurrent rinse systems can be employed. The pollutant concentrations in wastewater from plating operations can be reduced by minimizing drag-out from the plating tanks. Examples of techniques to reduce drag-out include proper positioning of the part on the draining rack, using drain boards to collect drag-out and reuse it in the plating tank, and raising the temperature of the plating bath to reduce the surface tension of the solution.

Nontoxic developers and finishers are available that can be substituted for the more traditional materials. Also, presensitized plates that are water resistant until exposed to light are available. Commercial printers can review the product literature to ensure they are using the most appropriate raw materials for their operation.

Pollution Prevention Successes

The Alaska Health Project conducted a waste minimization audit at a printing company. In addition to suggesting changing to an aqueous platemaking process to reduce hazardous waste generation and using water-based inks to eliminate spent solvent generation, the auditors suggested installing silver recovery to reduce silver concentrations in the photographic wastewater generated. The capital costs were estimated at $600 for a silver recovery unit with an expected payback period of 2 years (PPIC, 1992).

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703-487-4650

U.S. EPA. 1990. U.S. Environmental Protection Agency. Guides to pollution prevention: the commercial printing industry. EPA/625/7-90/008. NTIS PB91-110023. Washington, DC: Office of Research and Development.

U.S. EPA. 1986. U.S. Environmental Protection Agency. Waste minimization—issues and options. Volume I-III. EPA/530/SW-86/041 through /043. NTIS PB87-114351.

Pollution Prevention Summary:

Fabricated Metal Products

Process Description

The fabricated metal industry encompasses a wide variety of processes that machine, treat, coat, plate, paint, and clean metal parts. These processes can be broadly classified as (1) cleaning and stripping, (2) painting and applying other nonmetallic coatings, (3) machining, and (4) surface treatment and plating.

Cleaning and stripping of metal surfaces is accomplished by using one or more of four types of cleaning media: (1) solvents, (2) aqueous cleaners (alkaline and acid), (3) abrasives, and (4) water. Table B-3 describes variants of these major cleaning processes. Cleaning processes are required as part of all metal fabrication activities. Most metal fabrication activities also involve the application of paint or some other nonmetallic coating to provide a final finish surface. Table B-3 also describes major methods used for painting metals.

Machining involves the use of various cutting tools that travel along the surface of the workpiece, shearing away the metal ahead of it to create a piece of specified dimensions. Table B-4 describes some major metal-cutting processes. Metalworking fluids are commonly applied to the workpiece and cutting tool for cooling of materials, washing away metal shavings, protecting the workpiece surface, and giving a good final surface finish.

Table B-3. Metal Fabrication Processes: Cleaning, Stripping, and Painting

Process	Description
Cleaning and Stripping	
Solvents	Use of halogenated and nonhalogenated solvents to remove oil-based materials. Cold cleaning can be accomplished by (1) wiping with solvent-soaked rags, (2) soaking in a solvent tank, (3) use of ultrasonic units in tanks to increase cleaning action, and (4) use of a steam gun stripper for paint removal. Diphase cleaning methods use a water bath followed by solvent spray. Vapor phase cleaning occurs in the vapor zone above the liquid solvent.
Aqueous (alkaline and acid cleaners)	Use of alkaline and acid solutions in soak tanks to displace oil, old plating and paint (alkaline), rust, scale, and smut formed from electrocleaning. Constituents of alkaline cleaning solutions include builders (sodium salts of phosphates, carbonates, silicate, and hydroxides); surfactants (detergents and soaps); and other possible additives, such as antioxidants, stabilizers, and small amounts of solvents. Constituents in acidic cleaning solutions may include mineral acids, organic acids, detergents, chelating agents, and small amounts of solvents. Aqueous solutions also are used in electrocleaning (direct current electrical cleaning with the workpiece attached to the cathode) and electropolishing (reverse current cleaning in which workpiece is attached to the anode).
Abrasive	Use of abrasive cleaners, typically aluminum oxide or silicon carbide mixed with an oil- or water-based binder, to remove rust, oxides, burrs, old plating, and paint. Cleaning action can be accomplished using a buffing wheel, vibrating tank, tumbling barrel, or centrifugal barrel.
Water	Most of the cleaning processes described above require a water wash, using a soak tank or spray unit, before and after each operation.
Paint Application	
Spray gun	Use of compressed air or high-pressure to atomize paint and produce a fan or circular cone spray pattern. Electrostatic spray units, which are the most commonly used paint application method, create a positive charge on atomized paint particles that are attracted to the metal surface, thus reducing overspray.
Containers	Placement of a paint with a large number of small items in a container that is rotated until the correct point of tackiness is reached, at which time the items are transferred to a wire basket. Tumbling, barreling, and centrifuging are variants of this process.
Dipping	Lowering and withdrawal of object into a tank with paint. Commonly used for cylindrical items.
Other	Flow coating involves the use of high-pressure sprays to flood the item to be painted and then draining off excess paint. Roller coating operates by applying paint or coating material to a roller and transporting the item past the roller using a conveyer belt. Curtain coating uses a vertical flow that separates two conveyer belts. Items on the conveyor belt pass through the curtain to the conveyer belt on the other side without coating the conveyer belt. Roller and curtain coating are usually used with relatively flat items.

Metal surface treatment and plating operations include a large number of treatment processes that involve modifying the workpiece surface properties to improve corrosion or abrasion resistance, alter appearance, or otherwise enhance the utility of the product. Table B-4 describes more than a dozen specific treating and plating processes grouped in four major categories: (1) electroplating, (2) chemical and electrochemical conversion, (3) metallic coatings, and (4) case hardening.

Waste Streams

Table B-5 identifies five aqueous or liquid waste streams that may result from metal-cleaning and -stripping operations. The most likely streams of concern to POTWs are waste rinsewater and possibly grease-contaminated water from use of abrasives, which may ultimately be discharged into sewers. Spent alkaline and acid cleaning solutions generally require some treatment before they can be discharged. Facilities with onsite wastewater treatment often mix primary rinsewater and alkaline and acid cleaning solutions before treatment. Waste solvents will generally be handled as a hazardous waste.

Spent bath solutions from electroplating are high in toxic heavy metals, such as cadmium and chromium, and certain electroplating baths have high concentrations of cyanide. Table B-6 identifies the chemical composition of 10 common electroplating bath solutions and provides information on seven other types of metal-plating and -treating wastes. Quench oils and vent scrubber wastes produce contaminated wastewater that may be of concern if discharged to POTWs. Spent electroplating and case-hardening bath solutions, ion exchange reagents, filter and wastewater treatment sludges all are likely to contain high concentrations of toxic pollutants, and are usually treated as hazardous wastes and not discharged to a POTW. All machining and metal-plating and -treatment activities also will generate waste streams from cleaning and stripping, as described above. Accidental spills are

Table B-4. Metal Fabrication Processes: Machining, Surface Treatment and Plating

Process	Description
Machining	
Turning	Use of a lathe to hold and rapidly spin a workpiece against a single-edge cutting tool.
Drilling	Machines used for making holes. Also may be used for reaming.
Reaming	Enlarging or finishing of existing holes using a drill or machine using multiple-edge cutting tools.
Milling	Use of multiple-edge cutters to fashion unusual or irregular shapes.
Threading	Cutting of threads for screws, nuts, and bolts.
Broaching	Many-toothed cutting tool used to finish holes, of circular, square, or irregular shapes, or external surfaces such as keyways.
Other	Cutting and shaping, grinding, planing, polishing.
Surface Treatment and Plating	
Electroplating	Placement of a workpiece in a solution containing metal ions and use of an electric current with the workpiece as cathode to cause deposition of ions on the workpiece surface. Typical sequence involves (1) cleaning and stripping, (2) one or more electroplating baths, and (3) rinsing steps between and after each of the above operations.
Chemical and electrochemical conversion	Various bath treatment processes designed to deposit a coating on a metal surface for corrosion protection or decoration. Specific treatments include (1) phosphating, to form a base of metal phosphate crystals for final coatings (e.g., paints, lacquers); (2) chromating, to minimize rust formation and improve paint adhesion; (3) anodizing, to develop a surface oxide film to enhance corrosion resistance; and (4) passivation, to form protective films through immersion in an acid solution.
Metallic coatings	Various processes to create a durable, corrosion-resistant protective layer of one metal over a core metallic material that provides a load-bearing function. Major types of coatings include (1) diffusion coatings, in which the base metal is brought into contact with the coating metal at elevated temperatures allowing lattice interdiffusion of the two metals; (2) cladding, application using mechanical techniques such as high-pressure welding or casting; (3) vapor deposition; and (4) vacuum coating. Diffusion processes include hot dipping (immersion in molten metal bath), cementation (high-temperature application of metallic powder), and spraying.
Case hardening	Various processes to produce a hard surface over a softer metal core. Treatments include (1) carburizing, the diffusion of carbon into a steel surface at high temperatures; (2) nitriding, the diffusion of nitrogen into a steel surface using a nitrogenous gas or liquid salt bath; (3) carbonitriding and cyaniding, the diffusion of both carbon and nitrogen into a steel surface; and (4) heating and quenching, hardening caused by rapid heating and cooling of the metal surface.

Table B-5. Aqueous/Liquid Wastes from Metal Parts Cleaning and Stripping

Waste Description	Process Origin	Composition
Waste rinsewater	Equipment cleaning using water and/or caustic solutions	Water contaminated with solvent residue, additives, heavy metals from paint removal (lead, chromium)
Abrasives	Removal of rust, scale, polishing of metal	Grease-contaminated water
Spent alkaline solutions	Descaling, removal of organic coatings	Water contaminated with alkaline salts, additives, organic material[a]
Spent acid solutions	Removal of scale, smut (metal contaminants from electrocleaning)	Water contaminated with acids, dissolved metal, additives[b]
Waste solvent	Cleaning of oily surfaces	Halogenated and nonhalogenated solvents, oil-based contaminants[c]

[a] Commonly used chemicals in alkaline solutions include ammonium hydroxide, potassium hydroxide, and sodium hydroxide.
[b] Commonly used chemicals in acid solutions include hydrobromic acid, hydrochloric acid, hydrofluoric acid, nitric acid, phosphoric acid, sulfuric acid, perchloric acid, acetic acid.
[c] Commonly used solvents include tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, trichlorotrifluoroethane, trichlorotrifluoromethane, toluene, methyl ethyl ketone, benzene, chloroform, o-dichlorobenzene, p-dichlorobenzene, acetone, xylene, white spirits, kerosene, and butyl alcohol.

a potential concern if cleanup results in discharge of concentrated or diluted waste streams into sewers.

Pollution Prevention Options

Pollution prevention techniques can be applied to reduce waste streams in six areas: metal cleaning and stripping, metal-plating process solutions, metal-plating rinsewater, abrasives use, paint application, and machining operations.

Metal-Cleaning and Stripping

Waste streams from aqueous cleaning solutions can be reduced by extending the life of solutions through such means as reducing evaporation losses by use of tank lids, frequent sludge removal, filtration, and processing of waste solutions for reuse, such as oil separation. Substitution with less-toxic alternative aqueous cleaning solutions may be feasible in some situations. Alternative dry-cleaning and stripping methods, such as use of abrasives, may reduce or eliminate the need for aqueous cleaning solutions. Rinsewater from metal-cleaning and -stripping operations can be reduced in four ways: (1) reducing initial input requirements, (2) reducing makeup requirements, (3) extending the life of rinsewater, and (4) reusing rinsewater. Makeup requirements can be reduced through optimal parts handling (distributing parts on a rack to allow good cleaning and to minimize pockets, slowly removing parts from vapor zone, rotating parts to allow condensed solvent drop-off) and improved drainage (installing drainboards, drip guards, or drip bars). Solution life can be extended by precleaning parts, using air blowers, predipping parts in cold mineral spirits, frequently removing sludge, and avoiding cross-contamination of solutions.

Metal-Plating Process Solutions

Because metal-plating process solutions tend to be high in toxic heavy metals, efforts to reduce the amount or toxicity of waste solutions are important. There may be opportunities to substitute processes that create lower quantities or less-toxic waste streams. For example, methods for metallic coatings, such as cladding, diffusion coating, hot dipping, and cementation (see Table B-4) do not require use of aqueous process solutions. Also, chemical conversion methods generally involve less-toxic process solutions. Materials substitution to reduce the toxicity of process solutions also may be possible. For example, trivalent chromium is less toxic than hexavalent chromium. Noncyanide bath solutions are available for copper and tin electroplating. A variety of bath controls can be used to extend the life of process solutions, and a number of processes are available for recovering metals from waste bath/process solutions. Bath controls include installing bath filters, using deionized water for makeup, keeping racks clean, and reducing contamination by using high-quality raw materials in anodes. Materials can be recovered through evaporation, ion exchange, reverse osmosis, chromium electrodialysis, or electrolytic recovery/electrowinning.

Metal-Plating Rinsewater

Opportunities for reducing rinse wastewaters fall into three major categories: (1) drag-out reduction (reducing contamination of rinsewater by process solution), (2) improvement of rinsewater system design to reduce makeup or extend life of rinses (rinse tank design, multiple rinsing tanks, conductivity measurement to control rinsewater flow, reactive rinsing, fog nozzles and

Table B-6. Aqueous/Liquid Wastes from Electroplating and Other Surface Treatment Processes

Waste Description	Process Origin	Composition
Common Electroplating Bath Compositions		
Spent bath solutions	Brass and bronze	Copper cyanide, zinc cyanide, sodium cyanide, sodium carbonate, ammonia, Rochelle salt
	Cadmium cyanide	Cadmium cyanide, cadmium oxide, sodium cyanide, sodium hydroxide
	Cadmium fluoroborate	Cadmium fluoroborate, fluoroboric acid, boric acid, ammonium fluoroborate, licorice
	Copper cyanide	Copper cyanide, sodium cyanide, sodium carbonate, sodium hydroxide, Rochelle salt
	Copper fluoroborate	Copper fluoroborate, fluoroboric acid
	Acid copper sulfate	Copper sulfate, sulfuric acid
	Copper	Copper pyrophosphate, pyrophosphate potassium hydroxide, ammonia
	Fluoride-modified copper cyanide	Copper cyanide, potassium cyanide, potassium fluoride
	Chromium	Chromic acid, sulfuric acid
	Chromium with fluoride catalyst	Chromic acid, sulfate, fluoride
Other Metal-Plating and Treatment Wastes		
Quench oils and quench oil tank cleanup wastes	Case hardening	Water contaminated with oils, metal fines, combustion products
Spent salt bath (carburizing, nitriding, cyaniding)	Other case hardening	Sodium/potassium cyanide and cyanate
Vent scrubber wastes	Vent scrubbing	Similar to spent bath solution composition (see above)
Ion exchange reagents	Demineralization of process water	Brine, hydrochloric acid, sodium hydroxide
Filter sludges	Plating and chemical conversion	Silica, silicides, carbides, ash, plating bath constituents (see above)
Wastewater treatment sludge	Wastewater treatment	Metal hydroxides, sulfides, carbonates
Spills and leaks	Accidental discharge	Water contaminated with process/rinse solutions

sprays, automatic flow controls, rinse bath agitation, use of no-rinse coatings), and (3) reuse of contaminated rinsewater (secondary rinse as primary rinse or makeup; countercurrent rinsing; immiscible rinses; use ion exchange, chromium electrodialysis, electrowinning to recover metals so contaminated rinses can be reused; use evaporation or reverse osmosis to concentrate drag-out for reuse in plating bath).

Abrasives

Source reduction techniques can be applied, such as use of greaseless or water-based binders, an automatic liquid spray system for application of abrasive onto wheel, synthetic abrasives, precleaning of workpiece, and water-level control to ensure sufficient water during cleaning. Reusable blast media can be used. Deburring with organic, ceramic, or steel media may be replaced with dry abrasive blasting.

Paint Application

Pollution prevention techniques related to paint applications include process modifications (reducing empty container wastes, drip reduction, bake oven temperature, equipment maintenance), overspray reduction (equipment modifications, operator training), product substitution (solvent-based coatings with water-based coatings, radiation [UV] cured coatings, powder coatings), recycling/reuse of overspray, container wastes, solvent paint mixtures, and recovery (distillation, filtration).

Machining Operations

Pollution prevention options related to machining operations include preventing metalworking fluid contamination (use of demineralized water makeup; regular gasket, wiper, and seal maintenance/replacement), use of high-quality metalworking fluid, optimal fluid selection for particular need, recycling of metalworking fluid, periodic or

continuous filtration of metalworking fluid, fluid concentration control, material substitution (soluble borates for soluble borate lubricants, synthetic fluids, gas coolant), regular sump and machine cleaning, standardizing oil types used on machining equipment, improving equipment scheduling, and establishing dedicated lines.

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RCRA Information Center
U.S. Environmental Protection Agency
Office of Solid Waste (OS-305)
401 M Street, SW.
Washington, DC 20460

U.S. EPA. 1987. U.S. Environmental Protection Agency. Meeting hazardous waste requirements for metal finishers. Seminar publication. EPA/625/4-87/018. Cincinnati, OH: Center for Environmental Research Information.

U.S. EPA. 1990. U.S. Environmental Protection Agency. Guides to pollution prevention: the fabricated metal industry. Washington, DC: Office of Research and Development. EPA/625/7-90/006. NTIS PB91-110015.

U.S. EPA. 1990. U.S. Environmental Protection Agency. Does your business produce hazardous waste? Many small businesses do: metal manufacturing. Washington, DC: Office of Solid Waste and Emergency Response. EPA/530/SW-90/027N.

Pollution Prevention Summary:

Industrial and Commercial Laundries

Process Description

Industrial and commercial laundry services process large volumes of industrial and commercial uniforms and linens. Many of these businesses also operate diaper services. Commercial laundering is a multistep procedure involving sorting, prewashing, washing, rinsing, drying, pressing, and redistributing. The wash and rinse stages are of greatest concern to POTWs. Conventional washing machines, which typically handle between 300 to 700 pounds per load, are single-load machines that can perform prewash, wash, and rinse cycles. These machines generally use between 5 and 6 gallons of water per pound of laundry. Laundry chemicals are either manually or automatically fed to the machines during various wash and rinse cycles.

Some industrial and commercial laundries use tunnel washers instead of conventional washers. Tunnel washers are composed of various dedicated segments that perform washing, rinsing, and drying. Washing is accomplished largely through the action of chemical additions rather than through agitation. Tunnel washers consume far less water than conventional washers, averaging between 1 and 1.25 gallons of water per pound of laundry. Many tunnel washers are equipped with countercurrent rinsing and rinsewater recycling mechanisms.

Most industrial and commercial laundries employ heat exchangers that preheat incoming makeup water with the heat from the outgoing wastewater. Heat exchangers can bring makeup water to within 4 degrees Fahrenheit of wastewater temperature, which generally varies between 90°F and 125°F. Launderers typically use water heated to 140°F to 150°F for washing and rinsing operations.

Waste Streams

Industrial and commercial laundries use a variety of powder and liquid chemicals in the wash and rinse cycles, including alkaline detergents, bacteriostats, chlorine bleach, sour (phosphoric acid), and fabric softener. A portion of these chemicals precipitate into wastewaters. In addition, wastewaters often receive contaminants from laundry articles such as oil and grease, petroleum hydrocarbons, zinc, chromium, copper, nickel, selenium, cadmium, lead, total suspended solids (TSS), and BOD. Other commonly found contaminants include ethyl toluene, n-propyl alcohol, isopropyl alcohol, toluene, xylene, ethylbenzene, bis(2-ethylhexyl)phthalate, phosphate, and sulfide. The contaminants found in a given facility's wastewater will in part depend upon the composition of the facility's business. For example, diaper services often find elevated levels of zinc in their wastewater due to the common use of zinc oxide-based diaper rash creams. On the other hand, a launderer who primarily serves automotive maintenance facilities might experience elevated levels of petrochemicals.

Pollution Prevention Options

Good Operating Practices

Implementing certain BMPs can achieve significant pollution prevention gains at low cost. These procedural changes encompass the following areas:

- Employee training
- Management commitment
- Inventory control
- Scheduling improvements
- Preventive maintenance
- Spill and leak prevention
- Segregation of rinsewater from other wastewater

Improving Chemical Handling

Poor manual handling of laundry chemicals can lead to accidental spills or under- or overuse of chemicals. Underuse of laundry chemicals might result in poorly cleaned laundry articles that must then be cleaned again. The overuse of laundry chemicals unnecessarily increases the volume of chemicals disposed of without realizing any additional benefits in terms of cleaner laundry. Optimizing the quantity of laundry chemicals used per load while minimizing the potential for accidental spills can be achieved through enhanced worker training, prepackaged laundry chemicals, or the use of an automated laundry chemical feed system. While laundries might incur up-front capital costs to install an automated system, the savings in terms of optimal chemical usage and possible reduction in labor costs might pay for the system in the long run.

Changing Customer Practices

In many cases, contaminants borne by incoming laundry precipitate into the laundry facility's wastewater, causing the facility to violate pretreatment standards. While some contaminants in laundry items might be endemic to particular business or consumer practices (e.g., mechanics will inevitably get oil and grease on their uniforms), the laundry facility, in certain circumstances, might be able to encourage its customers to alter their practices to reduce the presence of certain contaminants in laundry items. For example, a diaper service might ask its customers to substitute zinc oxide-based diaper rash creams with zinc-free alternatives.

Substituting Laundry Chemicals with Less-Toxic Alternatives

A number of less-toxic laundry cleaners are available, such as vegetable-based, enzyme-based, and nonchelating cleaners. Laundries should investigate these alternative cleaners to see if they are appropriate substitutes.

Although ozone is a highly toxic and hazardous material, its use in laundering is considered safe and can virtually eliminate use of other laundering chemicals. Ozone is an effective disinfectant and enhances the effectiveness of chlorine bleach. Leasing or purchasing an ozonation system can be expensive, but might pay for itself in terms of reduced chemical usage and sewer loadings. The major drawbacks of ozonation systems include the quality of cleaning achieved by the system and the potential for worker exposure. Also, because the waters used in an ozone-based system recirculate, laundry contaminants might become more concentrated than in conventional systems. Ozonation cleaning systems have not been used widely in this country and therefore their performance has not been evaluated.

Rinsewater Recycling and Reuse

Rinsewater discharged from conventional washing machines is generally of high enough quality to be reused for prerinsing or prewashing operations. A rinsewater reuse system requires segregating rinsewater from other wastewaters and rerouting it back to the initial stages of the washing process. Reusing rinsewater can result in significant savings by reducing the volume of wastewater discharged, thus reducing sewer charges, and by reducing the volume of incoming cold water that must be heated to the requisite washing temperatures of 140°F to 150°F.

Tunnel washers with countercurrent rinsing and rinsewater recycling mechanisms also can result in reduced wastewater discharges. With countercurrent rinsing, rinsewater flows countercurrent to the washing operation so that the final rinse is with pure water while preceding rinses use more contaminated water. Launderers should be aware that reducing water consumption without proportionately reducing process contaminants might increase wastewater contaminant concentrations, possibly resulting in discharges that exceed concentration-based limits; however, increased concentrations can improve wastewater treatment efficiencies.

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202-296-6744

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Pollution Prevention Summary:

Paint Manufacturing

Process Description

The major steps involved in the production of solvent-based and water-based paint, the two main products of the paint manufacturing industry, can be broadly grouped into *primary dispersion*, in which pigments and other materials are mixed and dispersed, and *let-down*, in which final mixing, dilution, filtering, and packaging occurs. Specific steps in grinding and mixing operations during primary dispersion differ somewhat between solvent-based and water-based paints, but both processes commonly use mills, the design of which varies depending on the types of pigments being handled. Single, high-speed mixers that accomplish all the grinding and mixing operations in a single step, thus eliminating the need for a mill, are being increasingly used by the industry.

Solvent-based paints involve the mixing of resins, dry pigment, pigment extenders, solvents, and plasticizers to create a paint base or concentrate. Let-down operations begin with the addition of tints and thinners to the paint base in an agitated mix tank until a proper consistency is reached. Water-based paints are prepared by first mixing water, ammonia, and a dispersant followed by the addition of dry pigment and pigment extenders. After mixing and grinding, the material is transferred to an agitated mix tank at which time the final ingredients are added in the following order: (1) resin and plasticizers, (2) preservative and antifoaming agent, (3) a polyvinyl acetate emulsion, and (4) water added as a thinner.

Once a batch of solvent-based or water-based paints reaches the desired consistency, it is filtered to remove any nondispersed pigment and transferred to a loading hopper, where the paint is poured into cans, labeled, packed, and moved to storage.

Waste Streams

Table B-7 identifies six aqueous or liquid waste streams that can result from paint manufacturing. The main waste stream of concern to POTWs is contaminated rinsewater that is discharged to sewers. Major environmental concerns include solvent residue from solvent-based paints, ammonia from water-based paints, and dissolved heavy metals and other toxic compounds from pigments of both paint types. Waste solvents will generally be handled as a hazardous waste. Accidental spills are a potential concern if cleanup results in discharge of concentrated or diluted waste streams into sewers. Similarly, paint sludges are a concern only if any liquids associated with the sludge are discharged to the sewer. Off-specification products resulting from poor process control increase waste loading to the extent that additional batches must be processed that would not otherwise have been required. The use of metal mesh filters in place of disposable filter cartridges is an example of efforts at minimizing solid waste that may result in increased wastewater flow, because washing of the reusable filters results in contaminated rinsewater.

Table B-7. Aqueous/Liquid Wastes from Paint Manufacturing

Waste Description	Process Origin	Composition
Waste rinsewater	Equipment cleaning using water and/or caustic solutions	Low pH, solvent residue, heavy metals (lead, chromium)
Waste solvent	Equipment cleaning using solvent	Solvents,[a] oxygen demand
Spills	Accidental discharge	Paint (lead, chromium),[b] solvents
Off-specification products	Color matching (small scale) production, poor process control	Paint (lead, chromium)[b]
Paint sludge	Equipment cleaning, sludges removed from cleaning solution	Supernatant wastewater contaminated with paint pigments, solvents, caustic solutions
Filter cartridges	Undispersed pigment	If metal mesh filters are used, contaminated wastewater will be created by cleaning and reuse

[a] Some solvents used in paint manufacturing include methanol, methyl ethyl ketone, toluene, lacquer thinner, mineral spirits, and isobutyl isobutyrate.
[b] About 27 percent of inorganic pigments used in the manufacture of paint are lead and chrome compounds.

Pollution Prevention Options

The pollution prevention options for paint manufacturing groups can be divided into four categories: (1) reduction of cleaning frequency, (2) reduction in the amount of water used for cleaning, (3) reuse of wastewater from previous cleaning activities, and (4) spills and area wash-downs.

Reducing Cleaning Frequency

Less-frequent cleaning of equipment during primary dispersion can be accomplished by modifying operating procedures to reduce the number of passes through a mill or by using high-speed mixers that eliminate multiple passes entirely. Dedicating mixing tanks to a single formulation, and increasing the length of production runs when the same tank is used for different formulations, will reduce the number of times equipment must be cleaned during let-down. It also may be possible to sequence paint batches from light to dark to eliminate cleaning between batches. Dedicating filter units to formulations can reduce the need for filter replacement and cleaning.

Reducing Water Used for Cleaning

Immediate cleaning of equipment before paint is allowed to dry reduces the need for caustic cleaning solutions. Extending the life of cleaning solutions also can reduce water requirements. For example, stable alkaline cleaning formulations may be able to cut solution replacement frequency in half. Reducing the amount of clingage and residue to be removed from mixing tanks will reduce both the degree of contamination of rinsewater and the amount of water required to complete the cleaning process. This can be accomplished using methods such as wiper blades (manual or mechanical), well-designed drains, and the use of foams or "plastic pigs" to clean lines. Teflon lined tanks reduce adhesion and improve drainage and may be worth considering for small batch tanks that are amenable to manual cleaning. Automatic wall scrapers (as opposed to manual wipers or squeegees) may be more cost effective for large tanks. The amount of rinsewater can be further reduced by using low-volume, high-efficiency cleaning equipment, such as steam cleaners, and high-pressure spray nozzles on hoses.

Wastewater Reuse

Collection of solvent rinses (solvent-based paints) and water washes (water-based paints) for use in the next compatible batch of paint can substantially reduce the amount of liquid waste that is produced from equipment cleaning. For example, one operation reduced annual waste solvent production from 25,000 gallons to 400 gallons by using solvent rinses for paint formulation.

Countercurrent rinsing reduces the volume of cleaning waste by using a recycled "dirty" solution to initially clean the tank, followed by a recycled "clean" solution to rinse the "dirty" solution. It also may be possible to extend the life of cleaning solutions by (1) sludge dewatering, (2) providing adequate solids settling time in spent rinse solutions, and (3) using de-emulsifiers in rinsewater to promote emulsion breakdown and organic phase separation. Cleaning wastes can be treated for reuse on site (distillation to recover/regenerate solvents) or off site (commercial recyclers) or may be sold to another firm for use in its process (waste exchange service).

Spills and Area Wash-Downs

Several possible options may be available for reducing the amount of wastewater resulting from cleanup of spills and area wash-downs. The use of dry absorbents to soak up liquids will reduce the degree of contamination of rinsewater, but will create a solid waste. Dedicated mops and squeegees also can be used to collect more concentrated wastes, reducing the degree of contamination of rinsewater. The use of recycled water for initial cleanup will reduce water use, as will low-volume, high-efficiency cleaning equipment such as high-pressure spray nozzles. The latter options will produce a lower volume of wastewater but higher concentrations of contaminants. (One operation actually plugged existing floor drains to encourage dry cleanup methods and discourage excessive use of water.)

Other Process Modifications

Other process modifications include substituting solvents and other raw material with less-hazardous materials (no-lead/chromate pigments, non-mercury-based bactericides); reformulating to reduce process wastes and cleaning requirements; minimizing evaporative losses; avoiding off-specification products (quality testing of raw materials, batch formulation in laboratory before large-scale production, strict quality control, automated processing systems, reformulation/blending of off-spec batches); blending obsolete products/customer returns into new products; blending/using waste streams to produce marketable products.

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Washington, DC 20460

U.S. EPA. 1990. U.S. Environmental Protection Agency. Guides to pollution prevention: The paint manufacturing industry. EPA/625/7-90/005. NTIS PB90-256405. Washington, DC: Office of Research and Development.

U.S. EPA. 1990. U.S. Environmental Protection Agency. Does your business produce hazardous waste? Many small businesses do: formulators. Washington, DC: Office of Solid Waste and Emergency Response. EPA/530/SW-90/027P.

Pollution Prevention Summary:

Pesticide Formulation

Process Description

Pesticide formulation involves the mixing of highly concentrated active ingredients with inert ingredients to create liquid-based or solid-based pesticides suitable for handling by mainly agricultural end users. The process for liquid formulations is relatively simple, involving the mixing of pesticide concentrate with solvents, such as xylenes, kerosenes, methyl isobutyl ketone, amyl acetate, or chlorinated solvents. Propellants (carbon dioxide, nitrogen) and other special-purpose ingredients, such as wetting and dispersing agents, masking agents, deodorants, and emulsifiers, also may be added. The mixed product is then filtered before being packaged in drums or glass containers.

Dry pesticides are formulated by mixing the concentrate with inert ingredients such as organic flours, sulfur, silicon oxide, lime, gypsum, talc, or clay minerals/materials (pyrophyllite, bentonite, kaolin, attapulgite, volcanic ash). Various crushing, pulverizing, grinding, and blending steps may be involved before final packaging in drums or paper bags for distribution.

Waste Streams

Table B-8 identifies seven aqueous or liquid waste streams associated with the formulation of pesticides. Dry pesticides typically generate only pesticide-contaminated wastewaters, whereas liquid pesticides generate both pesticide-contaminated and solvent-contaminated wastewaters. The main waste streams of concern to POTWs are (1) contaminated rinsewater from cleaning processing equipment, (2) laundry wastewater from washing protective clothing, (3) scrubber water from air pollution equipment used to control dusts associated with dry formulation, and (4) contaminated storm-water runoff from outdoor spills or deposition of dust from open processing areas (if runoff enters the sewer system). Major environmental concerns include the toxicity of pesticide residues in the wastewater and solvent residues from liquid formulations. Most waste streams associated with pesticide formulation, including waste solvents, are classified as hazardous and consequently are not likely to be discharged to sewers without treatment. Accidental spills are a potential concern if cleanup results in discharge of concentrated or dilute waste streams into sewers. Off-specification products resulting from poor process controls increase wastewater loading to the extent that additional batches must be processed that would not otherwise have been required.

Pollution Prevention Options

The fact that most waste streams resulting from pesticide formulation are classified as hazardous creates a strong incentive to minimize the quantity of all waste streams, and it is fortunate that there are many opportunities for accomplishing this. Most of these opportunities fall into five general categories: (1) process modifications, (2) reduction of cleaning

Table B-8. Aqueous/Liquid Wastes from Pesticide Formulation

Waste Description	Process Origin	Composition
Waste rinsewater	Equipment cleaning, area wash-down, hot water bath for leak checking	Pesticide- and solvent-contaminated wastewater*
Laundry wastewater	Washing of protective clothing	Pesticide-contaminated wastewater
Scrubber water from air pollution equipment	Unloading of dry pesticides into blending tanks	Pesticide-contaminated wastewater and solvents
Storm-water runoff	Pesticide spillage and fallout of pesticide dust in open process areas	Pesticide-contaminated wastewater
Waste solvent	Equipment cleaning	Pesticide-contaminated solvents, oxygen demand
Spills	Accidental discharge	Waste pesticide formulations, waste solvents*
Off-specification products and laboratory analysis wastes	Formulating and testing	Waste pesticide formulations

* Commonly used solvents include methyl alcohol, ethyl alcohol, isopropyl alcohol, toluene, xylene, chloroform, carbon tetrachloride, benzene, and tetrachloroethylene. Other solvents used in liquid pesticide formulations include kerosene, methyl isobutyl ketone, and amyl acetate.

frequency, (3) reduction in the amount of water used for cleaning, (4) reuse of wastewater from previous cleaning activities, and (5) spills and area wash-downs.

Process Modifications

Some process modifications to prevent pollution include substituting solvents and other raw materials with less-toxic materials; reformulating to reduce process wastes and cleaning requirements; using solvent or water used in formulation to clean the preceding equipment before adding to the mix tank; avoiding off-specification products (quality testing of raw materials, batch formulation in laboratory before large-scale production, strict quality control, automated processing systems, reformulation of off-spec batches); blending/using waste streams to produce marketable products; and using microscale glassware to reduce wastes from laboratory tests.

Reduction of Cleaning Frequency

The frequency with which equipment must be cleaned can be reduced in several ways. Equipment dedicated to a single formulation greatly reduces requirements for cleaning. Increasing the length of production runs when the same equipment is used for different formulations also will reduce the number of times equipment must be cleaned. In some situations, it also may be possible to use sequential formulations that do not require cleaning between batches.

Reduction in Water Used for Cleaning

A number of options are available for reducing water used in cleaning. First, reducing the amount of residue to be removed will both reduce the amount of contamination of rinsewater and the amount of water required to complete the cleaning process. This can be accomplished using methods such as wiper blades (manual or mechanical), well-designed drains, and the use of foams or plastic pigs to clean lines. The amount of rinsewater can be further reduced by using low-volume, high-efficiency cleaning equipment, such as steam cleaners, and high-pressure spray nozzles on hoses. For example, use of steam cleaners instead of batch-boil cleaning of mixing tanks will dramatically reduce the amount of water used. If a formulation is water-based, using the formulation water to clean equipment before adding it to the mixing tank essentially eliminates the production of wastewater.

Wastewater Reuse

Various possibilities exist for reusing wastewater during pesticide formulation. Where multiple rinses are required to clean equipment, the final rinse can be used as a prerinse during the next cleaning cycle. It also may be possible to store rinsewater and use it in subsequent formulations. For example, the amount of rinsewater from steam cleaning of equipment used for dry formulations may be small enough to be injected into the next batch. Similarly, waste rinsewater may be suitable to dilute subsequent liquid formulations. Cleaning wastes can be treated on site for reuse (regeneration/recovery) or off site by a commercial solvent recycler or sold to another firm for use in its process (waste exchange service).

Spills and Area Wash-Downs

Several possible options may be available for reducing the amount of wastewater resulting in cleanup of spills and area wash-downs. The use of dry absorbents to soak up liquids will reduce the degree of contamination of rinsewater, but will create a solid waste. Dedicated mops and squeegees also can be used to collect more concentrated wastes, reducing the degree of contamination of rinsewater. The use of recycled water for initial cleanup will reduce water use, as will low-volume, high-efficiency cleaning equipment such as high-pressure spray nozzles. The latter options will produce a lower volume of wastewater but higher concentrations of contaminants. High-spill areas can be paved for easier cleaning and spilled materials can be recovered and used.

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U.S. EPA. 1990. U.S. Environmental Protection Agency. Does your business produce hazardous waste? Many small businesses do: formulators. Washington, DC: Office of Solid Waste and Emergency Response. EPA/530/SW-90/027P.

Pollution Prevention Summary:

Pharmaceuticals Manufacturing

Process Description

Production processes for the manufacture of pharmaceuticals can be broadly classified as those involving (1) chemical synthesis, (2) fermentation, and (3) natural product extraction (products from natural materials such as roots, leaves, and animal glands). Other major types of activity associated with pharmaceuticals include research and development (R&D) in the fields of chemistry, microbiology, and pharmacology, and formulation of dosage forms, such as tablets, capsules, liquids, parenterals (injections), and creams and ointments. R&D activities may result in significant quantities of toxic aqueous and liquid wastes being generated. Natural product extraction does not generally produce wastewaters of major concern and is not discussed here.

A complex array of batch-type processes and other technologies are used for manufacturing pharmaceuticals and specific input materials, and processes will differ for each individual product. Chemical synthesis is the most commonly used method for production of drugs. A typical manufacturing plant will have one or more batch reactor vessels and ancillary equipment for separation and purification steps to make the desired end product. Depending on the product, the process may involve a relatively simple two-step reaction-separation sequence, or require a complex sequence of separation and purification steps. A wide variety of chemicals may be used during chemical synthesis.

Fermentation, a batch process that is typically used to produce steroids, vitamin B_{12}, and antibiotics, involves two major steps: (1) inoculum and seed preparation; and (2) fermentation, where nutrients are provided as a feedstock for microorganisms from the seed tank to produce a fermenter broth containing the product of interest. When fermentation is completed, the crude product is recovered and purified.

Waste Streams

Table B-9 identifies nine aqueous or liquid waste streams that may result from pharmaceuticals manufacturing. The pharmaceutical industry may generate a number of waste streams of potential concern to POTWs. Waste rinsewater and scrubber water from air pollution equipment may be contaminated with toxic inorganic and organic chemicals, depending on the processes involved. Solvent extraction and other extraction processes create contaminated spent aqueous solutions that may be of concern if discharged to a sewer. Spent fermentation broth generally does not have toxic contaminants, but typically has high biochemical and

Table B-9. Aqueous/Liquid Wastes from Pharmaceuticals Manufacturing

Waste Description	Process Origin	Composition
Waste rinsewater	Equipment cleaning, extraction residues	Contaminated water
Scrubber water from air pollution equipment	Dust- or hazardous-waste-generating processes	Contaminated water
Spent aqueous solutions	Solvent extraction processes	Contaminated water*
Spent fermentation broth	Fermentation processes	Oxygen demand, suspended solids
Process liquors	Organic synthesis	Solvents,* oxygen demand, suspended solids, high/low pH
Used chemical reagents	Research and development operations	Halogenated and non-halogenated solvents, photographic chemicals, radionuclides, bases, and oxidizers
Spent solvents	Solvent extraction or wash practices	Solvents,* oxygen demand
Spills	Accidental discharge from manufacturing and laboratory operations	Miscellaneous chemicals of environmental concern
Off-specification or outdated products	Manufacturing operations	Miscellaneous products

* Commonly used solvents include acetone, cyclohexane, methylene chloride, ethyl acetate, butyl acetate, methanol, ethanol, isopropanol, butanol, methyl ethyl ketone, methyl isobutyl ketone, tetrahydrofuran. Other solvents may include benzene, chloroform, carbon tetrachloride, phenol, toluene, and xylene.

chemical oxygen demand (BOD and COD) and total suspended solids (TSS) levels. Process liquors from synthesis processes typically have high BOD, COD, and TSS, with pHs ranging from 1 to 11. Organic and inorganic chemicals in the process liquors also may be toxic. Used chemical reagents from pharmaceutical research and development activities may involve a wide range of chemicals of potential environmental concern.

Waste solvents will generally be handled as a hazardous waste. Accidental spills are a potential concern if cleanup results in discharge of concentrated or diluted waste streams into sewers. Off-specification products resulting from poor process controls increase waste loading to the extent that additional batches must be processed that would not otherwise have been required.

Pollution Prevention Options

In general, stringent product specifications and the high cost of gaining approval to manufacture new pharmaceutical products limit the potential for waste reduction compared to many other industries. However, the great diversity of specific manufacturing processes and the variety of aqueous and liquid waste streams mean that a large number of pollution prevention options are potentially suitable.

Focusing attention on opportunities to improve management and operating practices is especially important in pharmaceutical operations because these can be accomplished without modifying existing processes. Some opportunities may exist for material substitution. For example, replacement of organic solvents with water-based solvents for tablet-coating operations and use of aqueous-based cleaning solutions instead of solvent-based solutions have been successful in reducing solvent waste streams in the industry.

Opportunities for reducing wastewater from equipment-cleaning operations will probably yield the greatest benefits to POTWs. For example, when separate alkaline and acid waste streams must be neutralized before being discharged to a POTW, (1) mixing the two may reduce the amount a new chemicals required to neutralize the streams separately, and (2) precipitation reactions may allow removal of dissolved constituents in the waste before discharge.

Specific pollution prevention opportunities discussed below are divided into three categories: (1) process modifications, (2) equipment-cleaning wastes, and (3) spills and area wash-downs.

Process Modifications

Process modifications that can prevent pollution include substituting solvent and other raw material with less-toxic materials; reformulating to reduce process wastes and cleaning requirements; using solvent or water used in formulation to clean the preceding equipment before adding to the mix tank; avoiding off-specification products (quality testing of raw materials, batch formulation in laboratory before large-scale production, strict quality control, automated processing systems, reformulation of off-spec batches); blending/using waste streams to produce marketable products; mixing acid and alkaline waste solutions to reduce requirements for neutralization reagents; and using microscale glassware to reduce wastes from laboratory tests.

Equipment-cleaning Wastes

Equipment cleaning procedures that prevent pollution include maximizing production runs to reduce cleaning frequency; using sequential formulations that do not require cleaning between batches; dedicating equipment to formulations to reduce the need for cleaning; reducing clingage and residue to be cleaned between batches (manual use of wiper blades, squeegees, mops; mechanical wipers on mix tanks; rework remainder into products; clean lines using foam/plastic pigs instead of, or prior to, flushing with solvent or water; self-draining piping design); using low-volume, high-efficiency cleaning (new nozzle heads/higher pump pressures on existing hoses; high-pressure spray washers; steam cleaners); substituting aqueous systems for solvents where possible; collecting and reusing rinsewater and cleaning wastes (final rinse as prerinse of next cleaning cycle, reuse for primary cleaning, reuse as part of compatible formulation); treating cleaning wastes for reuse (regeneration/recovery of solvents by distillation); reusing wastes off site (waste exchange services, commercial brokerage firms); and standardizing cleaning solvents.

Spills and Area Wash-Downs

Cleaning procedures for spills can be improved by using dedicated vacuum system (powders), using dry cleanup methods (dry absorbents), closing floor drains to encourage dry cleanup methods and discourage excessive water use, dedicating mops and squeegees to reduce water hosing for floor washing, using recycled water for initial cleanup, using high-pressure water knife spray nozzles on hoses to reduce water used for floor washing, paving areas where spills frequently occur, and recovering and using spilled materials.

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U.S. EPA. 1990. U.S. Environmental Protection Agency. Does your business produce hazardous waste? Many small businesses do: formulators. Washington, DC: Office of Solid Waste and Emergency Response. EPA/530/SW-90/027P.

Pollution Prevention Summary:

Photoprocessing

Process Description

The photoprocessing industry consists of businesses that develop and finish photographic film. While the actual chemistry of photoprocessing is extremely complex, the process itself is a relatively simple procedure involving various stages in which film and paper are submersed for prescribed periods in developer, bleaches, stop baths, fixers, and stabilizers. After each stage, the film or paper is thoroughly drained, washed, rinsed, or dried, depending on the stage of development and the type of film and processing. Photoprocessing can be conducted manually for low-volume processing or with automated systems. The two systems differ primarily in the means used to transfer film or paper through the sequence of solutions.

In recent years, color photoprocessing, with a 90 percent share of the total photoprocessing market, has shifted toward the use of small automated labs (i.e., 1-hour processing) with "washless" or "plumbingless" systems that do not use a conventional wash cycle. Plumbingless minilabs use a proprietary chemical stabilizer in place of wash water. While conventional minilabs discharge 20 to 25 gallons of effluent per roll of film, these minilabs discharge less than 0.1 gallons of effluent per roll. Although plumbingless minilabs greatly reduce the volume of effluent, the concentrations of contaminants are likely to be quite high.

Waste Streams

Photoprocessing produces aqueous effluents containing toxic constituents from the various solutions listed in Table B-10. Chemical solutions are generally combined with spent rinsewater as a single effluent stream and discharged to an onsite treatment unit and then to a POTW via the sewer. All aqueous effluents contain silver, although in different forms and different concentrations. Table B-10 lists photoprocessing waste solutions generated.

Pollution Prevention Options

Simple management practices, such as controlling inventories, using floating lids to prevent evaporation, and improving quality control for all processes have proven effective in reducing photoprocessing wastes in many establishments and require only a minimal investment. A carefully designed inventory system that maintains a 1-month stock of materials and appropriate environmental controls can prevent needless chemical disposal due to expiration and damage during storage. Using floating lids or other means to reduce air space in containers will prevent evaporation and extend the life of process chemicals. Other simple quality control measures, such as inspecting inventory daily for spillage and leaks and ensuring that process chemicals are mixed only in quantities sufficient to meet realistic processing volumes, also will result in significant waste reduction.

Some manual and automated photoprocessing systems could install squeegees to wipe excess chemical solutions from film and paper. This reduces chemical carryover from one process bath to the next, thereby maintaining the purity of individual process chemicals and enhancing their "recyclability." Several types of squeegees are available, including wiper blades, air squeegees, vacuum squeegees, wringersling squeegees, and rotary-buffer squeegees. Squeegees should not be used on rack-and-tank, basket, or drum processors.

Material substitution is a less-viable alternative in most photoprocessing operations. Alternative materials are generally unavailable, more expensive, and do not perform as well. Most operators use established chemical packages with few options for substituting alternative

Table B-10. Aqueous Wastes Generated from Photoprocessing

Solution	Composition
Prehardeners, hardeners, and prebaths	Organic chemicals, chromium compounds
Developers	Organic chemicals
Stop baths	Organic chemicals
Ferricyanide bleaches	Ferricyanide
Dichromate bleaches	Organic chemicals, chromium compounds
Clearing baths	Organic chemicals
Fixing baths	Organic chemicals, silver, thiocyanate, ammonium compounds, sulfur compounds
Neutralizers	Organic chemicals
Stabilizers	Phosphate
Sound-track fixer or redeveloper	Organic chemicals, ammonium compounds
Monobaths	Organic chemicals

Note: In addition, photoprocessing solutions may be acidic or alkaline.

materials. Photoprocessors, however, should encourage photochemical manufacturers and suppliers to develop processes that result in lower-volume and less-toxic wastes.

Silver Recovery

Many photoprocessing operations recover silver from photoprocessing solutions and rinsewater for sale to reclaimers. Fixer and bleach-fix will contain between 80 and 100 percent of the recoverable silver from photoprocessing operations. Photoprocessors most commonly employ metal replacement, electrolytic recovery, and chemical precipitation to recover silver from fixer and bleach-fix. Other methods, such as reverse osmosis (RO), ion exchange, and evaporation are less common and more suitable for silver recovery from rinsewaters and washwaters with low silver concentrations. Metallic replacement and precipitation require the least investment of silver recovery technologies.

Color Developer Regeneration

Color photoprocessors can regenerate color developer and reduce replenisher purchases by about 50 percent. One regeneration process uses an ion-exchange unit to remove the excess development by-products from the developer solution. Other available processes include electrolytic, persulfate, and ozone regeneration; RO; and precipitation.

Rinsewater Recycling

Photoprocessing requires many rinse cycles, which can produce large volumes of rinsewater with low concentrations of process chemicals. Commercial rinsewater recycling systems that treat and restore purity to rinsewater for further use are available. These systems generally add a small amount of incoming clean water to the recycled rinsewater and discharge an equivalent amount following the fixer wash. Countercurrent rinsing also can reduce rinsewater discharge volume. In this process, rinsewater flows countercurrent to the photoprocessing operation so that the final rinse uses pure water and preceding rinses use contaminated rinsewater. It is recommended that photoprocessors employing countercurrent rinsing use squeegees to reduce carryover of contaminants in each rinse stage. Photoprocessors should be aware that reducing water consumption is likely to increase wastewater contaminant concentrations. While increasing contaminant concentrations may exceed concentration-based discharge limits, total pollutant mass discharged will not increase. Also, increased concentrations, if present, can improve wastewater treatment efficiencies.

Evaporation

Evaporation of photoprocessing effluents coupled with silver reclamation and rinsewater recycling also can minimize waste discharges. Such a system evaporates photoprocessing effluents and reclaims silver from the resulting sludge. Complete systems condense and recycle water vapor during wastewater evaporation. This "zero discharge" system may require control technologies to capture volatile organics from the evaporating wastewaters. Contaminants may remain in the condensed wastewater, potentially causing problems for wastewater recycling in photoprocessing operations. Evaporation systems generally have large energy requirements.

Pollution Prevention Successes

PCA International, Inc., of Matthews, North Carolina, recycles photographic processing waste (ultimately discharged to the sewer) to recover silver and regenerate spent fixer, developer, and bleach. Silver is recovered using an electrolytic recovery unit with a rotating electrode. PCA recovers 2,200 troy ounces of 96 percent pure silver per week from color negative film fixer solutions and paper fixer solutions. PCA then aerates de-silvered solutions and returns them to full strength; 96 percent of the original solution is reused. PCA regenerates color developer by ion exchange and reuses 84 percent of the original solution. PCA also recovers 90 percent of bleach solutions. PCA saves over $1.1 million each year by recovering and reusing spent solutions. In 1989, silver recovery added another $800,000 to these savings (PPIC, 1992).

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U.S. EPA. 1991. U.S. Environmental Protection Agency. Guides to pollution prevention: the photoprocessing industry. Washington, DC: Office of Research and Development. EPA/625/7-91/012. NTIS PB92-129121.

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Pollution Prevention Summary:

Printed Circuit Board Manufacturing

Process Description

Most printed circuit board manufacturers employ a series of sequentially ordered mechanical and chemical processes that selectively deposit copper on a flat sheet of nonconducting material to create a predetermined circuit for a given application. A typical nine-stage manufacturing process is described in Table B-11.

Waste Streams

Printed circuit board manufacturers produce a variety of rinsewater waste streams generated after scrubbing, plating, and etching operations (see Table B-12). These rinsewaters can contain suspended solids, metals, fluoride, phosphorus, cyanide, and chelating agents. Low pH values often characterize these waste streams due to acid cleaning operations. In addition, printed circuit board manufacturers must control air emissions from board preparation, acid cleaning, and vapor degreasing. Manufacturers also must treat acid and alkaline cleaning solutions and manage spent chlorinated solvents either through disposal, in-house recovery, or offsite reclamation.

Pollution Prevention Options

Good Operating Practices

Circuit board manufacturers can use a variety of best management practices to achieve significant reductions in toxic waste discharges at relatively low costs. An important first step at any circuit board manufacturing establishment is to procure management's commitment to pollution prevention and provide employee training and incentives. These management initiatives can greatly increase employee awareness of pollution prevention as a company goal. A carefully designed inventory system that maintains a 1-month stock of materials and appropriate environmental controls can prevent needless chemical disposal due to expiration and damage during storage. Other simple quality control measures (e.g., inspecting inventory storage areas daily for spillage and leaks; conducting preventative maintenance; maintaining spill prevention and emergency response plans; and ensuring that process chemicals are mixed only in quantities sufficient to meet realistic processing volumes) also will result in significant waste reduction.

Table B-11. Nine Stages in Printed Circuit Board Manufacturing

Manufacturing Stage	Description
Board preparation	Laminated sheets of nonconducting material are cut to size, drilled by programmed high-speed drills, and deburred at the holes and board edges.
Electroless copper plating	A thin layer of copper is deposited by electroless plating on boards that are first cleaned and rinsed and then coated with a catalyst for reducing copper.
Dry film application	Circuit pattern is applied by laminating a photosensitive polymer resist, developing with sodium carbonate, and rinsing with water.
Electrolytic copper plating	Electrolytic plating of copper occurs on the circuit design developed in the previous stages.
Electrolytic tin plating	Tin is electrolytically plated over the copper to protect the circuit design from the alkaline etchant used to strip away the plating resist.
Etching and stripping	Any copper not protected by the tin is etched away by an alkaline solution. An ammonium bifluoride hydrogen peroxide solution removes the tin to complete the electronic circuitry on the board. Etched and stripped board is then water-rinsed and dried.
Gold tab plating	To meet customer specifications, connectors are sometimes nickel- and gold-plated.
Solder application	Solder is applied to portions of the boards not coated by an epoxy solder mask.
Final processes	Finished boards are inspected, labeled, packaged, and stored.

Table B-12. Waste Streams Generated from Circuit Board Manufacturing Processes

Process	Waste Stream	Composition
Cleaning/surface preparation	Airborne particulates, acid fumes/organic vapors, spent acid/alkaline solution, spent halogenated solvents, waste rinsewater	Board materials, sanding materials, metals, fluoride, acids, halogenated solvents, alkali
Catalyst application/electroless plating	Spent electroless copper bath, spent catalyst solution, spent acid solution, waste rinsewater	Acids, stannic oxide, palladium, complexed metals, chelating agents
Pattern printing/masking	Spent developing solution, spent resist removal solution, spent acid solution, waste rinsewater	Vinyl polymers, chlorinated hydrocarbons, organic solvents, alkali
Electroplating	Spent plating bath, waste rinsewater	Copper, nickel, tin, lead, gold, fluoride, cyanide, sulfate
Etching	Spent etchant, waste rinsewater	Ammonia, chromium, copper, iron, acids

Rinsing and Cleaning, Surface Preparation

Mechanical cleaning methods offer an alternative to solvent-based techniques and generate less hazardous waste. Abrasive blast cleaning uses plastic or ceramic media to remove oxidation layers, old plating, paint, and burrs. To prevent damage to the board, abrasive cleaners must be harder than the layer to be stripped but softer than the substrate.

Both cleaning agents and rinsewaters can be reused and recycled. For example, copper sulfate can be recovered from spent peroxide/sulfuric acid solution, which is used as a mild etchant and for cleaning copper and removing oxides prior to plating. The recovered copper sulfate crystals can then be used in a copper electroplating makeup bath. Ion exchange recycling devices can regenerate spent acid baths for reuse. Countercurrent cleaning arrangements also can reduce cleaning solution consumption.

Closed loop rinsewater recycling can dramatically decrease wastewater discharges. Effluent from a rinse system that follows an acid bath can be reused as influent water to a rinse system following an alkaline cleaning bath. This system can actually improve the efficiency of the rinse system following the alkaline bath. Using acid-laden rinsewater accelerates the chemical diffusion process in the alkaline rinse system since the alkaline material at the interface between the drag-out film and the surrounding water is reduced by the neutralization reaction. In addition, the neutralization reaction reduces the viscosity of the alkaline drag-out film, thus improving rinse efficiency. Rinsewater reuse opportunities exist in other areas as well, especially where rinsing cycles do not require purified rinsewater.

After rinse solutions become too contaminated for use in any rinse processes, they may be concentrated through evaporation and returned to process baths as makeup, providing they contain high enough concentrations of process chemicals.

Pattern Printing and Masking

A number of alternatives to traditional developing methods are available to reduce use of toxic developers and solvents. For example, the use of aqueous processable resist allows for the use of caustic and carbonates as developer and stripper in place of solvents necessary to develop and strip solvent processable resist. Using screen-printing instead of photolithography eliminates the need for developers. While screen-printing has traditionally been used to produce low-resolution circuit boards, several companies have recently developed screen-printing techniques that can provide higher degrees of resolution.

Spent photoresist stripper can be recycled and reused by decanting and filtering the solution into a clean tank. This is feasible because the stripper usually becomes ineffective as a result of residue buildup as opposed to a decrease in the chemical strength of the stripper itself.

Reducing Drag-Out from Plating and Process Baths

Reducing drag-out from plating baths will extend the useful life of other plating baths as well as reduce metal and chemical contamination of rinsewaters. Several factors contribute to drag-out. These include workpiece size and shape, as well as bath viscosity, chemical concentration, surface tension, and temperature. Table B-13 describes drag-out reduction techniques.

Improving Rinse Efficiency

Many techniques are available that can improve the efficiency of a rinsing system, reduce toxic contaminants in rinsewater, and reduce the volume of rinsewater used. Table B-14 lists some of the more common techniques.

Table B-13. Drag-Out Reduction Techniques

Drag-Out Technique	Description
Minimize bath chemical concentration	Controls drag-out because: (1) reduces the quantity of chemicals and toxicity of any drag-out that does occur, and (2) greater concentrations of some chemicals in a process solution increases viscosity.
Increase bath operating temperature	Lowers viscosity and surface tension of process solution.
Use wetting agents	Reduces surface tension of process solution.
Position workpiece properly on plating rack	Facilitates maximum drainage of drag-out back into process bath. Positioning guidelines include: – Orient surface as close to vertical as possible. – Orient with longer dimension of piece horizontal. – Orient with lower edge tilted from the horizontal so that runoff is directed from the corner rather than the entire edge.
Withdraw boards slowly and allow for ample drainage	The slower an item is removed from the process bath, the thinner the film on the workpiece surface and the less the drag-out volume. It is recommended that workpieces drain for a minimum of 10 seconds.
Use drain boards	Capture process chemicals that drip from the workpiece as it is moved from one bath to another and return it to the original bath.
Use still or dead rinses	Avoid need for a continuous flow of feed water. The chemical concentration of the rinse increases over time to the point where it can be used to replenish the original bath or as makeup for future batches.
Use computerized control systems	Allows for monitoring of process bath conditions for viscosity and surface-tension increasing factors and for controlling board withdrawal and drainage.

Table B-14. Rinsing Techniques

Rinsing Technique	Description
Closed circuit or countercurrent rinsing	Rinsewater flows countercurrent to the electroplating operation so that final rinse is with pure water and preceding rinses with more contaminated water. The most contaminated rinsewater can then be used to replenish the original process bath.
Spray rinsing and fog nozzles	When the board is removed from the process bath, it is sprayed over the bath before it is rinsed in immersion tanks. Much of the drag-out can be removed over the process bath in this manner. Much less water is needed with a fog nozzle than with conventional spray nozzles.
Proper equipment design/operation	Rinsewater use can be reduced with the proper monitoring and plumbing design. Various devices are available to optimize rinsewater flow rates.
Conductivity probe or pH meter	Conductivity probes or pH meters can be employed to control the flow of fresh water through rinse systems. The probe/meter measures the level of dissolved solids or hydrogen ions in the rinse solution. When this level reaches some preset minimum, the probe/meter activates a valve that shuts off the flow of fresh water.
Deionized water	Deionizing water removes natural contaminants from incoming water and can improve rinse efficiency and reduce sludge volume in wastewater treatment systems.

Recovering Metal from Bath Rinses

Recovered metals can be used in two ways: (1) recovered metal salts can be recirculated back into process baths, and (2) recovered elemental metals can be sold to a metals reclaimer. Metal recovery is made much easier if rinse streams are segregated. Many metal recovery techniques are available, including evaporation, reverse osmosis, liquid membranes, ion exchange, electrolytic recovery, electrodialysis, and high surface area electrowinning/electrorefining. The method deemed most appropriate will depend on the facility's particular economic and technical circumstances.

Etching

Etching processes can result in high chemical concentrations in rinsewater. Circuit board manufacturers have achieved reductions in etchant wastes using the following techniques:

- Using thinner copper foil to clad laminated boards reduces the amount of copper that must be etched away to complete the desired circuit pattern.
- Pattern plating requires copper electroplating only the holes and circuitry, whereas panel plating electroplates the entire board, which increases the amount of copper that must be subsequently etched away.

- Using the additive method as opposed to the subtractive method to eliminate the need for copper etching.
- Using nonchrome etchants such as ferric chloride or ammonium sulfide to reduce waste toxicity.
- Recycling spent etchants.

Pollution Prevention Successes

Advanced Quick Circuits (AQC) of Melbourne, Florida, implemented a number of pollution prevention actions including process modifications, drag-out prevention techniques, better work habits, and addition of an ion exchange unit to recover metals from and reuse rinsewater. Prior to taking these pollution prevention steps, AQC produced over 300,000 gallons of wastewater per day. Because of this large volume of wastewater, the local POTW advised AQC that it would either have to reduce its wastewater discharges by 20 percent or meet a much lower copper concentration limit of 0.5 mg/l. After investigating various treatment options, AQC decided on the above pollution prevention actions. In a matter of months, AQC had reduced its wastewater discharges to 114,000 gallons per day with copper concentrations of only 0.088 mg/l (PPIC, 1992).

Teradyne Connection Systems of Nashua, New Hampshire, has reduced toxic discharges dramatically through pollution prevention. After monitoring compliance data from the waste treatment effluent with respect to copper concentration, it became evident that Teradyne's pretreatment system was incapable of consistently meeting pretreatment standards for copper. To reduce the hydraulic loading on the wastewater treatment system, noncontact cooling water and scrubbing water were eliminated by installing closed loop systems. Equipment wash-downs also were reduced 80 percent by installing automatic shutoffs on the wash-down hoses and devising and implementing strict water conservation specifications. In addition, to reduce the water flow rate supplying the process equipment, rinsing specifications were determined and flow restrictors were installed. Electronic controls also were installed to shut down the water flow to production equipment when unattended. The facility also installed an ion exchange/electrolytic system to recover metals from one of the rinsewater systems.

As a result of these actions, process-water flow rates were reduced approximately 40 percent. The flow rate reduction was successful in increasing the effectiveness of the treatment system, resulting in a copper removal efficiency of 99 percent. Wastewater generation has fallen from 346 gallons per minute (gpm) to 106 gpm. At the same time the quantity of metal hydroxide sludge generated at the facility has fallen from 410,000 lb to 101,675 lb annually (PPIC, 1992).

For Further Information

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U.S. EPA. 1990. U.S. Environmental Protection Agency. Guides to pollution prevention: the printed circuit board manufacturing industry. Washington, DC: Office of Research and Development. EPA/625/7-90/007. NTIS PB90-256413.

Pollution Prevention Summary:

Selected Hospital Waste Streams

Facility Description

Hospital facilities generate many varied waste streams from unrelated processes that are ultimately discharged to the sewer system. POTWs usually grant permission to discharge noninfectious, nonhazardous wastes. A general surgical hospital has the following types of in-house departments: dialysis, pathology, histology, analytical laboratory, clinical laboratory, respiratory therapy, autopsy, radiology, housekeeping, engineering, and facilities management. Many of these departments produce toxic wastes that are discharged to sewers.

The dialysis department of a hospital can produce substantial quantities of formaldehyde waste, which is discharged to the sewer system. Formaldehyde is generally purchased as a 37 percent formaldehyde in water solution (formalin) for use in dialysis and is then diluted with deionized water to obtain a formaldehyde concentration of 2 to 4 percent. This is pumped into dialysis machines to disinfect membranes, and the effluent is discharged to the sewer. The pathology, histology, laboratory, respiratory therapy, and autopsy departments generate primarily solvent and formaldehyde wastes. Solvents are used in tissue processing, and formaldehyde is used to preserve specimens that produce small amounts of waste discharged directly to the sewer.

In general, most full-service hospitals have radiology departments. The photographic developing solutions used to produce X-rays consist of a fixer and a developer. The remaining aqueous waste from the fixing and developing solution used by the X-ray process and discharged to the sewer after silver recovery consists of approximately 1.4 percent glutaraldehyde, 0.3 percent hydroquinone, 0.2 percent potassium hydroxide, and trace amounts of silver. The housekeeping, engineering, and facilities management departments of any hospital will use oxidizers and caustics, usually in small quantities for cleaning and maintenance.

Waste Streams

General surgical hospitals differ from industrial facilities in that they produce relatively small volumes of wastes while producing a wide range of waste streams. The variety of waste generated is a result of the use of potentially toxic and hazardous materials in hospital facilities for numerous diagnostic and treatment purposes, in addition to using the cleaning and maintenance chemicals essential for maintaining a sanitary environment.

Table B-15 lists hospital waste solutions, their source within the facility, and their constituents.

Pollution Prevention Options

Better operating practices and simple management practices consist of proven procedures, which can be implemented at low cost, to reduce waste streams. These procedures include improved management oversight, tracking, and inventory control of potentially toxic chemicals.

Better operating practices include keeping different waste streams segregated. This ensures hazardous waste will not contaminate nonhazardous waste, recyclable waste will be kept separate from nonrecyclable waste, and toxic chemical waste will be segregated from infectious wastes. To achieve this waste segregation, waste containers should be clearly marked.

Good management and control practices include centralizing purchasing and dispensing of chemicals; monitoring chemical flows throughout the hospital from receipt to disposal; improving inventory control by using existing stock before ordering new chemicals and ordering chemicals in limited quantities to prevent waste due to expired materials; and implementing and encouraging waste reduction throughout the entire facility. If chemicals must be purchased in bulk, an inexpensive way to minimize possible waste generation due to bad batches is to demand that they be tested in small quantities to ensure that large amounts of imperfect chemicals will not require disposal. Recycling also should be encouraged as much as possible.

Inexpensive waste reduction strategies for formaldehyde waste include reducing the strength of formaldehyde solutions, minimizing wastes from cleaning of dialysis machines and RO units, and investigating the possibility of reusing waste formaldehyde in pathology and autopsy laboratories. To reduce or eliminate solvent wastes, solvents may be replaced by less-toxic cleaning agents. Photographic chemical waste can be reduced by ensuring developer and fixer tanks are adequately covered to reduce evaporation and oxidation, by using squeegees to

Table B-15. Selected Waste Streams from Hospitals

Waste Description	Source of Waste	Composition
Formaldehyde	Dialysis, pathology, autopsy	Waste discharged to sewer contains between 4 and 10 percent formaldehyde
Solvents	Respiratory therapy and pathology laboratories	Alcohol, acetone, xylene, residual heavy metals
Photographic chemicals	X-ray	Fixer and developer solutions. Aqueous waste contains glutaraldehyde, hydroquinone, silver, and potassium hydroxide
Disinfecting cleaning solutions	Scrubbing floors, other applications	Phenolic compounds, zinc, copper
Laundry wastes	Laundry	Phosphorus-based detergents, chemicals
Radioactive wastes	Clinical chemistry, nuclear medicine	Radioactive isotopes
Utility wastes	Heating and cooling	Boiler/cooling tower feedwater treatment residuals (resin regeneration brine, spent resin), boiler/cooling tower cleaning wastes
Maintenance wastes	Maintenance	Oils, cleaning solvents, paint stripping wastes, leftover paints, painting accessories, and incinerator residuals

reduce chemical carryover from one solution bath to the next, and by recycling waste film and paper.

Another highly effective, low-cost approach to reducing waste entering the sewer system is to conduct a facility-wide analysis of all floor drains to determine if they are necessary, and then seal drains deemed unnecessary or drains where the potential for slug loading is high. All necessary drains should be beveled or bermed to prevent accidental spills from entering the sewer system.

Silver Recovery

The wastewaters from photoprocessing contain silver that can be recovered at a reasonable cost. Methods for recovering silver include metallic replacement, chemical precipitation, and electrolytic recovery. Silver recovery equipment is available for even the smallest generator. Metallic replacement is the most widely used silver recovery process employed by hospital facilities and is the least expensive of the available silver recovery technologies. Recovered silver is worth approximately 80 percent of its market value. One advantage of using silver reclaimers on photoprocessors at a hospital rather than having wastewater processed by an outside company is that this eliminates the need for onsite storage of chemical waste and so reduces the risk of accidental spillage.

Choice of Clinical Chemistry Analyzer

Some clinical chemistry analyzers used in hospital laboratories produce large quantities of liquid chemical waste. This waste is usually diluted with large quantities of water and then discharged to the sewer system. However, clinical chemistry analyzers exist that produce no toxic liquid chemical wastes and so eliminate these discharges. This kind of chemistry analyzer uses nontoxic liquid solutions, and the resulting chemical waste may be disposed of at commercial biomedical waste-handling facilities.

Install RO Water Supply Equipment

Formaldehyde waste is generated primarily through the cleaning of dialysis equipment. The use of RO units reduces the number of times dialysis equipment must be cleaned and so reduces the resulting waste stream. In addition, RO machines, although usually cleaned with formalin, may be cleaned with hydrogen peroxide, which is less persistent in the environment.

Recycling Solvents

Recovery of waste solvents may be feasible using onsite distillation equipment. Separating different chemical waste streams enhances the feasibility of recycling solvents, because this allows the use of less-expensive, simple batch distillation equipment rather than fractional distillation equipment. Solvent recycling systems are available that suit the specific needs of hospitals. One such unit consists of a fractional distillation system equipped with a microprocessor to automatically distill, fractionate, and purify a solvent.

Pollution Prevention Successes

St. Mary's Regional Medical Center in South Portland, Maine, has derived many environmental and economic benefits from implementing a pollution prevention and waste reduction policy. St. Mary's housekeeping department adopted a new disinfecting floor tool, to replace conventional wet mops, buckets, and wringers, that produces virtually no waste. All of the cleaning solutions prepared are used and there are no spent

solutions to discharge to the sewer system. The result of using this cleaning device has been a 75 percent reduction in chemical usage in the housekeeping department, and an estimated savings in labor costs of 25 percent. Additionally, the cost and volume associated with laundering the new floor tools is one fifth of that associated with laundering conventional wet mops.

St. Mary's laundry department has relocated bulk chemical storage to a section of the hospital with no floor drains, to reduce slug loading potential, and has switched chemical vendors, chemicals, and procedures on chemical usage to help reduce pH levels in its wastewater. These efforts have been successful given that pH levels now average between 8.5 and 8.7, whereas they had been consistently over 10.5. In addition, this facility has changed its clinical chemistry analyzer with a resultant 100 percent reduction in liquid chemical waste discharged to the sanitary sewer system. The original chemistry analyzer generated 20 gallons of liquid chemical waste on a weekly basis, whereas the replacement does not generate any.

A 1988 study of a San Francisco Bay Area hospital commissioned by the California Department of Health Services (Calif. DHS, 1988) discovered the following pollution prevention measures had been implemented at that facility. Hazardous materials are procured in two central areas—the materials management department and the pharmacy—and the hospital uses a computerized inventory system to track the use and disposal of these compounds throughout the hospital. A product evaluation committee was established to review product toxicity and investigate the potential for using less-toxic substances in the hospital. The review resulted in the substitution of disinfectants containing glutaraldehyde with an alcohol compound formulated in a nonflammable water mixture. The facility has developed a unique approach for disposing of obsolete or expired supplies. Any drugs that are unusable because their potency limit is below that required by U.S. law, but that still have a high degree of potency, are shipped to Third World countries where such drugs are scarce. Finally, laboratory waste quantities have decreased due to recent automation of equipment and reduction in the quantity of analytes and reagents used for analysis. The laboratory also has taken steps to completely eliminate highly toxic chemicals. These steps include substituting xylene for benzene and eliminating the use of ether completely.

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